MPSC 2019

Maharashtra Public Service Commission

Assistant Engineer Examination

Civil Engineering

Computer Aided Design and Design of Structures

Well Illustrated **Theory** *with*
Solved Examples and **Practice Questions**

MADE EASY Publications

Computer Aided Design and Design of Structures

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AutoCAD

1.1 Introduction

1.1.1 Computer aided drafting

Like manual drawing equipments, the computer aided drawing or drafting techniques requires the following computer hardware and software to draw engineering drawing. The personal computer with high graphic resolution monitor and few additional peripherals are used to prepare engineering drawings.

1.1.2 Computer Hardware for CAD

Processor : Intel core i5 – 750 processor and above

RAM : 6 GB or more

Display : 17″ wide screen monitor

**Input devices :** Standard keyboard/Mouse

Output devices : Penplotter (color) or inject plotter (color or Black & White).

Storage devices : Hard disk drive (HDD) 500 GB storage capacity or more 16 × DVD RW Drive

1.1.3 Computer Software requirement

There are many software available for computer aided drafting. In our discussion, the widely used CAD software AUTO CAD 2000 is considered.

- The computer and the peripherals (Mouse, Plotter, CD–ROM etc.) with the required CAD Software are arranged conveniently to execute computer aided design and the drafting is called as CAD workstation.
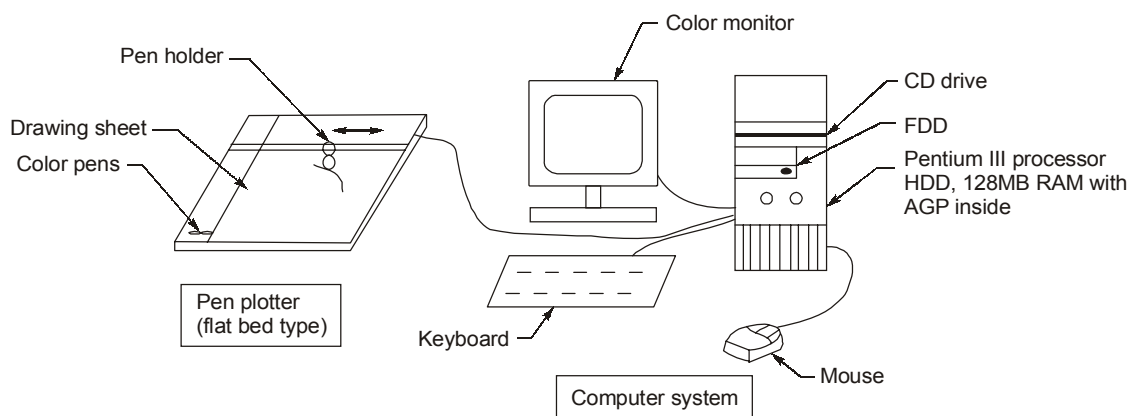
- The rules to be followed to prepare the drawing in CAD are similar to the method followed in manual drawing. The major difference is that a CAD workstation is used for the drawing purpose, replacing the manual drawing equipment.

1.2   Display Technology

The efficient use computer system for graphical application is largely depending on the display devices used. Most of the latest computers use the monitor which is a Cathode Ray Tube (CRT).

Following display devices are used in computer graphics applications.

(i)   Raster Scan Monitor

(ii)   LCD Monitor

(iii)   Plasma Panel Display

In these types, plasma panel display and LCD (liquid crystal display) are not commonly available in personal computer. The raster scan color monitor is widely used and is discussed here.

Raster Scan Monitor : The commonly used monitor is raster scan monitor. The CRT has an electron gun which emits electron beam and is directed to strike on a phosphor coated screen. There is a bright spot produced as result of the beam and is called as a pixel. The beam is deflected to produce many such pixels/dots on the screen from top to bottom. The intensity of the pixels are increased to produce a graphical image on screen. In order to maintain the image on the screen, the beam is again deflected from top to bottom and is repeated at the rate of 50 to 60 frames per second to display the picture without any flickering and is called as refresh the monitor.
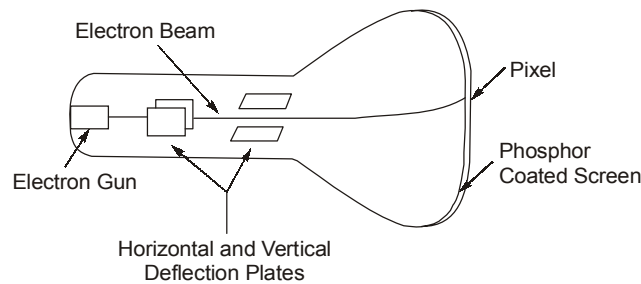
Fig. Cathode ray tube
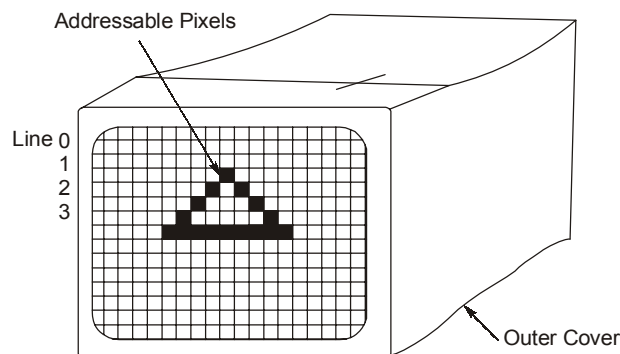
Fig. A triangle displayed using raster scan monitor

