**Introduction**

CAD is an abbreviation for Computer-Aided Design. It is the process used to design and draft components on your computer.

This process includes creating designs and drawings of the product or system. AutoCAD is a CAD software package developed and marketed

by Autodesk Inc.

It can be used to create two-dimensional (2D) and three-dimensional (3D) models of products.

AutoCAD is one of the first CAD software packages.

It was introduced in the year 1982.

It has become the industry leader among all CAD products.

It is the most widely used CAD software.

The commands and concepts introduced by AutoCAD are utilized by other systems.

**Starting AutoCAD 2016**

To start AutoCAD 2016, double-click the AutoCAD 2016 icon on your Desktop (or) click Start > All Programs > Autodesk > AutoCAD 2016 > AutoCAD 2016.



**Workspaces in AutoCAD**



**Drafting & Annotation Workspace**

This workspace has all the tools to create a 2D drawing.

**BASICS OF AUTOCAD**:

**Elements of Screen:**

* Application menu
* Quick access tool bar
* Info center
* Title Bar
* Menu bar
* Ribbon
* Tabs
* Panels
* Tools
* Drawing Area
* UCS Icon
* Command Bar
* Status Bar

**Types of Workspaces available in Auto CAD:**

* 2D Drafting & Annotation
* 3D Basics
* 3D Modeling
* AutoCAD Classic



**3D Basics and 3D Modeling Workspaces**

These workspaces are used to create 3D models.

**Auto CAD:**

* It is a technical software
* 2D- 2 dimensional

Y

X

2D

* 3D- 3 Dimensional

Y Z

X

**Some terms:**

* **AUTO:** Autodesk is a company name
* **CAD:** Computer Aided Designing
* **CADD:** Computer Aided Designing & Drafting
* **CAM:** Computer Aided Manufacturing
* **ECAD:** Electrical Computer Aided Designing

**Starting a new drawing**

Quick Access Toolbar

**Application Menu**

The **Select Template** dialog appears when you click the **New** button. In this dialog, selectthe **acad.dwt** (inch units) or **acadiso.dwt** (metric units) template for creating a 2Ddrawing. Select the **acad3D.dwt** or **acadiso3D.dwt** template for creating 3D models.

**UCSICON** (User Coordinate System):

To make UCS icon fix within the screen, the process is:-

UCSICON (Enter: )

Select No origin

* **Setting of Limits**--- **(**Shortcut: LIMITS)

LIMITS

Specify lower left corner value (0, 0)

Specify upper right corner value (x, y)

Z enter

A enter

**Note**: Z (Zoom), A (All) commands are for the purpose of following:

“To bring the limits to the screen”

* **Setting of Units**---(shortcut: UN)

UN

Select length type (for ex: Decimal)

Select precision value (0.00)

Select Insertion scale value (for ex: millimeters)

Select international

Ok

* **Pan**---(shortcut: P)

By using this, we can move the screen.

**Process:**

P

ESC

* **Line**--- (shortcut: L)
* Specify 1st point (click)
* Specify next point
* ESC

* **Circle**---( shortcut :C)

By using this, we can create circles

**Types:**

* Center radius
* Center diameter
* 2- point
* 3-point
* Tan Tan Radius
* Tan Tan Tan
* **Center radius:**

C

Specify center point for circle (click)

Specify radius of circle

* **Center diameter**:

C

Specify center point for circle

D

Give some diameter value

* **2- Point:**

C

2P

Specify 1st end point of circle’s diameter

Specify 2nd end point of circle’s diameter

* **3-Point:**

C

3P

Specify 1st point on circle

Specify 2nd point on circle

Specify 3rd point on circle

* **Tan Tan Radius**---( shortcut : Ttr)

C

TTR

Specify point on object for 1st tangent of circle

Specify point on object for 2nd tangent of circle

Specify radius of circle

* **Tan Tan Tan**

Click on Tan Tan Tan icon

Specify 1st point on circle

Specify 2nd point on circle

Specify 3rd point on circle

* **Arc**--- (shortcut: A)

It can be constructed by using any of the following characteristics of an arc.

