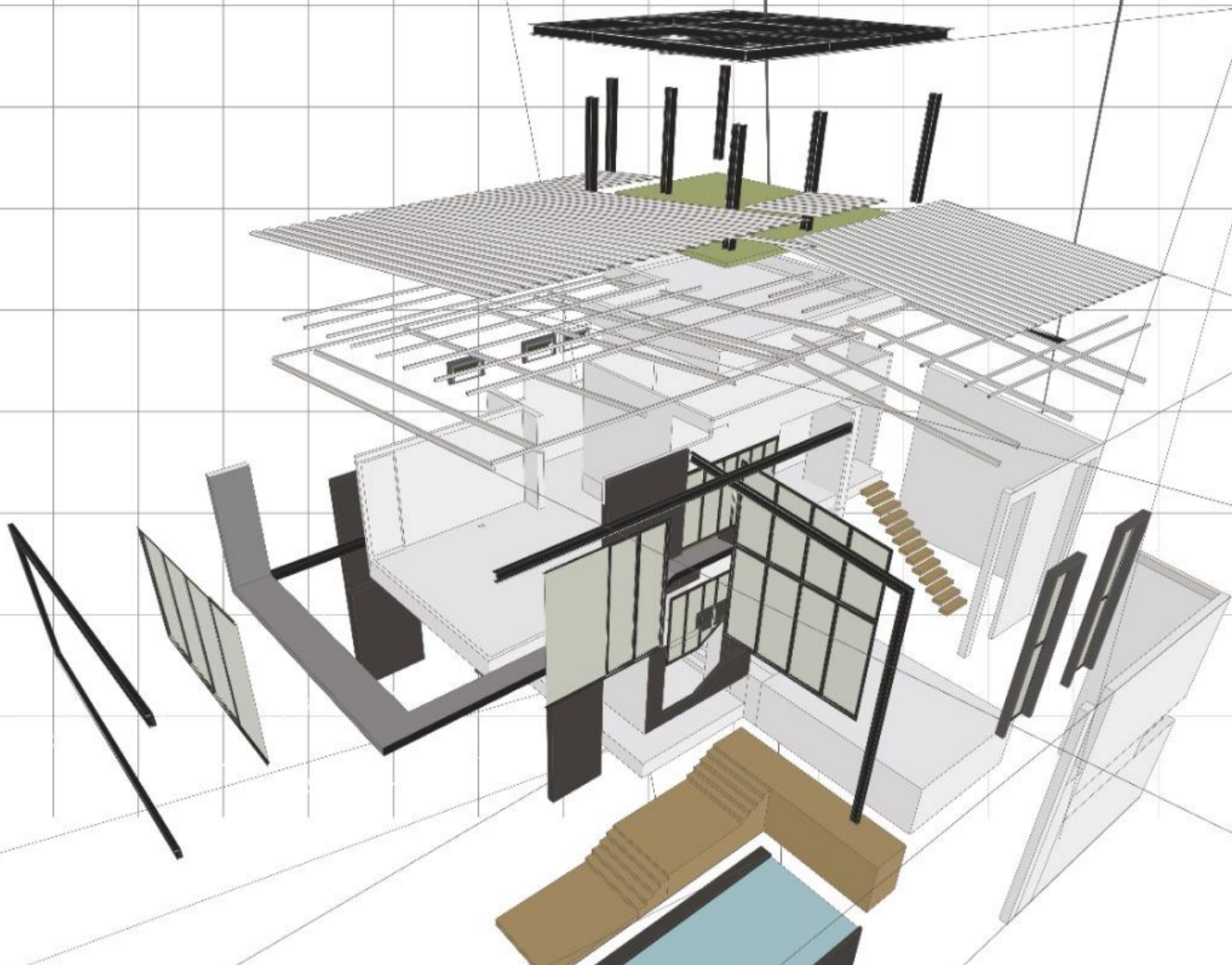




Architectural Drafting

LEVEL 3

Teacher Learning Material
National Vocational Certificate Level-3
Version II-April-2025
(06 Months)



Published by

National Vocational and Technical Training Commission Government of Pakistan

Headquarter

Plot 38, Kirthar Road, Sector H-9/4, Islamabad, Pakistan www.navttc.org

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Photo Credits

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This document has been produced with the technical assistance of the TVET Sector Support Programme, which is funded by the Government of Pakistan. National Vocational and Technical Training Commission (NAVTTTC), Provincial Technical Education and Vocational Training Authorities (TEVTAs), Punjab Vocational Training Council (PVTC), Qualification Awarding Bodies (QABs) and private sector organizations are involved in whole process of TLM development.

Document Version

April, 2025

Islamabad, Pakistan

INTRODUCTION

Architectural drafting is a critical skill used by architects, draftsmen, and design professionals to create precise construction drawings, floor plans, and structural layouts. This discipline extends beyond architecture, playing a key role in engineering, interior design, and product development through detailed 2D and 3D representations.

To standardize expertise in this field, the National Vocational & Technical Training Commission (NAVTTTC) has introduced the “National Vocational Certificate Level-2 in Information Technology (Architectural Drafting).” Developed in consultation with industry leaders and employers, this qualification ensures alignment with current sector demands and professional drafting standards.

Based on national competency guidelines, this Teaching and Learning Material (TLM) is structured into following key topics to develop essential architectural drafting skills:

- Fundamentals of Advance Architectural Drafting
- Technical Drawing & 3D Modeling Techniques
- Real-World Applications and Project-Based Practice
- Designed to bridge theory and practice, this material equips learners with the necessary skills to excel in architectural drafting and related technical professions.

Module 1: Perform Advance Architectural Drawings

Module 2: Perform Architectural Graphics

Module 3: Develop 3D in AutoCAD

This TLM provides support for more effective training and productive learning. Each of the learning modules contains learning outcomes and information regarding learning elements in the form of knowledge, skills and attitudes. At the end of every learning module are Frequently Asked Questions (FAQs) and Test Yourself which will help learners in self-assessment before proceeding to modular or final assessment.

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Learning Outcomes:

After completion of this learning module, trainee will be able to:

- Draw Space Planning/ Spatial Planning
- Draw Set of Working Drawings

Learning Unit 1.1**Draw Space Planning/ Spatial Planning****Learning Outcomes**

After completion of this Learning Unit, trainee will be able to:

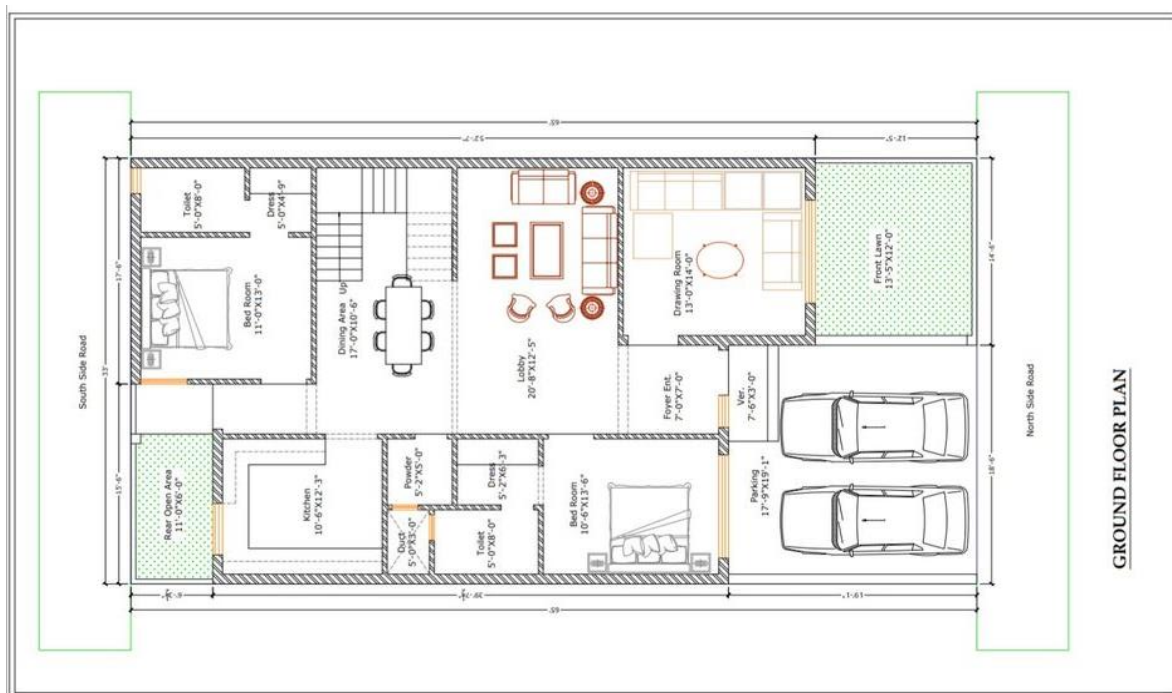
- Design a Bathroom
- Design a Kitchen/ Dining
- Design a Bedroom
- Design a lounge
- Design a Drawing Room

1.1.1 Terminology of Architecture Views**Plan:**

In architectural or building drawing, top view is always drawn as a sectional top view formed by assuming an imaginary horizontal cutting plane just above the sill level. The view is drawn after removing the upper part and is termed as PLAN. Plan shows the position and the size of different elements of a building like wall thicknesses, position of beams, doors windows, almirahs and ventilators, etc., besides other optional details as sanitary fittings, electric fittings, and furniture, etc.

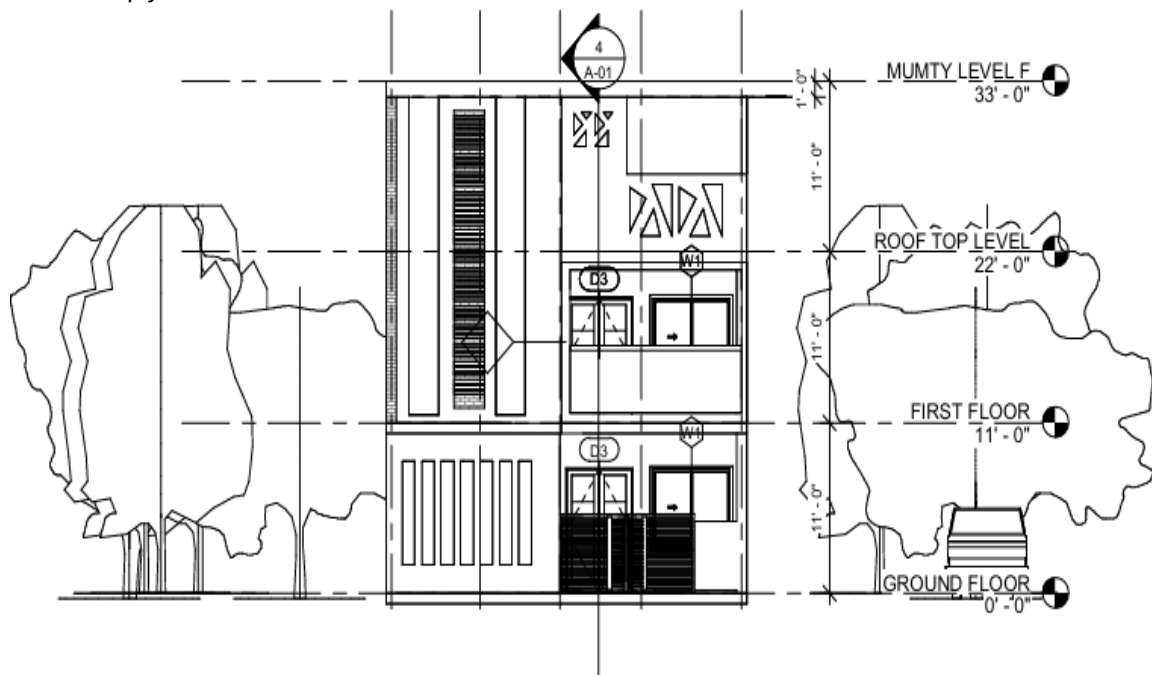
Remember

In building drawing, dashed line is used to show certain important features in plan like beams, sunshades, lintels, etc., which are above the horizontal cutting plane and are removed with the upper part during the sectioning.

**Elevation:**

Simple orthographic view used to show the appearance of the finished building is called elevation which is equivalent to front view in the model drawing. Elevation is only drawn for the super-structure; a thick line is drawn at the bottom showing the ground level and what is present above it is shown. This view is used only to communicate the appearance; hence, dimensioning is avoided in it. More than one elevation may also be drawn for a building namely front elevation, rear elevation, left elevation and right

elevation. Sometimes elevations are named according to their directions, for example, N- elevation, S-elevation, E-elevation and W-elevation. Usually the most important view or the front elevation is drawn and is simply called elevation.

