

# MPSC

# 2023

## **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**



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# Computer Aided Design and Design of Structures

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# AutoCAD

## 1.1 Introduction

### 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.

### 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

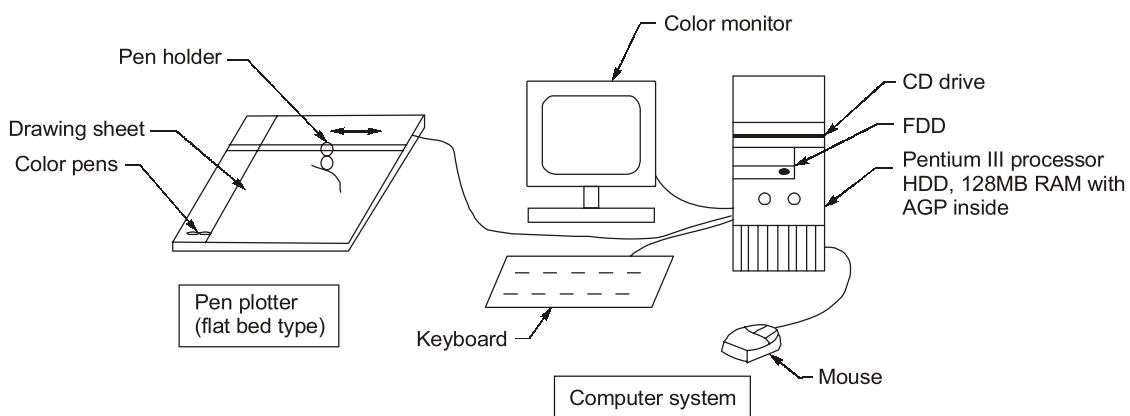
**Output devices :** Penplotter (color) or inject plotter (color or Black & White).

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

### 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

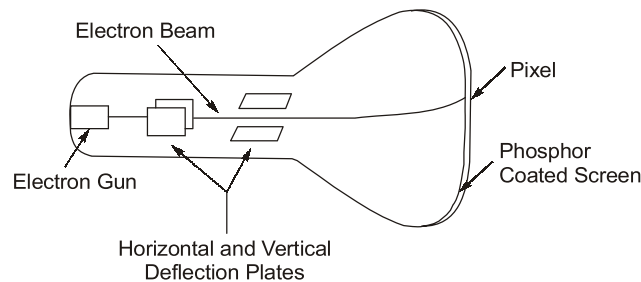
The efficient use computer system for graphical application is largely depending on the display devices used. Most of the latest computers use the monitor which is a Cathode Ray Tube (CRT).

Following display devices are used in computer graphics applications.

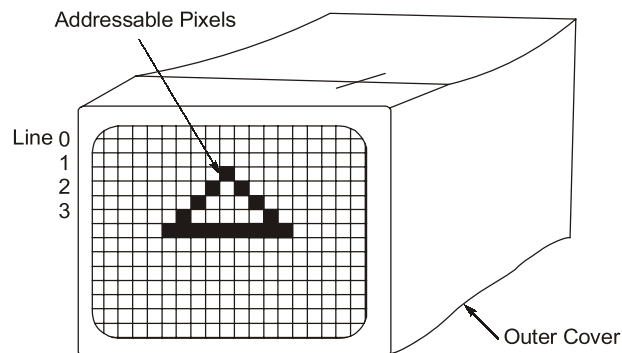
- Raster Scan Monitor
- LCD Monitor
- Plasma Panel Display