* Its start point on the arc
* Second point- (its end point)
* Its radius- (Length of the arc)

Possible methods to construct an arc are:-

* 3 Point
* Start, center, end
* ,, , ,, , angle
* ,, , ,, , length
* ,, , end , angle
* ,, , ,, , direction
* ,, , ,, , Radius
* Center, start, end
* ,, , ,, , angle
* ,, , ,, , length
* Continue
* **Rectangle**---( shortcut : Rec)

By using this we can create rectangles.

**Process:**

Rec

Specify 1st corner point (click)

Specify other corner point (x, y)

Enter

**Polygon**

* **Polygon**----(shortcut: POL)

2 types.

1. Inscribed in circle

2. Circumscribed about circle

* **Inscribed in circle**

we can create a polygon with known distance (center of polygon to each vertex of polygon)

* **Circumscribed about circle**

we can create a polygon with known distance (center of polygon to midpoint of each edge of polygon)

.

**Process:**

Pol

Enter number of sides

Specify center of polygon (click)

Select any one option (Inscribed or circumscribed)

Specify radius of circle

**If we want to create polygon with known edge, Process**:

Pol

Enter number of sides

E (E: Edge)

Specify axis start point of polygon

Specify axis next point of polygon

Example



* **Ellipse**----(shortcut: EL)

**Process:**

EL

Specify axis endpoint of ellipse (click)

Specify other end point of axis

Specify distance to other axis

* **Xline (construction line)** ----(shortcut: XL)

By using this, we can create infinity horizontal, vertical and angular lines.

**Process:**

XL

A

Specify angle value (A: Angular)

Specify through point

ESC

* **Donut**-----(shortcut: DO)

By using this, we can create filled circles

**Process:**

Do

Specify inside diameter of donut

Specify outside diameter of donut

Specify center of donut

Esc

* **Ray**-----(shortcut: RAY)

It has starting point but don’t have end point.

**Process:**

Ray

Specify start point

Specify through point.

ESC

* **Spline**-----(shortcut: SPL)

By using this, we can create continuous lines and curves. It is used as path curve in the preparation of rod like structures in 3d.

**Process:**

Spl

Specify 1st point

Specify next point

* **Multi Line**-----(shortcut: ML)

**Process:**

ML

S

Enter mline scale

Specify start point

Specify next point

* **Break**-----(shortcut: Br)

By using this, we can divide a continuous line into multiple pieces

**Process:**

Br

Select object (specify 1st break point)

Specify 2nd break point

* **Wipe out**

**Process:**

Go to Annotate tab

Go to markup panel

Click on wipe out

Specify first point

Specify second point

* **Join**-----(shortcut: J)

By using this, we can combine multiple lines and make it into a polyline (continuous line)

**Process:**

J

Select total lines

* **Lengthen**-----(shortcut: Len)

**Process:**

Len

De (de: delta)

Enter delta length

Select an object to change

ESC

Editing Tools

The Move tool

The Copy tool

The Rotate tool

The Scale tool

The Trim tool

The Extend tool

The Fillet tool

The Chamfer tool

The Mirror tool

The Explode tool

The Stretch tool

The Polar Array tool

The Path Array tool

The Rectangular Array tool

The offset tool

**Move ; (shortcut M )**

**M**

Select object

Enter

Select the center of the circle as the base point.

Move the pointer toward right and pick a point .

This moves the circle to the new location.

**Copy ;(shortcut CO )**

Co

Select object

Enter

Select the center of the circle as the base point.

Move the pointer toward right.

**Rotate**

**Ro**

Select object

then right-click to accept.

Select the center of the other circle as the base point.

Select the **Copy** option from the command line.

Type -90 as the rotation angle and press ENTER

**Scale; ( SC)**

Sc

Select the circles. and right-click to accept the selection

Select the center point of the selected circles as the base point.

Type 0.8 as the scale factor and press ENTER.