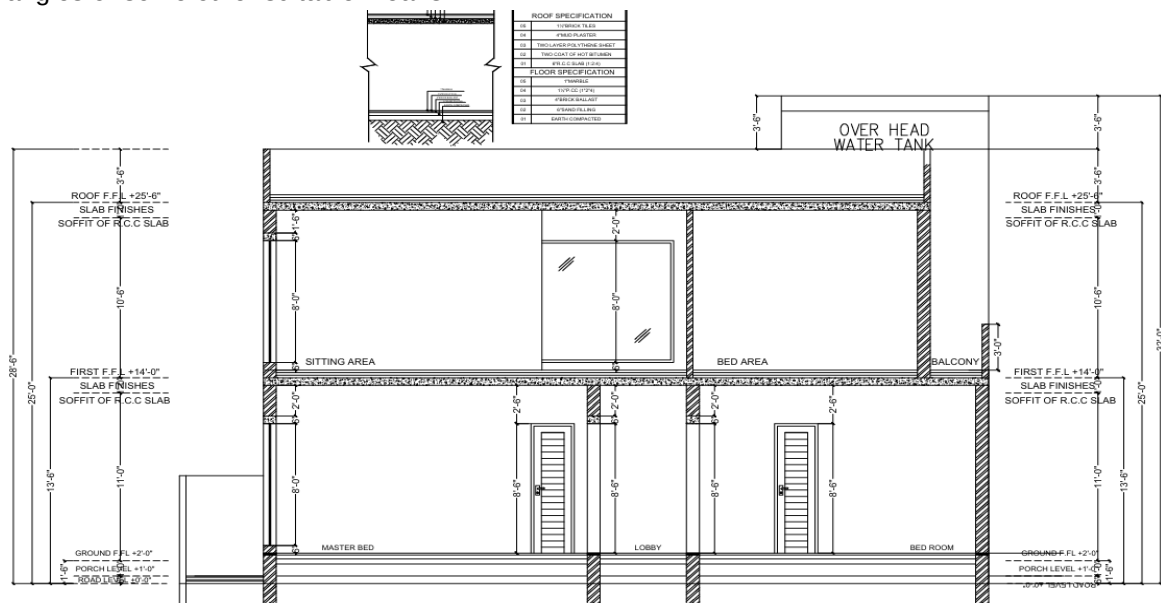


Section:

Section, in building drawing, is a term used for the sectional front view or end view of a building drawn to a suitably bigger scale showing both the super-structure and the sub-structure; maximum details and all the dimensions are given in it. Vertical cutting is assumed starting from the top of the parapet wall right up to the bottom of the foundation exposing all the hidden details like wall thicknesses, floor layers, roof layers, beams and lintels. Further heights of doors, windows, and ventilators as well as ceiling heights for various parts of the building are also shown. If the details are more complicated, more than one sections may also be drawn. Plan and section are completely dimensioned for each and every part. Before starting with a particular section, its path of cutting must be shown in plan otherwise it will become meaningless. Direction of vision to obtain a sectional view is also shown on the cutting plane by arrows, triangles or some other suitable means.

Remember

Each cutting plane and its associated section may be denoted by different letters or numbers.



Schedule of Opening

Schedule of doors and windows contains information about doors, windows, ventilators and almirahs including their designation, size, quantity or number, sill level and the description in a sentence. The description includes the type of that opening and material of construction, etc., such as: - Single leaf flush doors with wooden frame - Wooden paneled double leaf doors - Steel glazed windows with wire-gauze - Wooden glazed ventilators.

S. NO.	ITEM	SIZE	SILL LEVEL W.R.T. P.L.	QUANTITY	DESCRIPTION
1	D1	4'-0" x 7'-0"	0'-0"	2	WOODEN PANELLED SINGLE LEAF DOOR
2	W1	4'-0" x 4'-0"	+3'-0"	4	STEEL PANELLED GLAZED WINDOW WITH WIRE-GAUZE

Reduction factor

The conversion factor between the actual size and the drawing size, also referred to as reduction factor, is called SCALE.

The first difference of the building drawing from the model drawing is that now the object will be much bigger, dimensions may be in feet instead of few inches. Because of this greater difference of size of the object with the drawing space available, the dimensions are to be reduced many times for the drawing work.

Following set of scales is ordinarily used in the building drawing when working in the imperial units, called architectural scale (refer to para 13 of the article 1.2): 1, 1/2, 1/4, 1/16, 1/32, 1/64

Ceiling Height (C.H.)

Bottom of roof slab is called ceiling. Height of the ceiling from the finished floor level is called ceiling height which normally varies from 8 to 12 ft. In other words, the clear height available inside a building is known as ceiling height.

Sill Level (S.L.)

It is the level of bottom of main windows generally 3 ft. higher than the floor level. In the past, a sill or slab was provided at the bottom of the windows projecting from the wall from which the term S.L. is derived. Now a days this type of sill is not used but the term S.L. is still there and is also important for some other definitions.

Finished Floor Level (F.F.L.)

Top level of floor in any part of the building is called finished floor level. It may be different for rooms, verandahs and open areas of a building.

Plinth Level (P.L.)

It is the level of the ground floor top in main part of the building. It is made higher than the ground level by an amount depending upon the following factors with a minimum of 1 ft. a) The building must be prevented from the rainwater to come inside the building. b) Drainage of the used water from the building must be easy. c) Future trends in the locality like raising of street and road levels is to be kept in mind.

Ground Level (G.L.)

It is the level of ground in or near the building which may be natural or developed ground level.

Super-Structure and Sub-Structure

The portion of a structure which is visible or which is above the ground level is called super-structure. The portion of the structure present underground is called substructure including the foundations and the basements, if present.

Parapet

Remember

Architectural scale is actually an inch-foot scale and One-scale means that one inch of the drawing.

Remember

Bigger ceiling height is preferable for single storey buildings for better natural air conditioning. Smaller ceiling height is preferable for multistorey buildings and for buildings where artificial air-conditioning is to be used.

Small wall provided on periphery of the roof for safety and privacy purposes is called parapet wall having a height of 1'-0" to about 5'-0" from top of the roof slab. One foot height is only recommended in those buildings where access to the roof is not available and is only used to retain the filling materials on the roof surface.

1.1.2 Space and Circulation Standards for Building

Bedroom with Attached Bath:

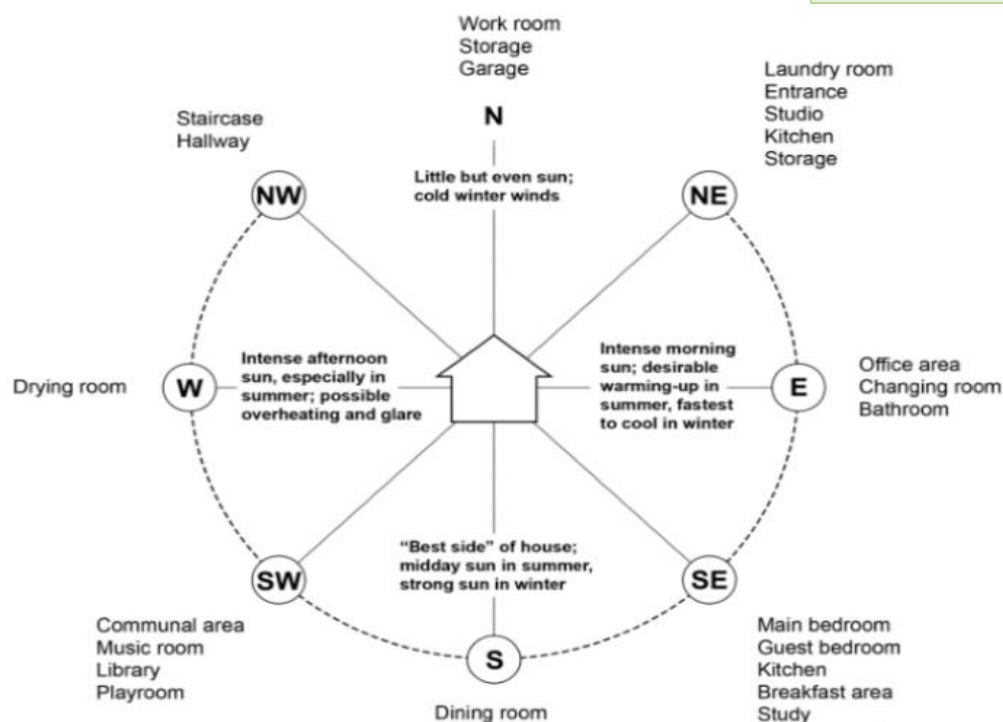
This room should be located on open side or back periphery of the constructed block to maintain good natural ventilation and light. Bedroom should be made as independent and private as possible but it should have easy access to all the common places in the house. Reasonable size is 180 Sft like a bedroom of size 12 x 15. The bathroom should have a minimum size of 30 Sft and at least one side of it must be towards the open side for better ventilation. Sometimes a small portion called dressing is also provided close to the bath. Passage of the bathroom, in this case, is through the dressing. Area of the dressing room may be kept smaller even about 25 Sft. One or two cupboards or wardrobes must be provided in each bedroom or in the attached dressing.

Drawing Room:

Preferable size is about 215 Sft with a minimum of 110 Sft. It should be made well-ventilated and lighted and should have a direct approach from the main entrance of the building. A powder room having a minimum size of 12 Sft is to be attached with the drawing directly or through the living room. The powder room is to be fitted with a W.C., a wash hand basin and hangers.

Do you know

T. SS (Time Saves Standards) contain guideline for spaces for all types of building.



Living Room:

It is sometimes referred to as Common Room or TV Lounge. Living room should be the central place of a house and direct access to all other components should be available from here. This place should be the most comfortable and graceful part of the house so that the occupants are attracted to it and a common sitting is automatically arranged at suitable times. This room should give an impression of being open. If greenery is visible from inside the living room, the architectural appearance is improved and for that large glazed windows on suitable sides may be recommended. This room is generally the biggest place in the house having an area ranging from 215 to 325 Sft.

Dining Room:

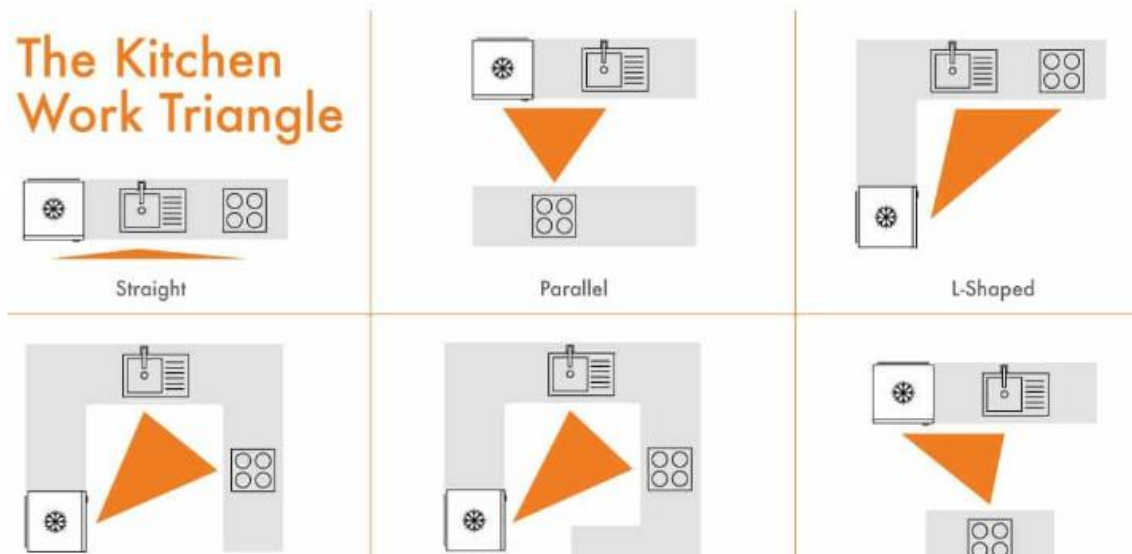
This room having a minimum size of about 150 SFt should be located adjacent to the drawing and the living room. Kitchen should also be connected to the dining room for easy working. Sometimes a pantry (having about 50 SFt area) in- between the kitchen and the living is provided to store the kitchen articles and the cooked food temporarily. This room should have cupboards and shelves. In modern houses, drawing, dining and living rooms may be combined in any required pattern. In that case, area requirements are slightly reduced.

Do you know

Placing the building in right direction play an important role in conserving energy and reducing and reducing utility bills.

Kitchen:

Reasonable size for the kitchen is about 80 SFt but it depends upon the plot size, number of members of the family and the way in which the kitchen is used. Ventilation should be very good and space may also be provided for exhaust fan.



Store or Box Room:

It is a small (about 50 SFt) but safe room present in the interior of the building to store valuable articles.

Stair Case:

Position of the stairs is also very important which may be provided in a separate stairhall or directly in the living. If stairhall is to be provided, it should preferably have one opening to the outside and one to the living room so that the upper storey remains somewhat separate yet easily approachable from the ground floor. Natural light should always be available for the stairs.

Verandah:

It may be 6'-0" to 10'-0" wide and should be located on either the front or the back of the building.

Servant Room:

For ten marla /one kanal or bigger house, a servant room may be provided having a size about 10x12 ft. If it is on the ground floor, it should be independent and on the back side of the house but if it is on the top floor, preferably it should have a separate approach usually by wrought iron stairs. A bathroom would be provided with it.

Remember

Windows are preferably designed on north and south directions.

Car Porch or Portico:

Car porch is constructed in front of the building to park the car. It is generally a roof provided over pillars, boundary wall or already constructed walls open from two or three sides.

Corridor:

It is covered passage inside a building to provide approach to a room without disturbing the working of the other rooms. Corridors should be avoided as far as possible.

Lobby:

It is a small place or hall at the main entrance which is connected to the living room and drawing room.

1.1.3 Building Elements/Components

Drawing components vary based on the type of building. Here are some common components:

- Boundary Wall
- Window
- Ventilator
- Door
- Roof Details
- Floor Details

Remember

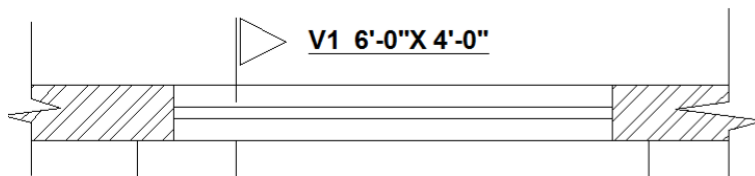
Building is divided in three zones

- Public (drawing room, lobby, gaurage)
- Semi public (living room, kitchen, dinning room)
- Private (bedroom, washrooms)

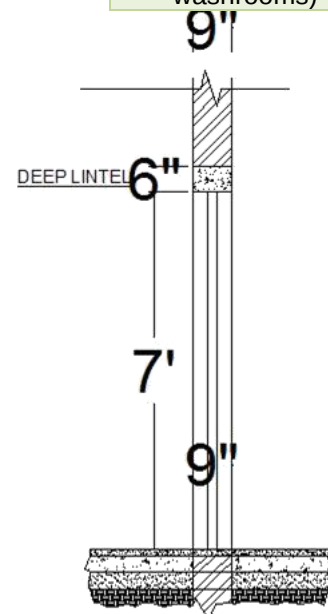
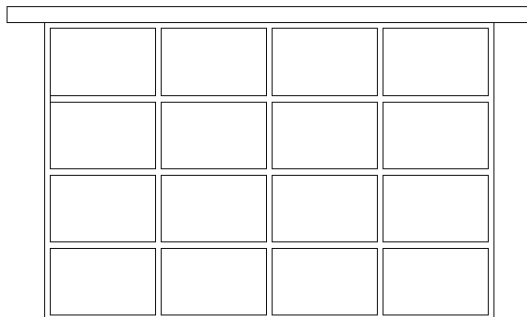
Window:

An opening especially in the wall of a building for light and air that is usually closed by casements or sashes containing transparent material (such as glass) and capable of being opened and shut.