RGB Color Monitor : A shadow mask method is widely used to produced colors in monitors. In this method, the phosphor coating for a pixel is made of three tiny dots, one emits red, another emits green, and the

third emits blue light when the electron beams strike them. Different colors are generated using the phosphor coating and the intensity of the electron beam through a shadow mask grid. It uses three electrons guns, one for red, another for green and the third for blue and is called as RGB monitor.

Following technical details are considered in selection of a monitor for graphical applications.

- Number of pixels are displayed on the monitor screen horizontally as well as vertically and is called as resolution of a monitor. High resolution monitors are used to display a smooth picture. The latest raster scan monitors have resolution of the order 640×480 to 1040×1040 or more.
- Each pixel displayed has an address which can be assigned a value. A single bit value is assigned to a pixel in black & white monitor which has the status 0(black) or 1(white). But in color monitor each pixel has been assigned a 4 bits ($2^4 = 16$ colors) or 8 bits ($2^8 = 256$ colors) values.
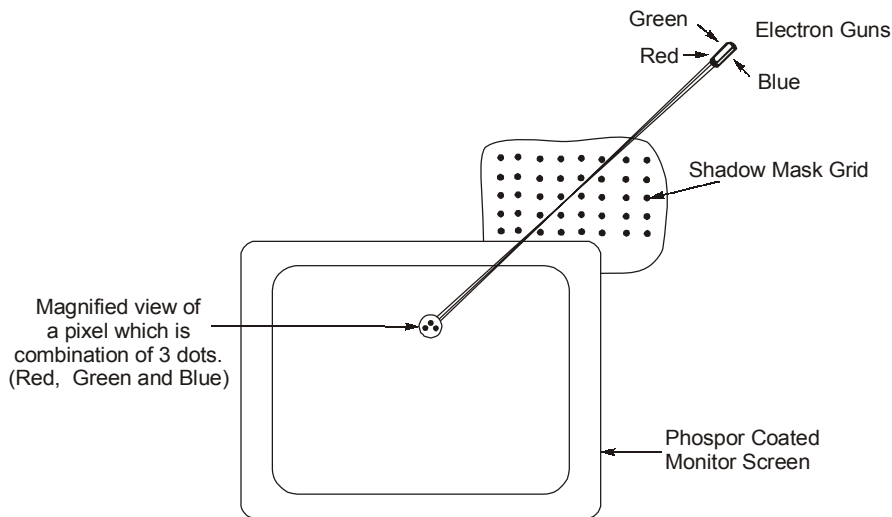

Fig. RGB colour monitor

- The information about the status of the pixels are stored in a digital frame buffer (display memory) to generate the picture on the screen.
- When the monitor resolution is low the inclined line will not be displayed smooth and is displayed in staircasing effect.
- The ratio of number pixels needed to display equal length lines in horizontal and vertical direction on the screen is called as aspect ratio.
- In order to refresh the screen faster, the even numbered lines are scanned first then the odd numbered lines are scanned and is called as interlacing. Non–interlaced monitors are used for computer aided design which used the application of computer graphics. Interlaced monitors are suitable for computer graphics applications.

1.3 Introduction to Design and Drafting

The term *Computer Aided Design* (CAD) refers to the design of an object using the three features :

- Geometric modelling
- Computer graphics
- Design tools (analysis, codes, etc.).

Any CAD work is executed with the help of the computer with necessary hardware (*CPU, Monitor, Mouse, Keyboard, etc.*) and software (*graphics and modelling programs*).

A geometric model is a graphical representation of an object, using the mathematical database in the computer. There are three type of geometric modelling techniques used namely, wireframe modeling, surface modelling and solid modelling. The term modelling always refers to 3D representation of an object.