* **Trim**---(shortcut: TR)

By using this we can remove the extended lines or any unwanted curves or arcs.

**Process:**

TR

Select object to trim

ESC

* **Extend**---(shortcut: EX)

By using this we can increase the length of the line.

**Process:**

EX

Select the object to extend

ESC

* **Offset**---(shortcut: O)

By using this, we can create number of duplicate objects with some offset distance.

**Process:**

O

Specify offset distance

Select object to offset

Specify point on side to offset

ESC

EX

* **Mirror**---(shortcut: Mi)

By using this, we can create mirror image of the source object

**Process:**

Mi

Select object

Specify 1st point of mirror line Source object Mirror image

Specify 2nd point of mirror line

Erase source objects (yes/no)

* **Fillet**---(shortcut: F)

By using this we can create rounded corners

**Process:**

F

R

Specify fillet radius

P (P: Polyline)

Select 2d object

* **Chamfer**---(shortcut: Cha)

By using this we can create inclined corners

**Process:**

Cha

D (D: Distance)

Specify first chamfer distance

Specify second chamfer distance

P (P: Polyline)

Select 2D polyline (select object)

* **Explode**---(shortcut: X)

By using this, we can divide the single object into number of object

**Process:**

X

Select object

* **Erase**---(shortcut: E)

By using this, we can delete the objects.

**Process:**

E

Select object

**Basic View Commands:**

* **Zoom**---(shortcut: Z)

By using this, we can zoom in or zoom out the objects

The options in zoom are the following:

* All---------------------(A)
* Center----------------(C)
* Dynamic-------------(D)
* Extents---------------(E)
* Previous--------------(P)
* Scale------------------(S)
* Window-------------(W)
* Object----------------(O)
* **Array**----(shortcut: ar)

3 types

* Rectangular array
* Polar array
* Path array
* **Rectangular array**

**Process:**

Ar

Select object

Select rectangular array

Edit number of columns and distance between columns

Edit number of rows and distance between rows

* **Note:**

In associative array, you have an option for modification. In non associative, we don’t have an option for modification.

* **Polar array**

**Process:**

Ar

Select object

Select polar array

Specify center point of array

Edit number of items and fill angle

Edit number of rows and distance between rows

* **Path array**

**Process:**

Ar

Select object

Select path array

Select path curve

Click on base point

Specify base point (on the source object)

Edit number of items and distance between items

Edit number of rows and distance between rows

**Hatch Patterns**

* **Hatch**----(shortcut: H)

By using this, we can apply different patterns like Brick pattern, sand, concrete, clay, gravel etc. within the closed boundary. And we can apply solid and gradient fills also.

**Process:**

H

T (T: setting)

Go to hatch tab

Go to pattern

Select required pattern

Ok

Edit scale and angle values

Click on add pick points

Pick internal points (Click on the object)

* **Gap tolerance**

To apply hatch for open boundaries, we have to give some gap tolerance value.

**Process:**

H

Go to options panel

In drop down list, give some gap tolerance value

Pick internal points (Click on the object)

Click on ‘continue hatching this area’

* **Dimensions**
* Linear dimensions (dli)
* Aligned dimensions (dal)
* Radius dimensions (dra)
* Diameter dimensions (ddi)
* Angular dimensions (dan)
* Continuous dimensions (dco)
* Baseline dimensions (dba)
* Leader and multi leader dimensions (lead)
* Arc length dimensions (dar)
* Ordinate dimensions (dor)
* Jogged dimensions (djo)
* **DDEDIT**

By using this, we can enter or modify the dimension text.

**Process:**

DDEDIT

Select an annotation object

Edit text

ESC

YES

**Note: D** or **DDIM** are the shortcuts for dimension style manager.

* **Dimension font:**

**Process:**

D

Go to modify

Go to text tab

Text height option

* **Dimension arrow heads**

**Process:**

D

Go to modify

Go to symbols and arrows tab

Arrow size option

* **Dimension overall size**

**Process:**

D

Go to modify

Go to fit tab

‘Use overall scale of’ options

* **Block**----(shortcut: b)

By using this, we can save objects in block file.