Horizontal section of window

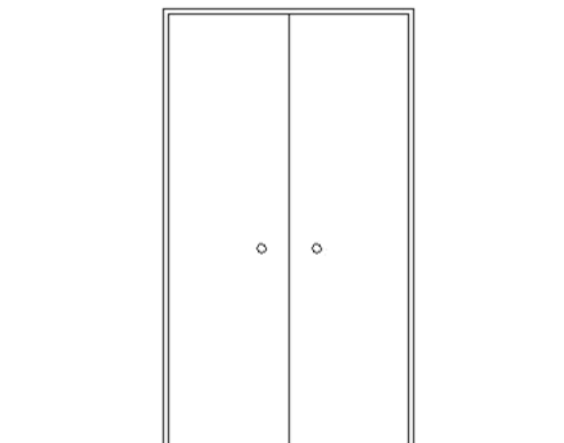


Elevation of window

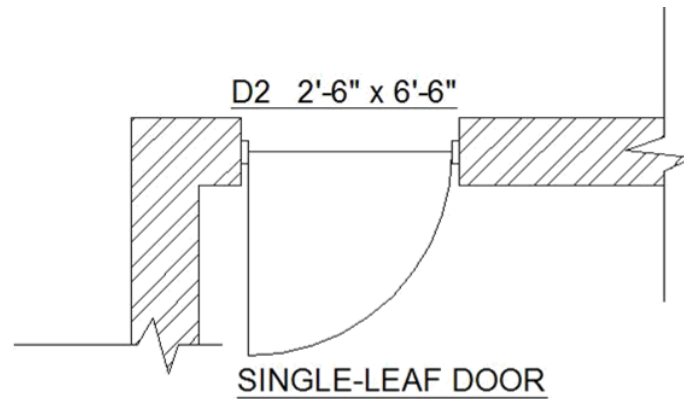


Door:

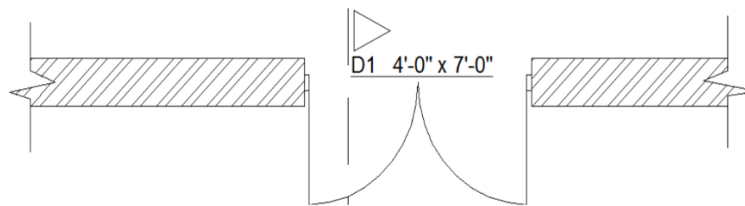
A door is a piece of wood, glass, or metal, which is moved to open and close the entrance to a building, room, cupboard etc.



Elevation of flush door

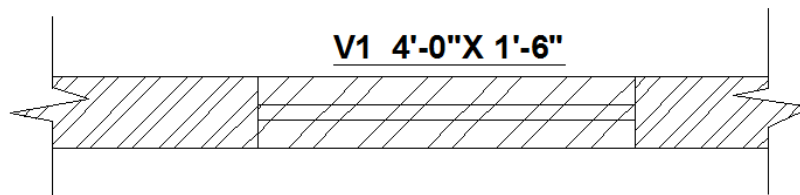


Horizontal section of double-leaf door



Ventilator

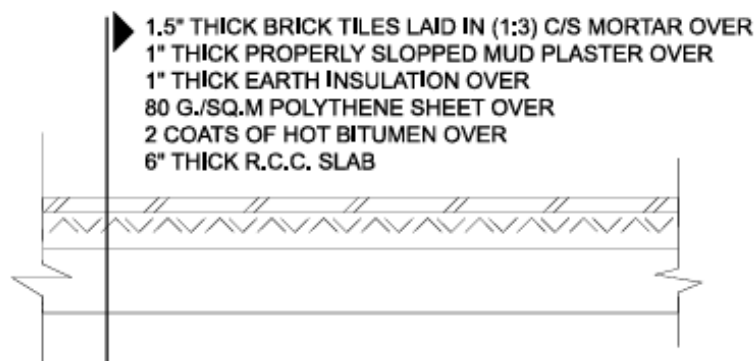
Ventilator is denoted by the letter “V” and is shown in vertical section and elevation just like a window. When we assume cutting for the plan, the ventilators are removed. Symbol of Ventilator in Plan with the upper part. At the level of cutting, there is a solid wall shown by the symbol of brickwork in section.



Roof details

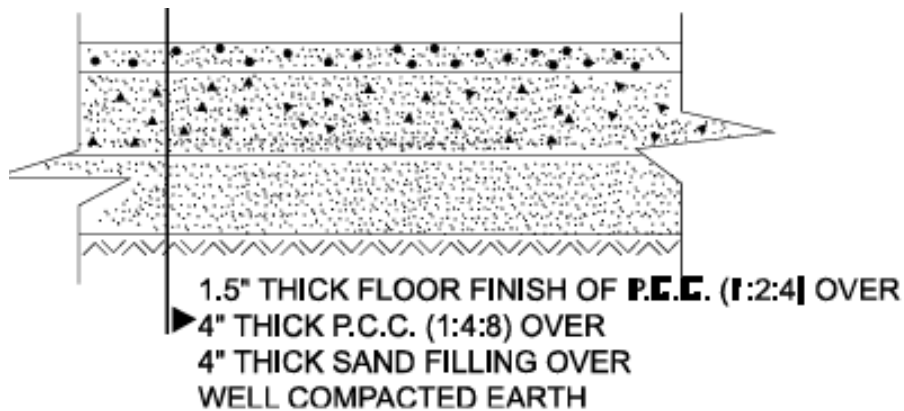
There are many variations in the roof details depending upon type of the building, the typical details are produced. Typical details are as follows

- 1.5” thick brick tiles laid in (1:3) c/s mortar over
- 1” thick properly slopped mud plaster over
- 3’ thick earth insulation over
- 80 G./SQ.M. polyethylene sheet over
- 2 coats of hot bitumen over
- 6” thick R.C.C slab



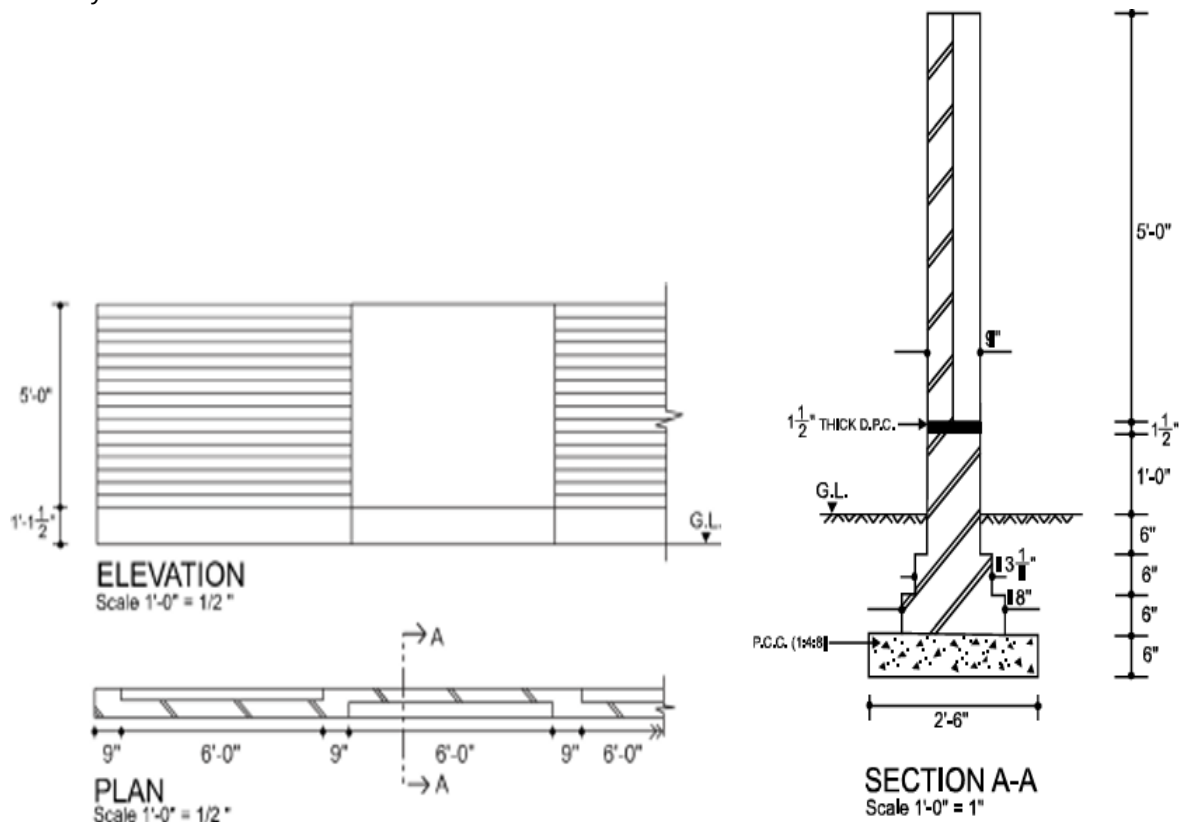
Floor Details

- 1.5" thick floor finishing of P.C.C. (1:2:4) over
- 4" thick P.C.C. (1:4:8) over
- 4" thick sand filling over
- Well compacted earth



Boundary Wall

It is the outer most wall of a building marking the boundary of the area used to provide safety and privacy inside the building. This height is about 5 to 7 ft. from the G.L. In developed areas, according to the bye- laws of the controlling authorities, the plot is to be kept open on at least three sides and inside a constructed block is made having its own outer wall with one or two entrances. This constructed portion is separately safe and provides privacy. So, in such cases, we may reduce the height of the boundary wall.

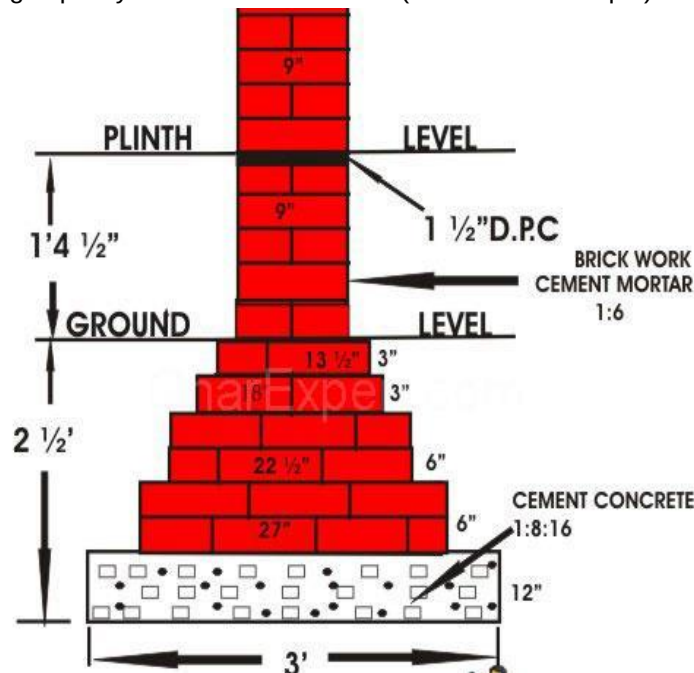


Foundation

The portion of a structure under columns and walls which transfers load of the structure to the soil underneath 'in a safe way without excessive settlement is called foundation. The load concentration within walls and columns is generally much greater because these structural elements resist the load of greater part of the building transferred to them by the beams and the roof-slabs. The function of a foundation is to re-distribute this load over a larger area reducing the load per unit area (load intensity) until it becomes equal to the safe bearing capacity of the soil underneath (0.5 to 1.5 tons/sq. ft).

Remember

Foundation step size for masonry structure depend upon size of brick used.