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**



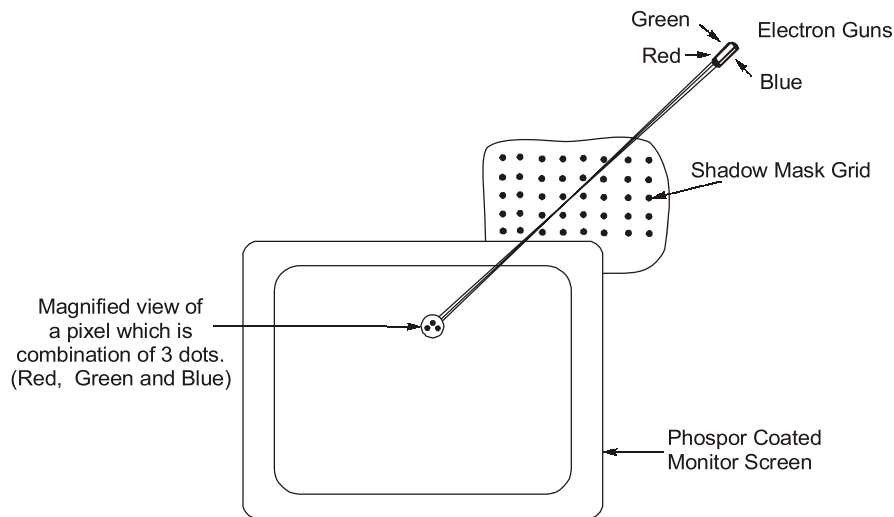
**Fig. A triangle displayed using raster scan monitor**

**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 electron 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  $640 \times 480$  to  $1040 \times 1040$  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.

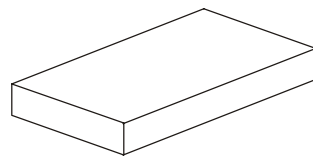
### Surface Model

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.

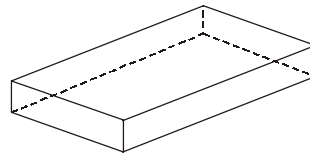
### Solid Model

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

### 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 button. 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.

### 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.*

### UNDO Command or U Command :

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

### REDO Command

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

**Command : REDO**

### 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.

### 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.

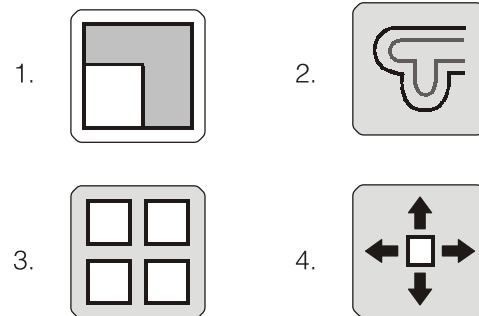
Select objects : Press *ENTER* to complete the selection.

**STUDENT'S ASSIGNMENTS**

- Q.1** In Auto CAD coordinates for the current position of crosshair of the cursor is seen in  
(a) menu bar  
(b) standard tool bar  
(c) properties toolbar  
(d) status bar
- Q.2** A line drawn in Auto CAD by specifying the first point as (2,7) and second point is specified by @ 6 < 20. The length of the line will be  
(a) 2 units  
(b) 7 units  
(c) 6 units  
(d) 20 units
- Q.3** "Tan-Tan-Tan" command is used in the CAD for the drawing of  
(a) Line  
(b) Ellipse  
(c) Circle  
(d) Both ((b) and (c))
- Q.4** 2-points option is used to draw circles by specifying the  
(a) two end points of a diameter  
(b) two end points of a radius  
(c) radius and tangent to two objects  
(d) center and two end points of a chord
- Q.5** How many points do you need to define for the Rectangle command?  
(a) four  
(b) one  
(c) two  
(d) three
- Q.6** Polar coordinates are used mostly for drawing  
(a) circles  
(b) arc  
(c) vertical lines  
(d) lines in particular angular direction
- Q.7** In Auto CAD which one of the following is not a valid option for drawing a circle?  
(a) 3 points method  
(b) Tan-Tan center method  
(c) Tan-Tan -Radius method  
(d) Tan-Tan-Tan method
- Q.8** Different command used in AUTOCAD are mentioned in list 1 and their symbols are mentioned in list 2. Match list-1 with list-2 and choose the correct answer.

**List-1**

- A. Move command
- B. Scale command
- C. Rectangular array
- D. Offset

**List-2**

- (a) A-1, B-4, C-3, D-2
- (b) A-1, B-2, C-3, D-4
- (c) A-4, B-3, C-2, D-1
- (d) A-4, B-1, C-3, D-2

- Q.9** Different modes used in AUTOCAD are mentioned in list-1 and when these modes are turned on then their effect is mentioned in list-2. Match list-1 with list-2 and choose the correct answer.