Wireframe Model

A wireframe model is the simplest geometric modelling type, where an object is described by points, lines, circles and curves in 3D representation.
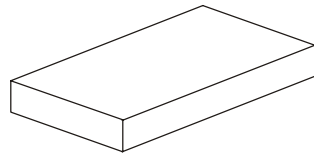
Surface Model

A surface model is similar to wireframe model where an object is described by surface entities such as B–spline surface, Bezier patches, coons patches, ferguson surface, etc.
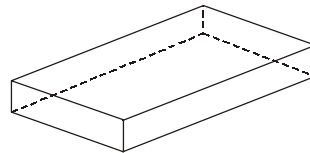
Solid Model

A solid model is a complete representation of a surface model, where the object is described by the solid entities such as block, cylinder, cone, sphere, wedge, torus, etc. It always appears as a solid to the viewer.

A solid model will have the necessary physical material properties such as mass, density, and other design data related with an object. A solid model can also be compared with an actual or existing object. It can be rotated easily to visualise the object in the software market. The commonly used solid modelling software are – PRO/ENGINEER, IDEAS, CATIA, UNIGRAPHICS, SOLIDWORKS, IRONCAD, MECHANICAL DESK TOP (MDT), etc.

Wire frame model
(hidden lines removed)

Solid model
(A surface model appears like this but does not have physical properties)

Modelling and Drafting

All the modelling softwares available in the software market have the capabilities of producing 2D drafting and sectional view in all ways. There are also dedicated 2D drafting softwares available in the software market but, are not commonly used now–a–days.

1.4   Computer aided Drafting Using Auto CAD

Auto CAD is one the 2D drafting and 3D modelling software commonly used in engineering practices. It is a powerful drafting tool that has the flexible features for creation of drawings, editing and plotting. Following are few application areas of computer aided drafting:

(i)   Preparation of 2D and 3D machine component drawings.

(ii)   Preparation of building drawings.

(iii)   Preparation of Graphs using mathematical data.

(iv)   Interior design and viewing.

(v)   Preparation of company logo and presentation.

(vi)   Preparation of work flowcharts, maps, layouts, etc.

After the release of Auto CAD, the latest version Auto CAD 2010 is released by Autodesk, Inc, USA software and its updations.

1.5   Auto CAD Commands

1.5.1   Line Command

The LINE command is used to draw a line, the line drawn may be continued with the same command and it is terminated by pressing ENTER key or right mouse bottom. Then select ENTER. The execution of LINE command is given as follows.

Command : Line or L

Specify first point : Select any point in the drawing area on the screen using left mouse button.

Specify next point or [undo] : Select second point using mouse.

Specify next point or [undo] : Select third point using mouse.

Specify next point or [close/undo] : C to close the lines.

The drawing seen on the screen is a triangle of arbitrary size. To prepare the correct dimensional engineering drawings, the Coordinate systems followed in Auto CAD is used.

1.5.2   ERASE Command

The ERASE command is used to erase objects which are drawn earlier. Select the objects to be erased one by one, or select them in a window by picking the lower left corner and upper right corner using the mouse.

Command : ERASE

Select objects : *Select the objects to erase mouse or in window.*

Select objects : *Press ENTER to remove the selected objects.*

1.5.3   UNDO Command or U Command :

The UNDO command is used to undo the operations which are previously executed. Command : UNDO or U.

1.5.4   REDO Command

The REDO command is used to REDO the operation immediately following the UNDO command, if necessary.

Command : REDO

1.5.5   Zoom Command or Z command

The ZOOM command is used to enlarge or reduce the size of the object on the screen. Note that the actual size of the object, remains unchanged.

Command : ZOOM or Z

Specify corner of window, enter a scale factor (nX or nXP), or

[All/Center/Dynamic/Extents/Previous/Scale/Window] <real time>:

Specify the window to zoom by picking the lower left corner and upper right corner using mouse.

1.5.6   MOVE Command

The MOVE command is used to move the object from the present position to a new location.
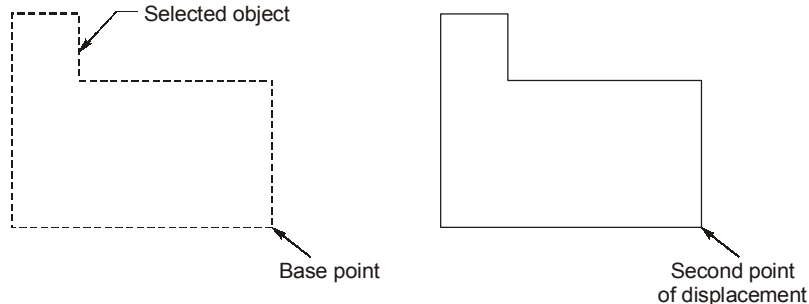
Command : MOVE

Select objects : Select the objects to move individually or in a window using mouse.