Types of Foundations

Shallow Foundation – For small structures; includes:

Spread footing Strip footing Raft foundation **Deep Foundation** – For large loads or weak soils; includes:

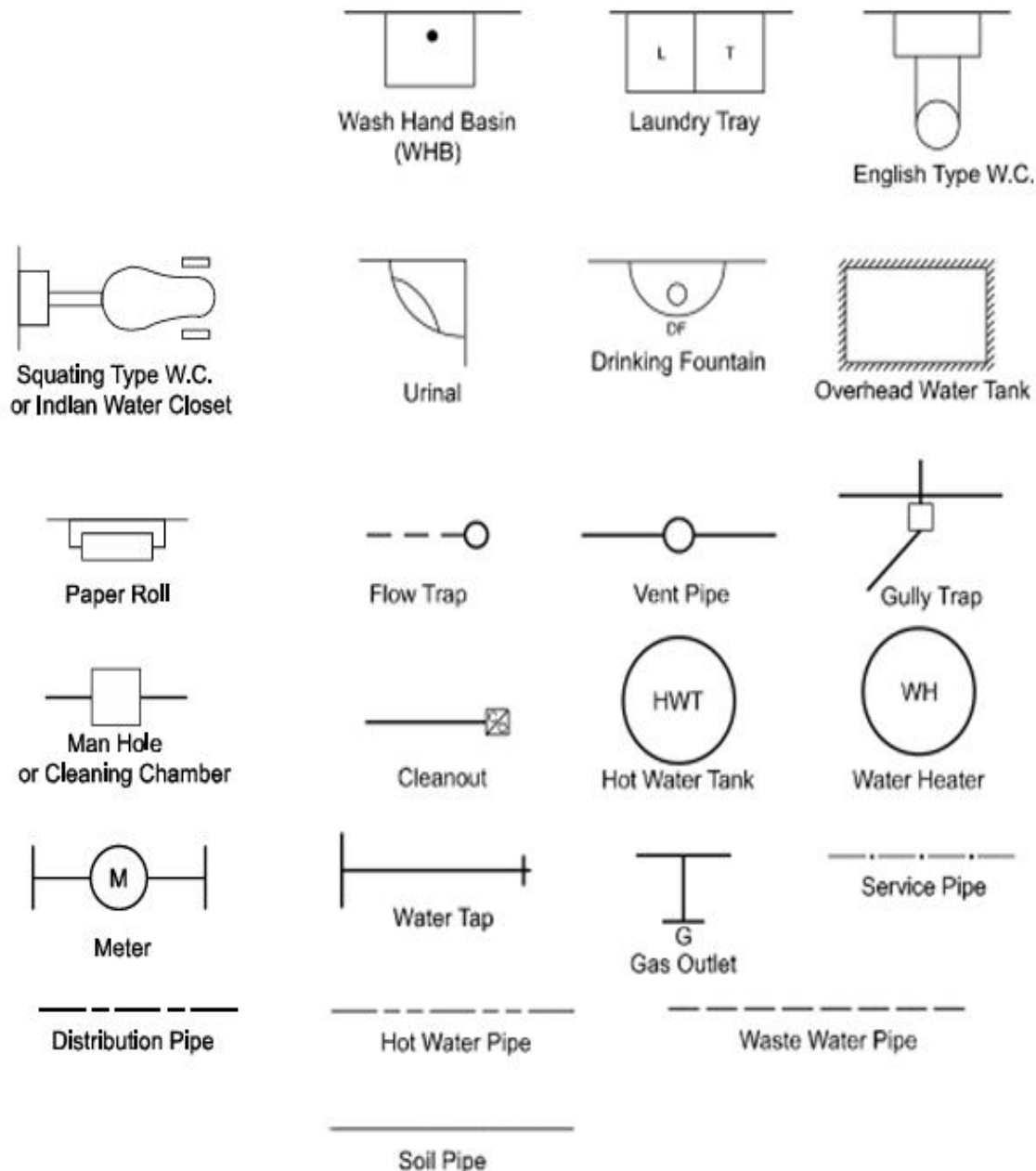
- Pile foundation
- Well foundation

1.1.4 Types of Plumbing Fixtures

- Sinks: Used for washing hands, dishes, and other items, found in kitchens, bathrooms, and utility rooms.
- Toilets: Used for waste disposal.
- Bathtubs: Used for bathing.
- Showers: Used for bathing.
- Faucets: Control the flow of water from pipes to plumbing fixtures.
- Urinals: Used for urination, commonly found in public restrooms.
- Bidets: Used for personal hygiene.
- Drinking fountains: Provide access to drinking water.
- Garbage disposals: Used to grind food scraps.
- Water heaters: Heat water for use in fixtures.

Do you know

The foundation of burj al arab is pile foundation. Pile foundation increase the stability of soil and withstand heavy load.



1.1.5 Types of building plan symbols

Stairs also have a wide variety, and the usage depends on both design aesthetics and the plan's requirement.

- **Scissor stair:** Stair floor plan symbols have a series of parallel lines and an arrow that indicates which direction is "up" depending on which level you're looking at.
- **Straight stair:** The straight stairs' symbol is a rectangle containing parallel lines.
- **Curved stair:** The curved staircase is represented through a curved shape with parallel lines.
- **Winding stair:** The winding staircase makes a 180° turn up toward the next level.

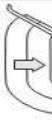
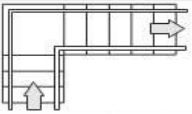
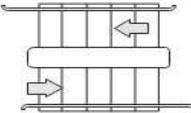
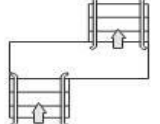
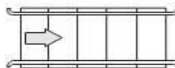
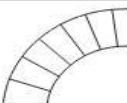
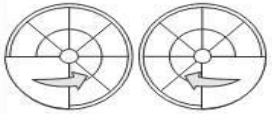
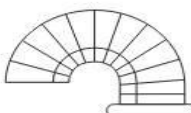
Remember

Thick Lines attract more attention while thinner lines appear more delicate and suitable

Do you know

Revolving staircase is used for a regal look, while a scissor staircase might be a good option to save space.

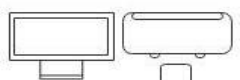
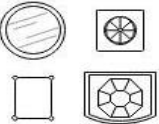
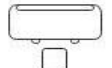
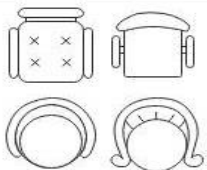
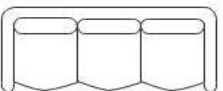
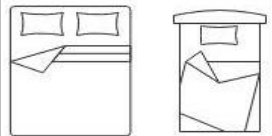
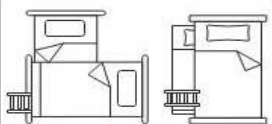
Floor Plan – Stairs Symbols

Symbol Name	Symbol	Symbol Name	Symbol
Ornamental Stair		Winding Staircase	
Scissor Staircase		Z-shaped Staircase	
Straight Staircase		Divided Return Staircase	
Curved Staircase		Spiral Staircase	
Curved Staircase		Stair Landing	

Floor Plan Furniture Symbols

The furniture set is not an essential part of the floor plan. However, furniture floor plan symbols in the draft helps the viewer. These floor plan symbols include sofa, bed, dining table, armchairs, and cupboards, etc.

Floor Plan – Furniture Symbols

Symbol Name	Symbol	Symbol Name	Symbol
Tea Tables		Desks	
Sofa Tables		Dressing Table	
Single Seater Chairs		Cabinet	
Three Seater Chair		Single and Double Bed	
Chair with Table		Bunk Beds	

Floor Plan Technology Symbols

In floor plans, especially floor plans with the kitchen, bathrooms, and living area, there is need of technology symbols. These appliances include stoves, refrigerators, washers, dishwashers, TV, and microwaves, etc. Again, these floor plan symbols are not essential but help give a clearer picture of the living space.

Floor Plan - Technology Symbols

Symbol Name	Symbol	Symbol Name	Symbol
Coffee Maker		Water Heater	
Refrigerator		Flat-panel TV	
Cooker		Disinfection Cabinet	
Gas Stove		Food Cooler	
Air Exhaust Fan		Tumble Dryer	
Microwave		Washing Machine	
Dishwasher		Water Cooler	
Fan		Chest Freezer	

Kitchen Floor Plan Symbols

The kitchen floor plan is a very important part of the floor plan because it needs plumbing, appliances, and layout elements all in one place. Kitchen floor plan symbols include closets, gas stoves, ovens, sinks, electric BBQ grills, dining tables, fridges, tables, chairs, cookers, plates, and more.

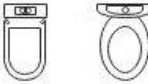
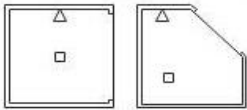
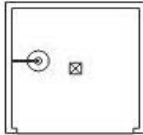
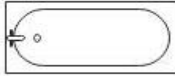
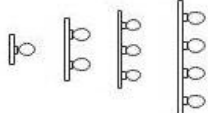
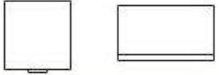
Kitchen Floor Plan Symbols

Symbol Name	Symbol	Symbol Name	Symbol
Closet		Microwave	
Island		Dishwasher	
Gas Stove		Trash Compactor	
Four-element Gas Range		Refrigerator	
Cooker		Sink	
Flat Electric Range		Juicer	
Wall Oven		Chopping Board	
		Smoke Machine	

Bathroom Floor Plan Symbols

The bathroom floor plan is also a very demanding space; just like a kitchen floor plan, it also needs to cover many architectural elements, including cabinets, plumbing, water disposal, ventilation, and much more. The most commonly used architectural floor plan symbols are different types of sinks, bathtubs, showers, lights, taps, drains, toilets, etc.

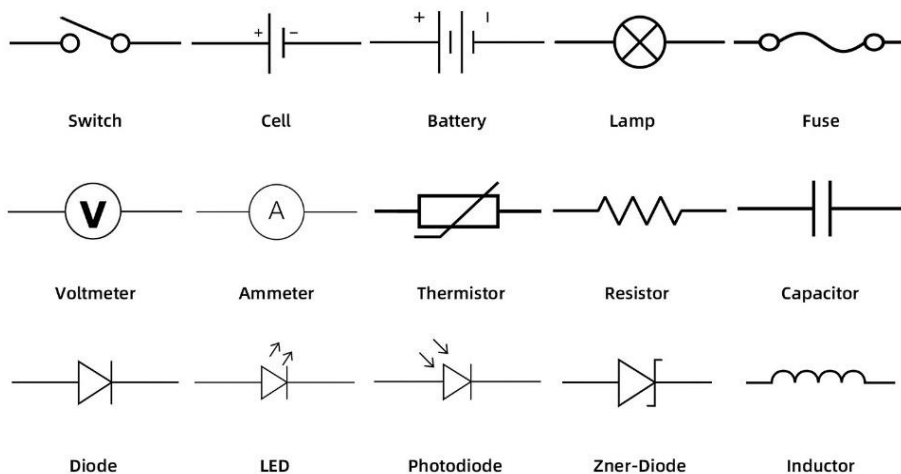
Bathroom Floor Plan Symbols

Symbol Name	Symbol	Symbol Name	Symbol
Sink		Water Tap	
Toilet		Dustbin	
Shower		Toilet Paper	
Bathroom		Towel Rack	
Bathtub		Lights	
Shower Drain		Shower Lamp	
Cabinet			

Electrical Symbols

Electrical symbols and electronic circuit symbols are used for drawing schematic diagram.

The symbols represent electrical and electronic components.



Remember

Electronic symbols primarily use for simplifying drafting and making circuit diagrams easier to understand

Resistor: Resistors restrict the flow of current. Used with a capacitor in a timing circuit.

Ground: Connection to the actual ground or other “grounding” structure. Used to provide electrical shock protection and for zero potential references.

Capacitor: Stores electric charge. Can be used to filter or block DC signals while passing AC signals. Used with a resistor in a timing circuit.

Battery: Generates constant voltage and supplies electrical energy.

Fuse: Sacrificial overcurrent protection device. This symbol represents low power/low voltage fuses.

Inductor: Coil of wire that generates a magnetic field when electrical current is passed through it. Passive two-terminal electrical component used to store energy in the resulting magnetic field. Can also be used as a transducer to convert electrical energy into mechanical energy.

Iron Core Inductor: Same as above, but with an iron core beneath the coiled wire.

Circuit Breaker: Automatically operated electrical switch that protects electrical circuits from damage caused by short circuits or overloads.

Voltmeter: Very high resistance device used to measure electrical voltage. Must be connected in parallel.

Ammeter: Zero resistance device used to measure electrical current. Must be connected serially.

Wattmeter: Device used to measure electric power.

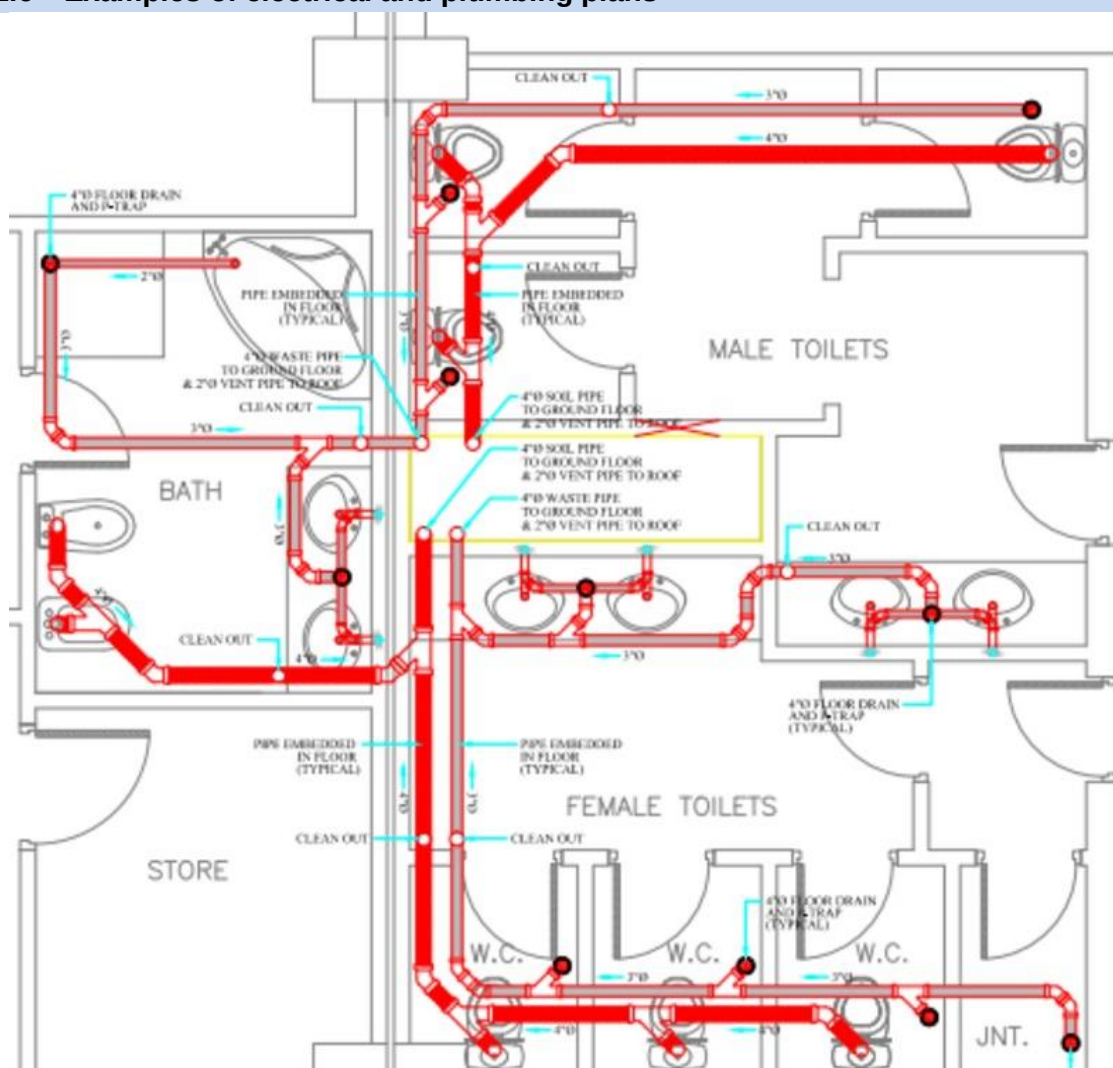
Bell: Electric bell, makes a single tone or repeated ringing sound when activated.