**Process:**

B

Click on select objects option

Select object

Edit name for block

Click on pick point

Specify insertion base point

Ok

* **Insert**----(shortcut: I)

**Process:**

I

Select required block

Ok

Specify insertion point

* **Write block**----(shortcut: W)

**Process:**

W

Select source (for ex: block)

Select required block

Choose destination

Ok

* **Divide**----(shortcut: DIV)

By using this, we can divide the object into equal number of segments.

**Process:**

Div

Select object to divide

Enter the number of segments

**Note**: To check whether the object is dividing or not, change the point style.

**Using block in dividing an object:**

**Process:**

Div

Select object to divide

B (B: block)

Enter name of block to insert

Align block with object(y/n)

Enter the number of segments

* **Text**

2 types

* Single line text
* Multi line text
* **Single line text**----(shortcut: text (or) dtext)

**Process:**

Text

Specify start point of text (click)

Specify height

Specify rotation angle of text

Enter some text

* **Multi line text**----(shortcut: t (or) mt)

**Process:**

T

Specify 1st corner (click)

Specify opposite corner

Edit some text

ESC

Yes

**Note**: To increase the size of the single line text or multi line text, we can use properties or scale commands.

* **Edit text**----(shortcut: ed)

By using this, we can modify the text

**Process:**

ED

Select an annotation object (click on text)

Modify the text

ESC

YES

* **Table**-----(shortcut: TB)

**Process:**

Go to annotate tab

Go to table’s panel

Click on table

Edit number of columns and column width

Edit number of rows and row height

Ok

Specify insertion point

* **Layers**----(shortcut: LA)
* Layers are groups of geometrical elements of a distinct theme.
* We use the layers for control.
* **Creating and deleting layers:**
* Layer property manager (command: La)
* 0-layer cannot be renamed or deleted
* Create new layer (Alt + n)
* Delete a layer (Alt +d)
* The layer which we select, it is called as ‘current layer’.
* Making a layer current layer
* Double click
* Click on the object
* Assigning colors to layers
* Auto cad color index -240 colors
* true colors – 16 million colors
* HSL (Hue, Saturation, Luminance)
* RGB (Red, Blue, Green)
* color books (pantone colors)
* The options ‘turn off’ and ‘freeze’ both having same function. If we select any of these two options, the object will hide.
* If we lock a particular layer, we can see that object. But we can’t do any modifications.

**Process:**

La

Click on ‘new layer’ option

Specify any one name for layer

Apply properties like line type and line weight

* **Properties**----(shortcut: PR) & also (CTRL+1)

By using this, we can modify the properties of the selected object.

**Process:**

PR

Click on ‘select object’ option

Select required properties

* **Line Type**----(shortcut: LT)

By using this we can apply different line types like hidden, dotted, continuous, etc.

**Process:**

LT

Click on load

Select required line type

OK

OK

PR

Click on ‘select object’ option

Select required object

Apply line type

* **Line Type Scale**----(shortcut: LTS)

By using this, we can change the scale of the line type.

**Process:**

LTS

Enter new line type scale factor

* **Matching Properties**----(shortcut: ma)

By using this, we can apply the properties of a single to other two or more number of objects.

**Process:**

Ma

Select source object

Select destination objects

ESC

**Advanced dimensions**

2 types

* Geometric constraints
* Dimensional constraints
* **Geometric constraints**-----(shortcut: Geomconstraint)

These include the following:

* Horizontal
* Vertical
* Perpendicular
* Parallel
* Tangent
* Smooth
* Coincident
* Concentric
* Collinear
* Symmetric
* Equal
* Fix

**Process:**

Geomconstraint

Click on tangent

Select first object

Select second object

* **Auto constrain**

It applies multiple geometric constraints to the selected objects.