**List-1**

- A. ORTHO MODE
- B. OSNAP MODE
- C. DYN MODE
- D. LWDISPLAY MODE

**List-2**

- 1. Display line weights
  - 2. Dynamic input features
  - 3. Provides a way to specify precise location on object
  - 4. Constrains cursor movement to the perpendicular
- (a) A-1, B-4, C-3, D-2
  - (b) A-1, B-2, C-3, D-4
  - (c) A-4, B-3, C-2, D-1
  - (d) A-4, B-1, C-3, D-2

- Q.10** To move an object six units along positive x axis of UCS, what would be the second point of displacement  
(a) @6, 0  
(b) @6 < 0  
(c) Both (a) and (b)  
(d) Neither (a) nor (b)



- Q.25** Which mode allow the user to draw 90° straight lines:  
 (a) 0 snap (b) ortho  
 (c) linear (d) polar tracking
- Q.26** Which of the following is incorrect statement?  
 (a) Chamfer command is used to bevel the edges  
 (b) Fillet command is used to round the corners  
 (c) Array command is used to draw multiple copies  
 (d) Scale command is used to draw plan scales
- Q.27** The fillet command creates  
 (a) Sharp corners (b) Round corners  
 (c) Angled corners (d) Smooth corners
- Q.28** Polar coordinates are used mostly for drawing:  
 (a) Circles (b) Arcs  
 (c) Vertical lines (d) Angled lines
- Q.29** Units command of Auto CAD is not used to set:  
 (a) units for linear measurement  
 (b) units for angular measurement  
 (c) units of drawing  
 (d) direction in which angle is to be measured
- Q.30** What does WCS stand for?  
 (a) Western CAD system  
 (b) Worldwide coordinate factors  
 (c) World coordinate system  
 (d) Wrong CAD setting
- Q.31** Which one is not a valid option of units command?  
 (a) Architectural (b) Decimal  
 (c) Meter (d) Metric
- Q.32** To move something six units to the right, what would be the 2nd point of displacement?  
 (a) @ 6, 0 (b) @ 6 < 0  
 (c) Both 1 and 2 (d) Neither 1 nor 2
- Q.33** Snap command is used to regulate the cursor movement to the specified increments along  
 (a) vertical axis  
 (b) horizontal axis  
 (c) cartesian coordinates  
 (d) polar angles
- Q.34** The number of points needed to draw a line using absolute coordinate is  
 (a) none (b) one  
 (c) two (d) four
- Q.35** Scaling objects makes them  
 (a) bigger  
 (b) smaller  
 (c) It only stretches them  
 (d) Both bigger and smaller

**ANSWER KEY**

**STUDENT'S  
ASSIGNMENTS**

- |                |                |                |                |                |
|----------------|----------------|----------------|----------------|----------------|
| <b>1. (d)</b>  | <b>2. (c)</b>  | <b>3. (c)</b>  | <b>4. (a)</b>  | <b>5. (c)</b>  |
| <b>6. (d)</b>  | <b>7. (b)</b>  | <b>8. (d)</b>  | <b>9. (c)</b>  | <b>10. (c)</b> |
| <b>11. (d)</b> | <b>12. (d)</b> | <b>13. (c)</b> | <b>14. (b)</b> | <b>15. (a)</b> |
| <b>16. (b)</b> | <b>17. (a)</b> | <b>18. (a)</b> | <b>19. (d)</b> | <b>20. (c)</b> |
| <b>21. (c)</b> | <b>22. (a)</b> | <b>23. (d)</b> | <b>24. (d)</b> | <b>25. (b)</b> |
| <b>26. (d)</b> | <b>27. (b)</b> | <b>28. (d)</b> | <b>29. (c)</b> | <b>30. (c)</b> |
| <b>31. (c)</b> | <b>32. (c)</b> | <b>33. (c)</b> | <b>34. (c)</b> | <b>35. (d)</b> |