Buzzer: Similar to an electric bell, an electric buzzer makes a constant buzz when activated.

Remember

Electronic symbols primarily use for simplifying drafting and making circuit diagrams easier to understand

1.1.6 Examples of electrical and plumbing plans



ELECTRICAL PLAN

wiring lighting

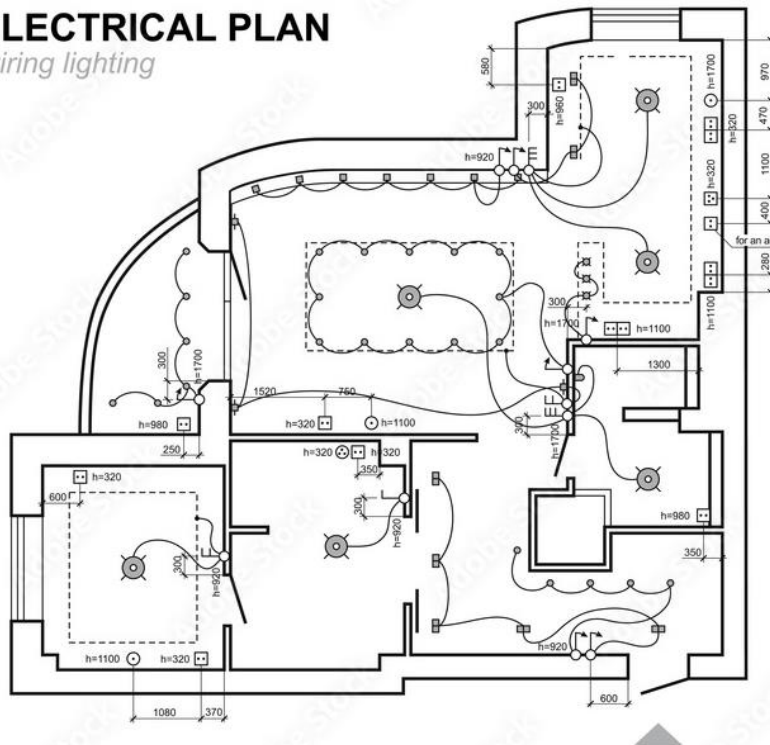


Table of symbols

- Lamp
- Lamp built-in swivel dual
- Built-in halogen lamp 12 V
- The lamp built into the floor 12 V
- Lamp pendant
- Sconce (mounting height H=1850)
- Wall lamp
- Switch lock
- One-key switch
- Three gangs one way switch
- Switch rheostat (dimer)
- Led strip light RGB LED
- Socket
- Socket double
- Outlet for the oven
- Antena tv
- Internet cable

Activity1:

Practice to draw and design bathroom with fixtures

Activity2:

Practice to design and draw kitchen/Dinning

Activity3:

Practice to draw and design bedroom

Activity4:

Practice to design and draw lounge

Learning Unit 1.2

Draw Set of Working Drawings

Learning Outcomes

After completion of this Learning Unit, trainee will be able to:

- Draw Working Plan Set
- Draw Key Plan
- Draw Site Plan
- Draw Working Elevation & Section
- Draw Foundation Details
- Draw MEP Details

1.2.1 TYPES OF BUILDING DRAWINGS

Following are types of building drawing

1. Proposal drawing
2. Perspective drawing
3. Submission drawing
4. Working drawings
5. Completion drawing

Proposal Drawing:

A proposal drawing or proposal sketch is an initial, conceptual illustration used to communicate design ideas during the early stages of a project. It is typically freehand or roughly drafted and focuses more on conveying the overall concept, layout, and functionality rather than precise measurements or technical details. These sketches help clients and stakeholders visualize the designer's vision before further development. These drawings include plans, elevation. For

Remember

Plans and elevation, in propasal drawings, are made attractive even by colouring and, if needed, perspectives are also drawn to impress the client.

proposals, plans and elevation are drawn on a very small scale like 1/8 or 1/16 while the section is usually not needed.

Perspective:

It is a drawing technique that represents three-dimensional objects on a two-dimensional surface, making them appear realistic and spatial. It helps to show depth, scale, and the relative position of objects as they would appear to the human eye, commonly used in architectural renderings to present buildings or spaces.

Submission Drawing:

It is a formal set of architectural or engineering drawings prepared according to regulatory standards and submitted to local authorities or governing bodies for approval. These drawings are used to obtain necessary permits before construction begins and typically include site plans, floor plans, elevations, and sections with detailed notes.

Remember

Submission drawings are actually legal documents used to approve the building plans.

Working Drawings:

These are highly detailed and accurate drawings used by builders and contractors during the construction phase. They include technical specifications, dimensions, materials, and construction methods. Working drawings serve as a guide to translate design into actual construction, and often include architectural, structural, electrical, and plumbing details.

In working drawings, we can make small changes from the approved plans like alteration in the position of doors and windows and small adjustments in the internal sizes of the rooms.

Remember

The sections are drawn on enlarged scales and as many numbers of sections are used as needed to clearly explain the structure.

Completion Drawing:

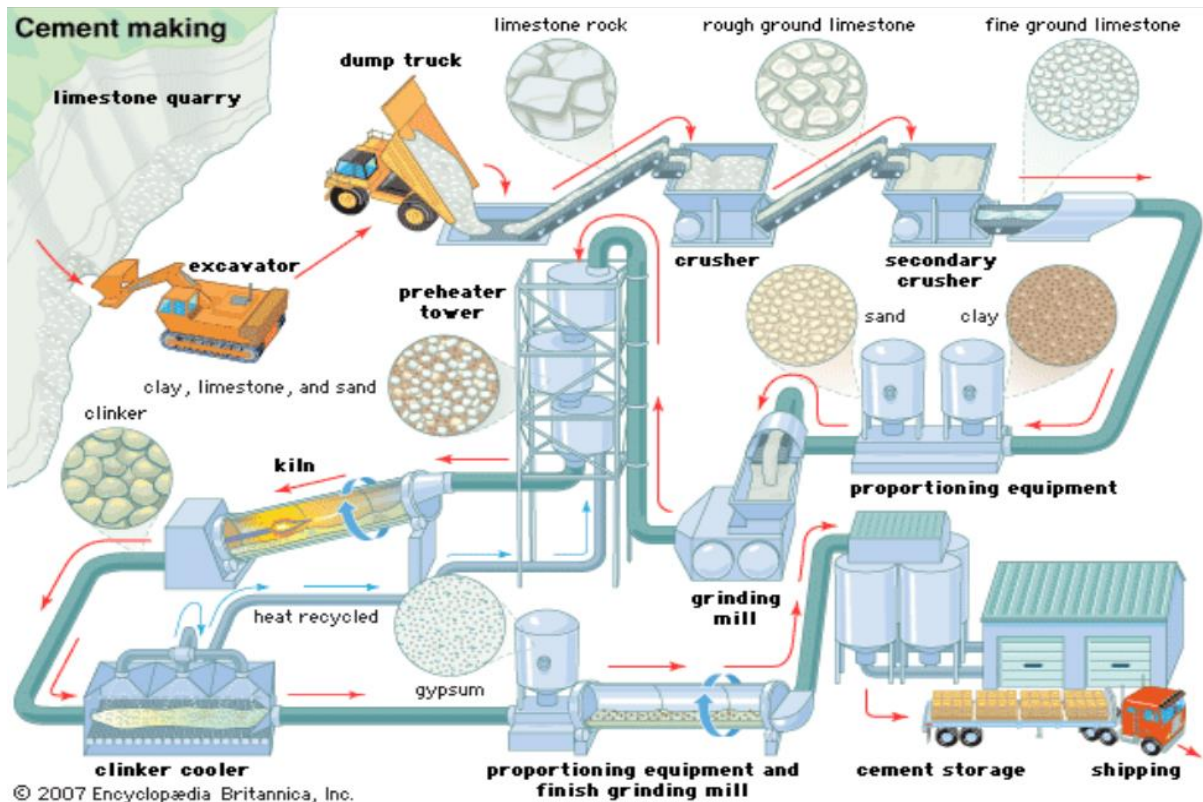
It is also known as an as-built drawing, is a final drawing that reflects all the changes and modifications made during the construction process. It shows the actual built structure and is typically used for maintenance, future renovations, or documentation. It is prepared after the construction is complete.

Drawing Type	Components Included	Typical Scale(s)	Purpose
Proposal & Perspective	Plans, elevations (usually colored), perspective views (optional)	1/8 or 1/16	To present initial design ideas to client; visually appealing, no sections.
Submission Drawing	Ground & first floor plans, one elevation, one section, site plan, location plan	Plans: 1/8	Legal document for authority approval before construction.
		Section: 1/8	
		Site Plan: 1/16 or 1/32	
		Location Plan: 1/64	
Working Drawing	Detailed architectural and structural plans, sections, plumbing, electrification, etc.	Enlarged or blown-up scales as needed	For actual on-site construction; includes all technical details.
Completion Drawing	As-built drawings representing the actual constructed building	Usually same as working/submission scales	Required for final approval and occupancy certificate.

1.2.2 Types of Building materials

Cement

A powder of alumina, silica, lime, iron oxide, and magnesium oxide burned together in a kiln and finely pulverized. Cement is a binding material used in construction. It is used as an ingredient of mortar and concrete.



The main parts of cement are calcium, silicon, aluminum, and iron. Portland cement, the most common, has about 85% lime and silica. Alumina and iron oxide are also important. This mix is what makes cement harden when mixed with water. Cement Component Percentage Lime (CaO) 60-67% Silica (SiO₂) 17-25% Alumina (Al₂O₃) 3-8% Iron Oxide (Fe₂O₃) 0.5-6%.

Do you Know

Additives are added in cement to enhance its strength and achieve desired properties.



Type of cement include:

- Ordinary Portland Cement (OPC) – General use.
- Rapid Hardening Cement – Gains strength quickly.
- White Cement – Used for decorative works.
- Pozzolana Cement – Eco-friendly, used in dams and water-retaining structures.

Concrete:

Ratio of the constituent materials is also written as Part of Cement: Part of sand : Part of Coarse Aggregate. For example, concrete (1:2:4) means that cement content by weight is one out of 7 parts, sand is 2 out of 7 parts and coarse aggregate is 4 out of 7 parts.



Types of concrete are as follows

- **Plain Cement Concrete (PCC):** It is abbreviated as P.C.C. and is the simple concrete without the provision of embedded steel bars (or reinforcement). It is sufficiently strong in compression (internal force corresponding to push on a body) but is weak in tension (internal force corresponding to pull on a body).
- **Reinforced Cement Concrete (RCC):** It is abbreviated as R.C.C. and is defined as the concrete with the addition of steel bars or reinforcement to resist tension. R.C.C. is used for beams, lintels, roof-slabs and concrete columns, etc.
- **Pre-stressed Concrete:** Pre-stressed concrete is a type of concrete in which internal stresses are introduced before any external loads are applied. This is done by tensioning steel tendons (wires or cables) within or alongside the concrete. It improves the concrete's strength and ability to handle heavy loads or longer spans without cracking.
Used in: bridges, large beams, slabs, flyovers, etc.
- **Ready-Mix Concrete:** Ready-mix concrete is concrete that is manufactured in a batching plant, mixed under controlled conditions, and delivered to the construction site in transit mixers (concrete trucks). It saves time and ensures consistent quality.
Used in: residential buildings, commercial projects, roads, etc.

Remember

Concrete proportions increase or decrease strength and durability properties.

Mortar:

Mortar is a material used for plastering of walls and roofs and to join bricks in masonry. Mud mortar and lime mortar were initially used but now-a-days cement sand mortar is most commonly used abbreviated as C/S mortar. Its constituents are cement and sand and the ratio of these materials is also specified. For example, (1:2) C/s mortar means that cement is one part out of three by weight and sand is two parts out of three by weight.

Bricks

A brick is a rectangular block made from clay, shale, concrete, or other earthen materials, typically hardened by drying in the sun or firing in a kiln. Bricks are commonly used in construction for building walls, pavements, and other masonry structures due to their strength, durability, and fire resistance. The nominal size of brick is 9"X4 1/2"X3".

- **Burnt Clay Bricks** – Most common type, used in walls, foundations, etc.
- **Fly Ash Bricks** – Made from fly ash and cement, eco-friendly and lightweight.
- **Concrete Bricks** – Made of cement and aggregates, used for facades and fences.
- **Engineering Bricks** – Strong and water-resistant, used in foundations.
- **Fire Bricks (Refractory Bricks)** – Withstand high temperatures, used in fireplaces and kilns.

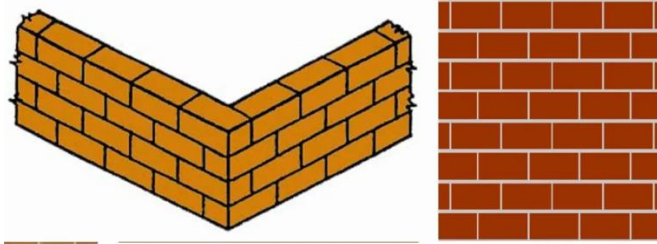
Remember

Over burnt bricks are not used in construction.

Types of Bonds (Brick Bonding Patterns)

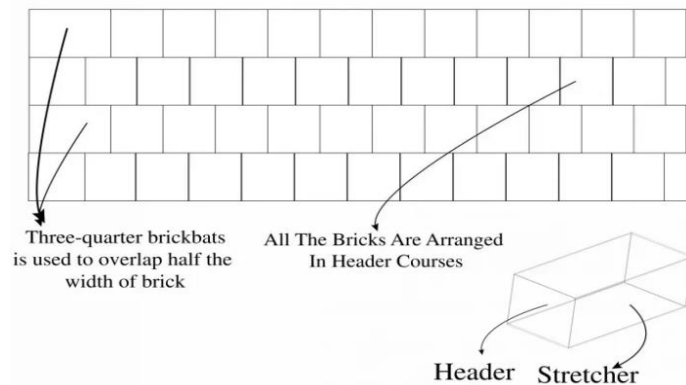
Bricks are usually laid in patterns (called bonds) and held together using mortar.