**Process:**

Click on auto constrain

Select object

* **Note:**
* If the CONSTRAINTINFER value is 0, auto constrain is in off mode
* If the CONSTRAINTINFER value is 1, auto constrain is in on mode

**To delete a geometric constraint, the process is:**

**Process:**

Delcon

Select object

* **Dimensional Constraints**-----(shortcut: Dim constraint)

We can apply the conditions by giving dimensional values.

**Process:**

Dim constraint

(For ex) Click on angular

Select first line

Select second line

Specify dimension line location

Edit dimensional value

* **Options dialogue box (**Shortcut---OP**)**

Type OP

(Or)

Right click on the screen

Click on options

**It include following tabs:**

* Files tab
* Display tab
* Open and Save tab
* Plot and publish tab
* System tab
* User preferences tab
* Drafting tab
* 3D modeling tab
* Selection tab
* Profiles tab
* Online tab
* **Customize User Interface**-----(shortcut: CUI)

It manages customized user interface elements in the product. User interface elements such as work spaces, toolbars, menus, ribbon panels, shortcut menus etc are all managed from this dialog box

**Process:**

CUI

Go to customize tab

Right click on any one workspace

Click on new workspace

Edit name for new workspace

Click on customize workspace

Add required tools, tabs, panels etc

Done

Click on apply and ok

* **Design Center**-----(shortcut: DC)
* In this, we have default symbols related to civil, mechanical, electrical etc.
* We can use these symbols by directly dragging on to the screen
* To increase the size of the symbol, use scale command
* To delete any data, use explode command

**Process:**

DC

Click on home

Go to design center folder

* **Plotting and Printing**

**Types of plotters:**

* Flat bed plotters
* Drum plotters

**Types of printers**

* Daisy wheel
* Dot matrix
* Inkjet
* Laser
* Thermal

**Plotting: Some standard paper sizes**

* ANSI A 8.5\*11 (inches)
* ANSI B 11\*17 (inches)
* ANSI C 17\*22 (inches)
* ANSI D 22\*34 (inches)
* ANSI E 34\*44 (inches)

**ISO Format**

* ISO A4 210\*297 (mm)
* ISO A3 297\*420 (mm)
* ISO A2 420\*594 (mm)
* ISO A1 594\*841 (mm)
* ISO A0 841\*1189 (mm)

**Scale:**

* For view ports, set scale as 1:1
* For casual printing, set scale as “fit to paper”

3D Modeling

**Introduction:**

**Primitives:**

* Box
* Cylinder
* Cone
* Sphere
* Pyramid
* Wedge
* Torus
* **Box**---(shortcut: BOX)

**Process:**

Box

Specify 1st corner

Specify other corner

Specify height

* **Cylinder**---(shortcut: CYL)

**Process:**

CYL

Specify center point of base (click)

Specify base radius

Specify height

* **Cone**---(shortcut: CONE)

**Process:**

CONE

Specify center point of base (click)

Specify base radius

Specify height

* **Sphere**---(shortcut: SPHERE)

**Process:**

Specify center point

Specify radius

* **Pyramid**---(shortcut: PYR)

**Process:**

PYR

Specify center point of base

Specify base radius

Specify height

* **Wedge**---(shortcut: WE)

**Process:**

We

Specify 1st corner

Specify other corner

Specify height

* **Torus**---(shortcut: TOR)

**Process:**

TOR

Specify center point (click)

Specify radius

Specify tube radius

**Basic commands in 3D**

* Region
* Extrude
* Subtract
* Union
* Intersect
* Boundary
* Spline
* Sweep
* 3D rotate
* Rotate3D
* Slice
* **Region**- (shortcut: Reg)

By using this cmd (command), we can convert an object that encloses an area into a region object.

**Process:**

Reg

Select total object (lines)

* **Extrude**---( shortcut: Ext)

By using this we can give height to the selected object.

**Process:**

Ext

Select objects to extrude

Specify height of extrusion

* **Subtract**---(shortcut: Su)

By using this, we can remove or subtract one object from another object

**Process:**

Su

Select main object

Select total object

* **Union**---(shortcut: uni)

By using this, we can select 2 or more 3D objects at a time.