Select objects : Press *ENTER* to complete the selection.

Select base point or displacement : Select any point as a base point to move the object.

Specify second point of displacement : Select the new location for the base point.

Consider the following illustration to move the object. The object in the original position will be removed.

Fig. Moving an object using MOVE command

1.5.7 COPY Command

The COPY command is used to copy the existing objects, to a new location. Multiple copies can also be made by selecting multiple option M in this command.
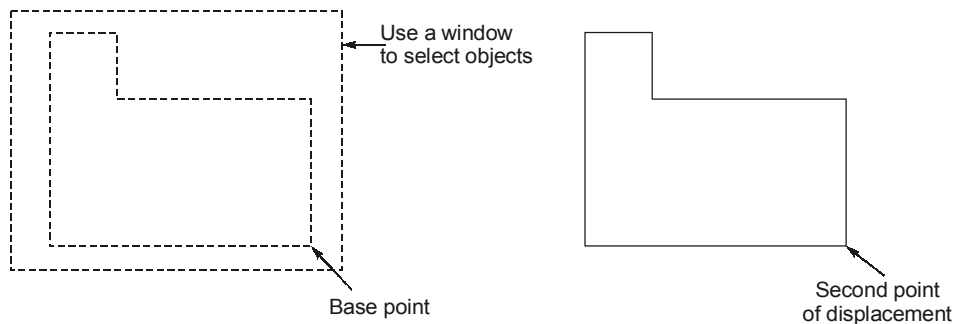
Command : COPY

Select objects : Selects objects to copy individually or in a window using the mouse.

Select objects : Press ENTER to complete the selection.

Select base point or displacement, or [Multiple] : Select any point as base point.

Select base second point or displacement : Select the new location for base point.

Consider the following illustration to copy the object. The object in the original position is retained.

Fig. Copying an object using COPY command

1.5.8 SAVE Command

The SAVE command is used to store the prepared drawing in the hard disk or floppy disk using a file name. AutoCAD will wait for the user to enter the file name to store the drawing through the displayed dialog box.

Command : SAVE

1.5.9 QUIT Command

The QUIT command is used to end the AutoCAD session to exit.

Command : QUIT

1.5.10 ORTHO Command

The ORTHO Command is used to help the user to draw horizontal and vertical lines.

<div align="center">

Command : ORTHO

N/OFF (off) : ON, Press *ENTER*

</div>

1.5.11 LIMITS Command

The LIMITS Command is used to set up new limits for your new drawing considering the drawing sheet size.

Command : LIMITS

Specify left corner [ON/OFF] <current> : 0, 0

Specify upper right corner <current> : 210, 297

<div align="center">

Command : ZOOM

</div>

[All/Centre/Dynamic/Extents/Previous/Scale/Window] <real time> : All

1.5.12 PLINE command or PL command

The PLINE Command is used to draw polyline segments and is similar to LINE command except some added features to change the line width, etc.

<div align="center">

Command : PLINE or PL

</div>

Specify the start point : *Select the starting point using mouse*

Current line width is 0.0000

Specify next point of [Arc/Close/Half width/ Length/undo/width] : Select the second point using mouse

Specify next point or [Arc/Close/Half width/Length/undo/width] : Select the third point using mouse

Specify next point or [Arc/Close/Half width/Length/undo/width] : Press ENTER to complete the drawing.

1.5.13 BHATCH Command

The BHATCH (boundary hatch) command is used to draw hatching lines in a closed region enclosed within a boundary by selecting a point inside the region.

<div align="center">

Command : BHATCH

</div>

Select the hatch pattern, scale, angle etc. through a dialog box and select [ok] to apply the hatching inside the specified boundary.

1.5.14 OFFSET Command

The OFFSET Command is used to draw parallel lines, arcs, concentric circles etc to the specified distance.
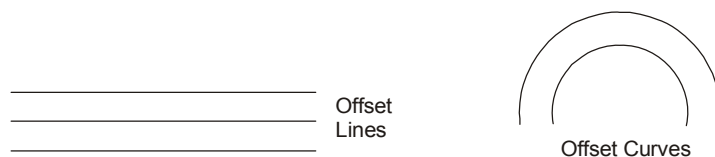
<div align="center">

Command : OFFSET

</div>

Specify offset distance or [Through] <Through> : Enter the distance using keyboard

Select object to offset or <exit> : Select object to offset using mouse.

Specify point on side to offset : Specify the side for offsetting using mouse.

Select object to offset or <exit> : Press *ENTER* to Complete the command.

Offset
Lines

Offset Curves

Fig. Offset an object