- **Stretcher Bond** – Bricks laid lengthwise; common for walls.

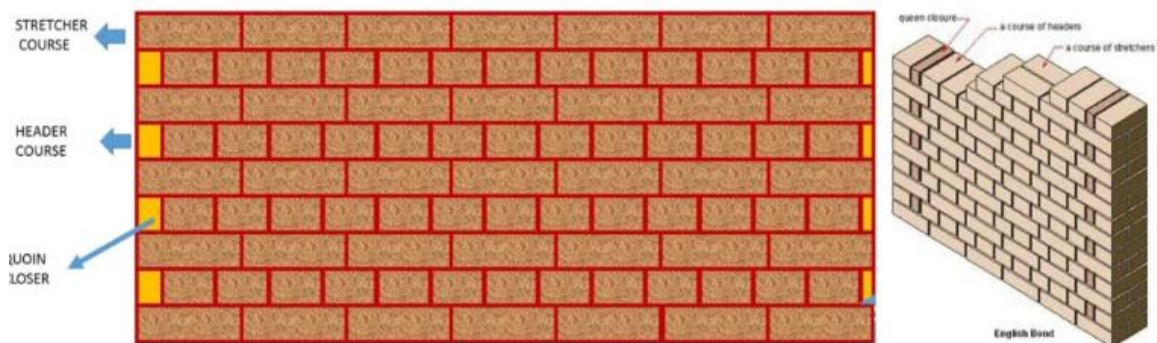


- **Header Bond** – Bricks laid with the short side facing out.

Header Bond In Brick Masonry

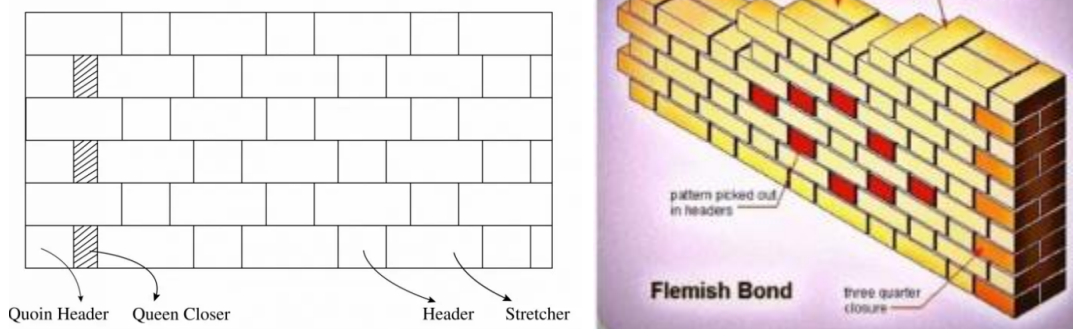


- **English Bond** – Alternates one course of headers and one of stretchers.



- **Flemish Bond** – Alternates header and stretcher in every course.

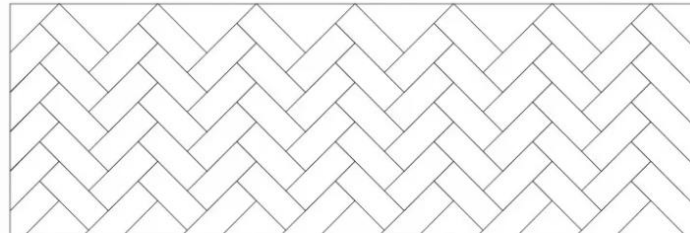
Flemish Bond In Brick Masonry



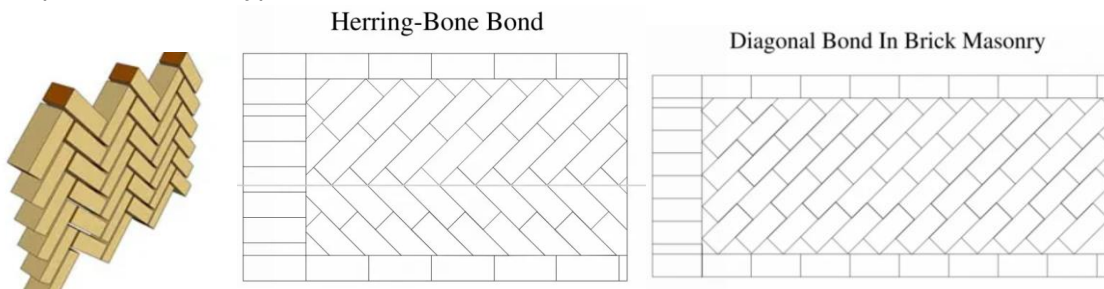
- **Stack Bond** – Bricks stacked directly on top of each other; decorative use.
- **Zig Zag Brick Bond** – Bricks are put in a zigzag pattern throughout the joint when using a zigzag bond. Two types of bonds that belong to the same category are zigzag and Herringbone bonds. Owing to its appealing look, it works well for domestic building paving projects like walkways

and floors. But it can't be utilized to construct a masonry structure's main walls since it can't support weights.

Zig-Zag Bond In Brick Masonry



- **Raking Bond** -In the raking bond, the bonding bricks are put at an angle other than zero or ninety degrees. Because of this configuration, English bond walls constructed in this manner are more stable over time. Bricks angled toward the wall's face are placed within a wall's exterior stretchers to create a bond between the two sections. The height of a wall is split into parts where this type of bond is added.



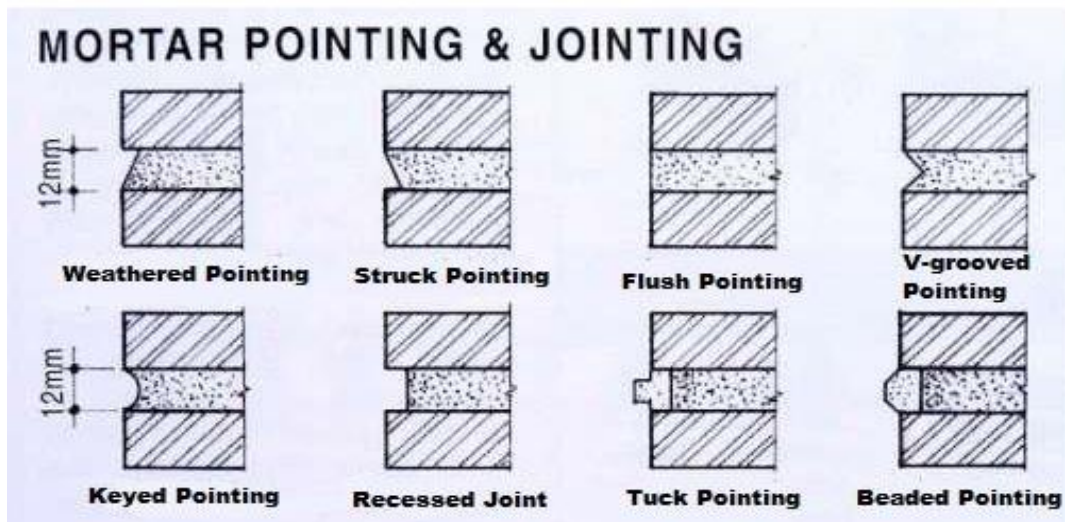
The raking bonds come with two different types of brick bonds:

Facing Bond: In these types of brick bonds, the header course comes after a number of stretcher courses. It's often used to make walls that are thick. It can be very helpful to bond together the two different sizes of the facing wall and the backing wall. In spite of this, there are not the same number of joints on the facing and backing sides. However, because of the unequal load distribution brought on by the broad range of thicknesses, there are not an equal number of joints in the backing and facing faces. Another possible consequence of this non-uniformity is the uneven settling of the masonry walls.

Brick Joints: A brick joint refers to the space filled with mortar between bricks in masonry work. It helps bond the bricks together, seal gaps, and provide stability and aesthetics.

Types of Joints include:

- **Flush Joint:** Mortar is finished flush (level) with the surface of the bricks. It gives a smooth, clean look and good for plastered walls
- **Raked Joint:** The **raked joint** involves recessing the mortar slightly from the brick face, usually 5 to 10 mm deep, which creates a shadow effect and highlights the brickwork, though it's less ideal for exterior walls exposed to heavy rain.
- **Weathered Joint:** The **weathered joint** is sloped downward and outward to shed water effectively, making it suitable for exterior walls.
- **Struck Joint:** The **struck joint** is sloped inward, which may allow water to collect and is generally used more for appearance than function.
- **Concave joint:** The concave joint is created by pressing the mortar inward with a rounded tool, forming a curved, compacted joint that is both durable and water-resistant.
- **V-joint:** It forms a V-shaped groove in the mortar using a special tool, offering a decorative finish with good strength.



DPC (Damp Proof Course)

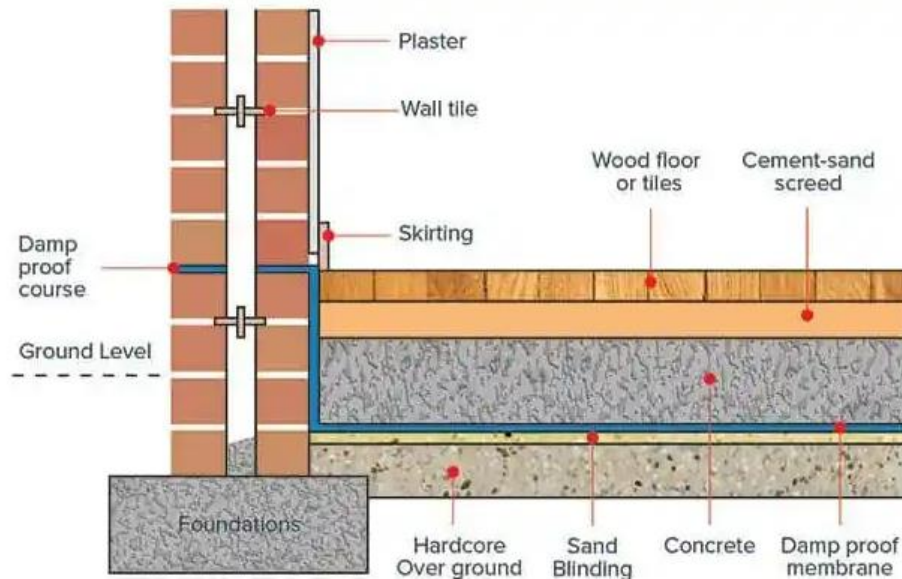
A Damp Proof Course is a layer of waterproof material (like bitumen, plastic, or concrete) applied at the base of walls to prevent moisture from rising up from the ground.

- DPC can be laid in any direction either horizontally or vertically.
- When damp proofing course is laid horizontally then the thickness of DPC should cover the entire thickness of the wall.
- If damp proofing course is exposed to the external wall surface it can get damaged while doing finishing work.
- Where the horizontal layer of the DPC is continued to the vertical face of the wall then a cement concrete fillet of 75mm radius should be provided at the junction.
- DPC should be continuous, especially at the junction and corners of walls. Otherwise, dampness can get entry from there.
- The supporting mortar bed for damp proof course should be even and leveled and should be free from projection of any sort. This will help DPC to remain intact and safe.

Remember

DPCs play an important role in keeping your home dry and preventing damage. Damp proof course should be continuous and no irregularity or break in layers should be seen.





The prime use for a **Damp proof course** is to stop the ingress of moisture and water up to the walls. There are various **methods to do a damp proofing course** in a building some of the methods are mentioned below:

- Bituminous membrane damp proofing.
- Integral damp proofing.
- Polyurethane DPC
- Surface treatment.
- Cavity wall construction.
- Guniting.
- Pressure grouting

Wood

It is a natural, organic material that forms the stem, branches, and roots of trees. It is primarily composed of cellulose, lignin, and other organic compounds.

- **Properties:** Wood is known for its relatively low density, good insulation properties, and ability to be shaped and worked with relative ease.
- **Uses:** Wood is used extensively in construction, furniture making, paper production, and various other applications.

Remember

Solid wood furniture is significant investment and with so many wood choices, it is important to choose the right wood type for your unique space and needs.

Softwood



Hardwood



Types:

- **Softwood** – Like pine, cedar (used for framing).
- **Hardwood** – Like oak, teak (used for finishing and furniture).

Metal:

Metals in historic buildings were used in a variety of applications including columns, roofing, window frames, and decorative features. The types of metals used include cast iron, steel, and aluminum, lead, bronze, brass, and copper. Metals should therefore be retained and repaired, wherever this is possible.

Remember

Metals are defined as lustrous, malleable, good conductors of heat and electricity, ductile, and possessing a silver sheen.

**Steel**

Steel is a strong, durable, and flexible metal made from iron with the carbon content typically below 2%, widely used in construction for reinforcement (RCC), structural frames, columns, beams, and roofing systems. It offers high tensile strength and resistance to deformation, making it ideal for modern buildings and infrastructure.

**Composition:**

Besides iron and carbon, steel may also contain other elements like manganese, silicon, phosphorus, and sulfur, which are added to enhance its properties.

Properties:

Steel is known for its high strength, durability, and resistance to deformation, making it suitable for a wide range of applications.

Uses:

Steel is widely used in construction, manufacturing, transportation, and many other industries.



Types:

- **Mild Steel** – Used in general construction.
- **Stainless Steel** – Corrosion resistant, used in finishings.
- **High Yield Strength Deformed (HYSD) bars** – Common in RCC.