**Process:**

Uni

Select total objects

* **Intersect**---(shortcut: In)

By using this, we can get the intersect part of two or more overlapping 3D objects.

**Process:**

In

Select total object

* **Boundary**---(shortcut: Bo)

By using this we can create a region from an enclosed area.

**Process:**

Bo

Click on pick points

Pick internal points

* **Sweep**---( shortcut: sweep)

It creates a 3D surface by sweeping 2d or 3d curve along a path. The sweep object is automatically aligned to the path object.

**Process:**

Spl (shortcut for spline command)

Create one continuous line

Create one small circle to the side

Type sweep

Select object to sweep (circle)

Select sweep path (continuous line)

* **3DRotate**---(shortcut: 3DROTATE)

By using this we can rotate the selected object in three types of directions

**Process:**

3DROTATE

Select object (3 types of color ribbons (called Gizmo))

Specify a base point

Give rotation angle

* **Rotate3D**---(shortcut: ROTATE3D)

**Process:**

ROTATE3D

Select objects

Specify 1st point on axis

Specify 2nd point on axis

Specify rotation angle

* **Slice**---(shortcut: SLICE)

By using this, we can divide a 3D object into multiple slices or parts.

**Process:**

Slice

Select objects to slice

Specify start point of slicing plane

Specify 2nd point on plane

* **Mirror3d**---(shortcut: MIRROR3D)

**Process:**

Mirror3d

Select objects

Specify 1st point of mirror plane

Specify 2nd point on mirror plane

Specify 3rd point on mirror plane

Delete source object (yes/no)

* **3DMove**---(shortcut: 3DMOVE)

By using this we can move 3D object in three types of directions.

**Process:**

3DMOVE

Select objects

Specify base point

Specify move point

* **3DScale**---(shortcut: 3DSCALE)

**Process:**

3DSCALE

Select object

Specify a base point

Specify scale factor

* **Fillet in 3D**---(shortcut: F)

By using this we can create rounded corners for 3D objects.

**Process:**

F

Select 1st object (click on anyone edge)

Enter fillet radius

Select an edge

* **Chamfer in 3D**---(shortcut: Cha)

By using this we can create inclined corners for 3D objects

**Process:**

Cha

Select 1st line (click on anyone edge)

Enter surface selection option (next/ok)

Specify base surface chamfer distance

Specify other surface chamfer distance

Select an edge

* **Revolve**---(shortcut: Rev)

It will create 3D solid or surface by sweeping a 2D or 3D curve around an axis.

**Process:**

Draw any one arc

Rev

Select objects to revolve

Specify axis start point

Specify axis end point

Specify angle of revolution

* **Shell**

It converts a 3D solid into a hallow shell with a wall of specified thickness.

**Process:**

SOLIDEDIT

B (B: Body)

S (S: Shell)

Select object

Right click

Click on Add

Again right click

Click on remove

Select top face

Select bottom face

Enter the shell offset distance (0.3)

Exit

Exit

* **Taper**

**Process:**

Go to home tab

Go to solid editing panel

Go to extrude faces

Click on taper faces

Select faces

Specify the base point

Specify another point along the axis of tapering

Specify taper angle

Exit

Exit

* **Loft**---(shortcut: LOFT)

It creates a 3D solid in the space between several cross sections.

**Process:**

2D wireframe, top view

Draw 1 circle

Draw 2nd circle with same diameter

Draw 1 inner small circle

Draw another inner small circle with same diameter

Move quadrant point of both small circles on the quadrant point of big circles

See it in SE (South East) isometric view and realistic

Move one big circle up to some little bit height

Move both small circles up to some height

Move 1 small circle up to some little bit height

Type LOFT

Select every circle one by one from down to up

Click on cross-sections only

Exit

Exit

* **Path Extrusion**

**Process:**

Create 1 circle

Create 1 line to the side

Ext

Select circle

Right click

Select path

Select extrusion path (line)