Glass:

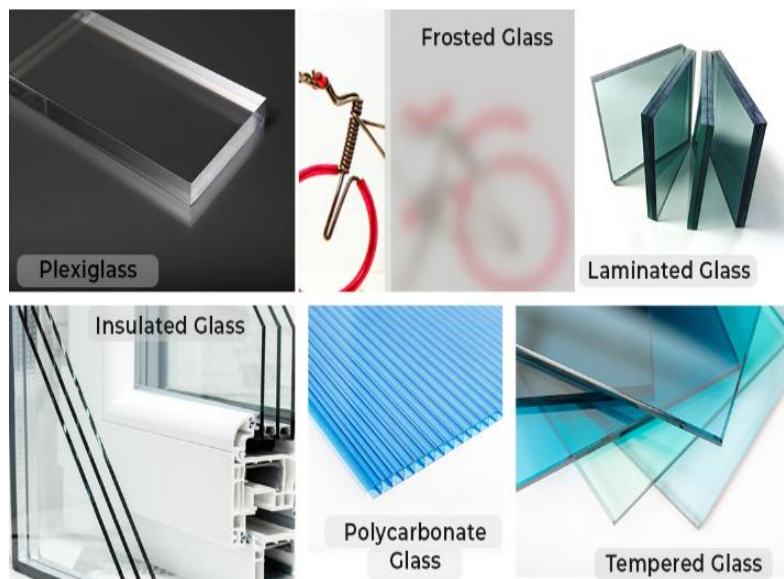
Glass is typically composed of silica (sand), soda ash (sodium carbonate), and lime (calcium oxide), which are melted together and then cooled rapidly to prevent crystallization.

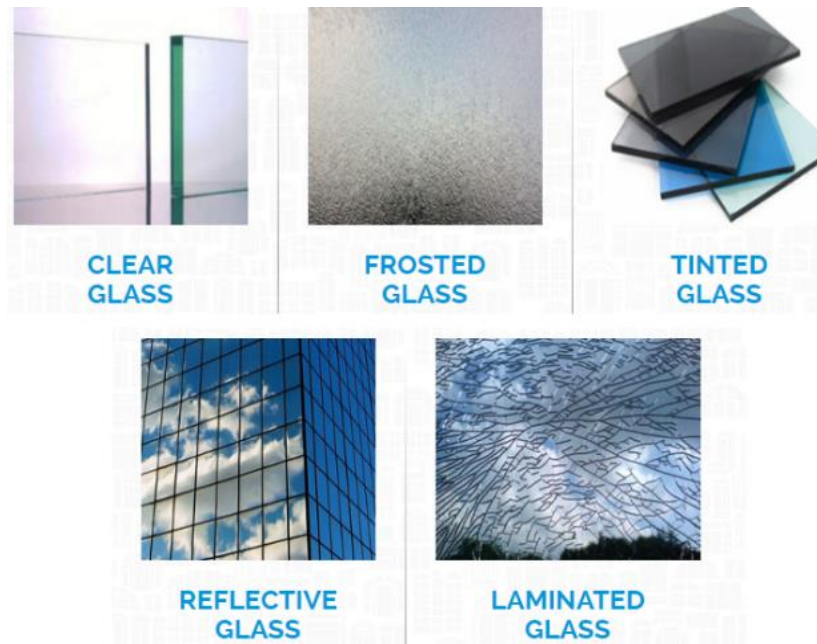
Properties:

It's known for its hardness, brittleness, and transparency or translucence.

Applications:

Glass is used in a wide variety of applications, including windows, bottles, containers, and optical lenses.





Plastics:

Plastics are made from long chains of molecules (polymers) derived from petrochemicals, natural gas, or other sources.

Uses Of Plastic In Building Construction



Properties:

Plastics are versatile and can be molded into various shapes, with properties like flexibility, durability, and resistance to certain chemicals.

Applications:

Plastics are used in a vast array of products, including packaging, containers, textiles, and construction materials.

SECTION		ELEVATION
	WOOD	
	BRICK WORK	
	STONE MASONRY	
	TERRAZZO	
	INSULATION	
	PLASTER	
	EARTH	
	SAND	

SECTION		ELEVATION
	GLAZED TILE	
	CAST IRON	
	GLASS	
	IN-SITU R.C.C.*	
	PRECAST R.C.C.*	
	PRESTRESSED R.C.C.*	
	P.C.C.**	
	DAMP PROOF MATERIAL	
	METAL	

Activity1:

Practice to draw working plan set

Activity2:

Practice to draw key plan

Activity3:

Practice to draw site plan

Activity4:

Practice to draw working elevation & section

Activity5:

Practice to draw foundation details

Activity6:

Practice to draw MEP details

SUMMERY

Performing working drawing of building by understanding of building material and drawing types to add specification and details of building components and also to continue a smooth workflow

FAQs:**Q1. Define space planning**

Ans: Space planning is the process of organizing interior spaces to ensure efficient use of space and functionality. It involves determining the layout, furniture placement, and circulation paths based on the purpose and needs of the users.

Q2. What are working drawing?

Ans: Working drawings are detailed, technical drawings used during construction. It includes plans, sections, elevations, and details that provide precise information about dimensions, materials, and methods for building the project

Q3. What is the building section?

Ans: A building section is a vertical cut-through drawing of a building that shows internal features such as room heights, wall thicknesses, floors, roofs, and structural elements. It helps visualize how different levels and components relate to each other.

Q4. Write plumbing fixtures.

Ans: Plumbing fixtures include devices connected to a plumbing system such as:

- Washbasins
- Toilets (Water Closets)
- Sinks
- Showers
- Bathtubs
- Urinals
- Bidets

Q5. What is the reduction factor.

Ans: A reduction factor is a scaling ratio used in drawing to reduce the real-life size of an object to fit on paper. For example, a scale of 1:100 means 1 unit on the drawing equals 100 units in reality.

Q6. What is the architectural scale?

Ans: Architectural scale is a standardized scale used in architectural drawings to represent large structures on paper. Common scales include 1:50, 1:100, or 1:200, allowing architects to accurately depict building elements.

Q7. What is schedule of opening?

Ans: A schedule of opening is a chart or list in architectural drawings that provides detailed information about all doors and windows, including their sizes, types, materials, and quantities.

Q8. What is foundation

Ans: A foundation is the lowest structural part of a building that transfers the load from the structure to the ground. It provides stability and prevents settlement or movement. Common types include shallow (e.g., spread footing) and deep foundations (e.g., piles).

Q9. Define cement.

Ans: Cement is a fine powder made from limestone and other minerals that, when mixed with water, acts as a **binder** to hold materials like sand and gravel together in construction.

Q10. What is concrete.

Ans: Concrete is a mixture of cement, sand, aggregates (like gravel), and water. It hardens over time and is used in construction for foundations, slabs, columns, and beams due to its strength and durability.

Q11. What is the plumbing drawing.

Ans: A plumbing drawing is a technical diagram that shows the layout of water supply, drainage, and sewage systems in a building. It includes details of pipes, fixtures, and connections to help plumbers install systems correctly.

Q12. What is the purpose of DPC.

Ans: The purpose of Damp Proof Course (DPC) is to prevent moisture from rising through the walls from the ground. It is a waterproof layer placed at the base of walls to protect the structure from dampness.

Q13. What is the use of mortar in construction.

Ans: Mortar is used in construction to bind bricks or stones together, fill gaps between them, and provide stability and waterproofing. It is made of cement (or lime), sand, and water.

Q14. What is metal.

Ans: Metal is a hard, shiny, and strong material that conducts heat and electricity. In construction, metals like steel, aluminum, and iron are used for reinforcement, structural frameworks, roofing, and fixtures.

Q15. What is prestressed concrete.

Ans: Pre-stressed concrete is a special type of concrete where steel tendons are tensioned before the concrete is poured. This process adds strength, reduces cracking, and allows the concrete to handle heavier loads or longer spans.

MCQs

- 1. What does a “Plan” show in building drawings?**
 - a. Vertical details
 - b. Appearance of front
 - c. Top view with horizontal section
 - d. 3D model
- 2. At what level is the horizontal plane assumed for a Plan?**
 - a. Plinth level
 - b. Roof level
 - c. Just above sill level
 - d. Ground level
- 3. Dashed lines in a plan are used to show features like ____.**
 - a. Foundations
 - b. Doors
 - c. Beams and sunshades
 - d. Floor patterns
- 4. Which drawing shows the appearance of a building from the front?**
 - a. Plan
 - b. Elevation
 - c. Section
 - d. Perspective
- 5. Elevation is equivalent to which view in model drawing?**
 - a. Top view
 - b. Isometric view
 - c. Front view
 - d. End view
- 6. Sectional views are drawn by ____.**
 - a. Top view cutting
 - b. Vertical cutting
 - c. Side cutting
 - d. No cutting
- 7. What is the main purpose of a section in building drawings?**
 - a. Color scheme
 - b. Electrical layout
 - c. Maximum structural detail
 - d. Ventilation design
- 8. What is shown in a schedule of opening?**
 - a. Furniture list
 - b. Beam sizes
 - c. Doors, windows, ventilators
 - d. Pipe layout
- 9. What is meant by reduction factor?**
 - a. Increase in size
 - b. Shrinking material

- c. Ratio of actual to drawing size d. Height-to-length ratio
- 10. Scale of 1:100 means ____.**
 a. 1 drawing unit = 100 actual units b. 1 cm = 1 inch
 c. 100 feet = 1 meter d. Same size
- 11. Ceiling height is the distance from ____.**
 a. Floor to ground b. Roof to slab
 c. Finished floor to ceiling d. Foundation to slab
- 12. What is the typical sill level height?**
 a. 6 feet b. 1 foot c. 3 feet d. 5 feet
- 13. FFL stands for ____.**
 a. Finished Floor Level b. Front Floor Line
 c. Foundation Floor Level d. Floor Front Length
- 14. Plinth level is raised to avoid ____.**
 a. Light reflection b. Rainwater entry c. Termite attack d. Decoration mismatch
- 15. What is the portion of a structure above ground called?**
 a. Substructure b. Plinth c. Basement d. Superstructure
- 16. Parapet wall is provided for ____.**
 a. Decoration only b. Insulation
 c. Roof safety and privacy d. Load bearing
- 17. What is the minimum area of a small bedroom?**
 a. 50sq ft b. 80sq ft c. 100sq ft d. 150sq ft
- 18. Drawing room should be accessed from ____.**
 a. Bedroom b. Kitchen c. Main entrance d. Verandah
- 19. Cement is used as a ____ in construction.**
 a. Binder b. Insulator c. Filler d. Reinforcement
- 20. The main ingredient in concrete is ____.**
 a. Clay b. Steel c. Cement d. Wood
- 21. Which material is used in DPC to prevent dampness?**
 a. Glass b. Bitumen c. Wood d. Paint
- 22. Plumbing drawings show ____.**
 a. Lighting plans b. Furniture layout c. Water systems d. Wall thickness
- 23. Which of the following is a softwood?**
 a. Teak b. Mahogany c. Pine d. Sal
- 24. Concrete is made up of ____.**
 a. Clay and lime b. Cement, sand, aggregate, water
 c. Sand and water d. Cement and wood
- 25. Flush joint in brickwork is ____.**
 a. Recessed b. Raised c. Level with the surface d. Concave
- 26. The tool used to make concave joints is ____.**
 a. Rake b. Trowel c. Pointer d. Round jointer
- 27. Steel is commonly used in RCC for ____.**
 a. Decoration b. Flexibility c. Reinforcement d. Waterproofing
- 28. Pre-stressed concrete is mainly used in ____.**
 a. Roofing tiles b. Pavements c. Long-span structures d. Interior walls
- 29. Which type of bond has one course of headers and one course of stretchers?**
 a. Flemish bond b. English bond c. Stack bond d. Header bond
- 30. The purpose of mortar is to ____.**
 a. Decorate bricks b. Act as insulation c. Bind bricks/stones d. Block moisture
- 31. Ready-mix concrete is produced ____.**
 a. On-site by hand b. On-site by machine c. At a central plant d. Using only cement

32. Which joint is sloped outward to drain water?

- a. Raked b. Weathered c. Struck d. Flush

33. Which one is a hardwood?

- a. Pine b. Cedar c. Teak d. Fir

34. The scale 1:100 means ____.

- a. 1 unit = 10 units b. 1 unit = 100 units c. 1 cm = 1 meter d. None of the above

35. Which foundation type is used for weak soil and heavy loads?

- a. Raft b. Strip c. Pile d. Spread footing

36. DPC is placed at which part of the wall?

- a. Roof level b. Window sill c. Base of the wall d. Parapet

True Answer

1.	c	2.	c	3.	c	4.	b
5.	c	6.	b	7.	c	8.	c
9.	c	10.	a	11.	c	12.	c
13.	a	14.	b	15.	d	16.	c
17.	c	18.	c	19.	a	20.	a
21.	b	22.	c	23.	c	24.	b
25.	c	26.	d	27.	c	28.	c
29.	b	30.	c	31.	c	32.	b
33.	c	34.	b	35.	c	36.	c

Learning Outcomes:

After completion of this learning module, trainee will be able to:

- Perform Toning and Shading
- Perform Manual Rendering

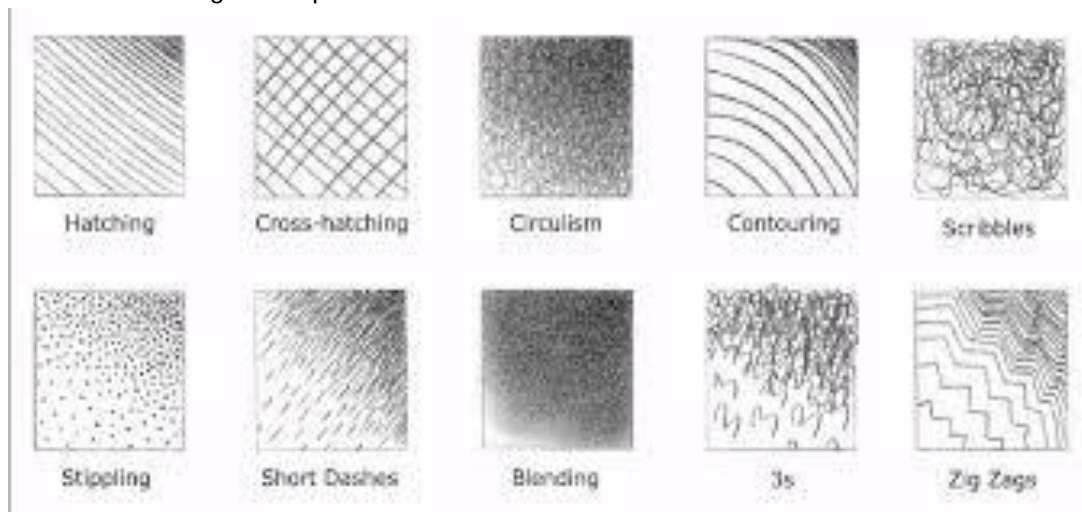
Learning Unit 2.1**Perform Toning and Shading****Learning Outcomes:**

After completion of this Learning Unit, trainee will be able to:

- Draw elements of design
- Draw principles of design
- Draw different shapes
- Practice of Sciography with shades and shadows.

2.1.1 Shading Techniques in Drawing

Shading techniques used to create texture, depth, and shading by using closely spaced lines. Here are some common shading techniques:



- **Parallel Hatching**
Lines are drawn parallel to each other, usually in one direction. The closer the lines, the darker the area appears.
- **Cross-Hatching**
Two or more sets of parallel lines cross over each other. Adds more depth and is great for shadows and high contrast.
- **Contour Hatching**
Lines follow the contours or curves of the subject. This technique enhances the form and gives a 3D effect.
- **Tick Hatching (or Stippling + Lines)**
Uses short, dash-like strokes. Often applied in a way that mimics texture like skin or fur.
- **Scribble Hatching**
Loose, random scribbles that build up value. Good for rough textures or quick sketches.
- **Cross-Contour Hatching**
A more advanced version of contour hatching, where lines wrap around the form in multiple directions, emphasizing volume.
- **Stippling (technically not hatching, but often grouped with it)**
Uses small dots instead of lines. The denser the dots, the darker the tone.

Remember

Vary line thickness to adjust the darkness. Change the angle or density of the lines to create texture. Use a fine-tip pen or pencil for controlled dot placement. Keep your pencil strokes aligned with the shape's curves for a natural look. Work gradually to build up the tone without over-blending, which can lead to a loss of texture.

- **Blending**

Smooth transitions achieved by gently rubbing the graphite with a blending stump, tissue, or even your finger. Creates soft, realistic shadows and smooth gradients.



2.1.2 Element of Drawing



- **Line:** A mark with length and direction. It can be straight, curved, thick, thin, etc.
- **Shape:** A two-dimensional area enclosed by lines. Can be geometric (circle, square) or organic (free-form).
- **Form:** A three-dimensional object or illusion of 3D (like cubes, spheres, etc.).
- **Color:** Hue (name of the color), value (lightness/darkness), and intensity (brightness/dullness).
- **Value:** The lightness or darkness of tones or colors; used to create contrast and depth.
- **Texture:** The surface quality (how it feels or looks like it feels – rough, smooth, soft, etc.).

2.1.3 Principle of Drawing



- **Space:** The area around, between, or within objects.
- **Balance:** Distribution of visual weight (symmetrical, asymmetrical, or radial).
- **Contrast:** Differences in elements (light vs. dark, rough vs. smooth, etc.) to create interest.
- **Emphasis:** Creating a focal point or area of interest in the artwork.
- **Movement:** The path the viewer's eye follows through the artwork, often to focal areas.
- **Rhythm:** Repetition of elements to create a sense of flow or visual beat.
- **Unity:** All elements work together harmoniously to create a cohesive piece.
- **Proportion:** The relationship of sizes between different parts of the artwork.
- **Variety:** Using different elements to create interest and avoid monotone

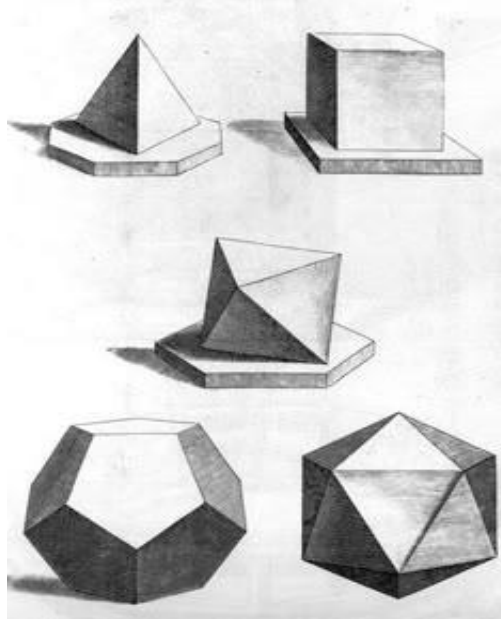
Use of different colours



Using different colors in drawing can add depth, interest, and meaning to a piece. It can also be used to create a specific mood, emphasize certain elements, and even create the illusion of three-dimensionality. By understanding color theory and how colors interact, artists can effectively use them to enhance their artwork.

2.1.4 Sciography in Architecture

It is the depiction of shadows and gradations of light and shade used in architecture to accurately represent how light interacts with objects and surfaces. It involves studying the manner in which various objects cast shadows based on assumptions about the light source's position, intensity, and direction.

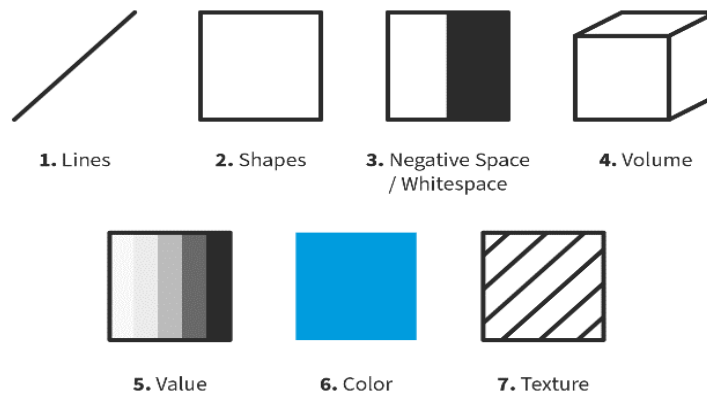


- Buildings designed by architects will have architectural forms/roof-forms, creative designs for facades with fenestrations.
- Effective representation of these elements requires the application of sciography techniques
- It provides an effect of height or depth in a drawing.
- Multiple planes of projecting and receding surfaces, projecting canopies, sunshades and balconies can be shown very effectively.

Activity 1:

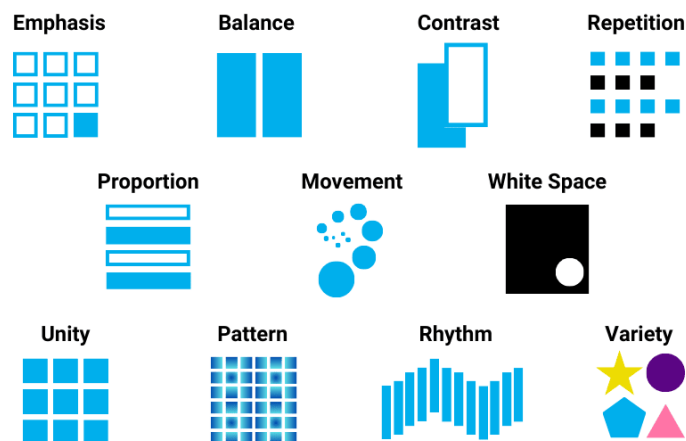
Practice to create designs with elements of design and label them.

Visual Design Elements



Activity 2:

Practice to create designs with principles of design.



Activity 3:

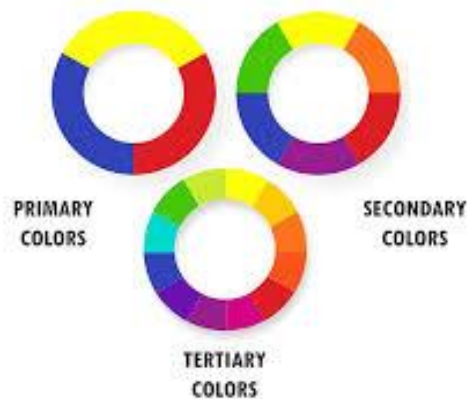
Practice to draw Sciography with shades and shadows.

- **Step-1: Light Source:** Establish direction, angle, and intensity
- **Step-2: Basic Forms:** Sketch the structure accurately.
- **Step-3: Shadow Zones:** Identify areas blocked from light.
- **Step-4: Core Shadows:** Darken regions with minimal light.
- **Step-5: Mid-Tones:** Gradually blend between dark and light.
- **Step-6: Highlights:** Keep direct light areas bright.
- **Step-7: Refine:** Smooth transitions and adjust edges for realism.

Learning Outcomes:

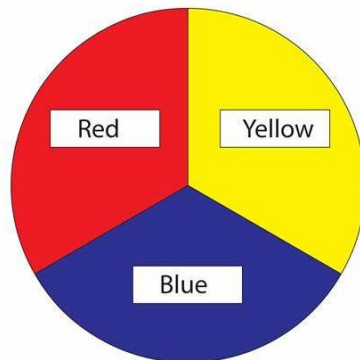
After completion of this Learning Unit, trainee will be able to:

- Draw and paint color wheel
- Render different shapes with tints and shades
- Render design with different color schemes
- Render design with pencil color technique
- Render design with poster color technique
- Render design with graphite pencil technique

2.2.1 Knowledge of Color wheel**Primary Colors**

These are the base colors that cannot be made by mixing other colors.

- **Red**
- **Blue**
- **Yellow**

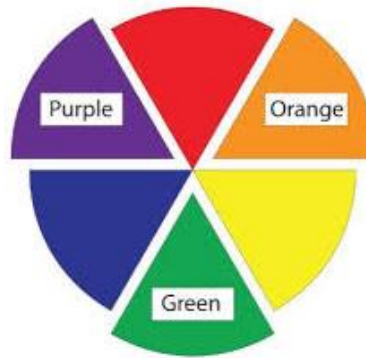
**Remember**

Start with small amounts of paint or ink and gradually mix to avoid waste.

Secondary Colors

Made by mixing two primary colors in equal parts.

- **Green** (Blue + Yellow)
- **Orange** (Red + Yellow)
- **Purple/Violet** (Red + Blue)

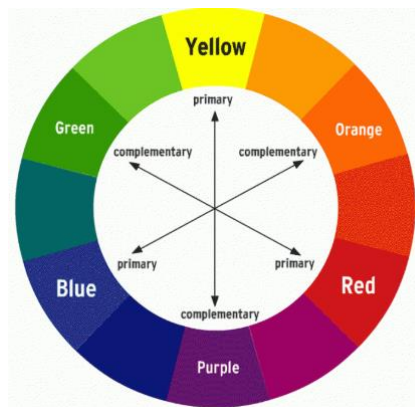


Tertiary Colors

Formed by mixing a primary color with a neighboring secondary color.

Examples:

- Red-Orange
- Yellow-Green
- Blue-Violet

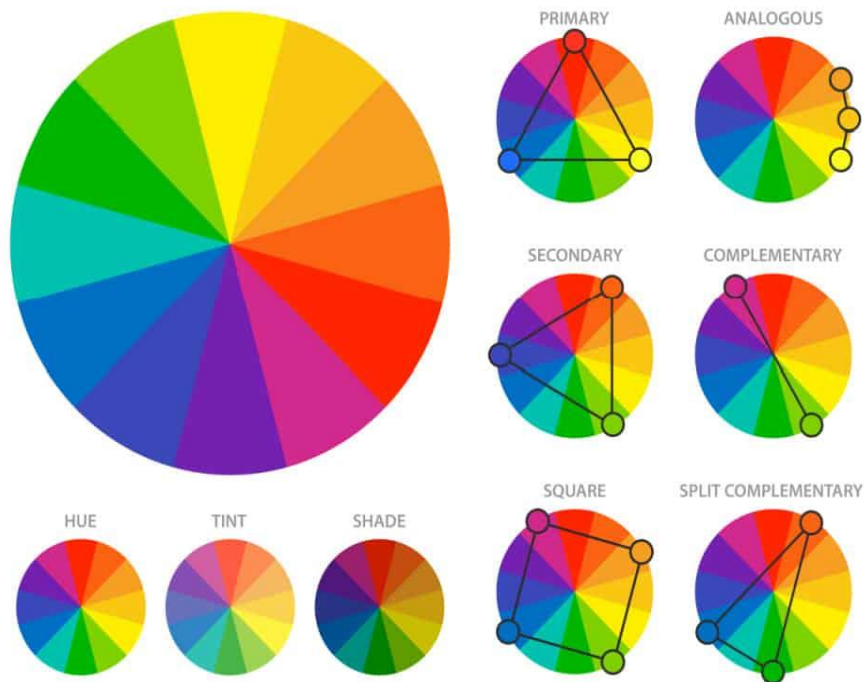


2.2.2 Color Techniques and Combination

Several types of colour combinations can be used to create different effects and moods. Here's a list of common colour combinations and their characteristics:

- **Monochromatic:** This scheme uses different shades, tones, or tints of a single colour, creating a harmonious and cohesive look.
- **Complementary:** As mentioned earlier, this involves pairing colours opposite each other on the colour wheel, creating a high-contrast and vibrant effect.
- **Analogous:** Using colours adjacent to each other on the colour wheel creates a harmonious and soothing colour scheme.
- **Triadic:** This combination involves using three equidistant colours on the colour wheel, creating a balanced and bold effect.
- **Split-Complementary:** This scheme uses one colour and the two colours adjacent to its complement, creating a high-contrast yet balanced look.
- **Double-Complementary (Tetradic):** This combination uses two pairs of complementary colours to create a rich and varied effect.
- **Tint** A base color combined with white in varying quantities creates a tint.
- **Shade** A base color combined with black in varying quantities creates a shade. **Tone** - A base color combined with gray in varying quantities creates a tone.

COMBINATION OF COLORS



2.2.3 Draw and Paint Color Wheel

Steps:

- Draw a circle and divide it into 12 equal sections like a pie chart.
- Start with Primary Colors: Red, Blue, Yellow (place them at equal distances).
- Mix primary colors to create Secondary Colors: Orange, Green, Violet.
- Mix secondary and primary colors to make Tertiary Colors: Red-Orange, Yellow-Orange, Yellow-Green, Blue-Green, Blue-Violet, Red-Violet.
- Paint: Use poster colors or watercolors.

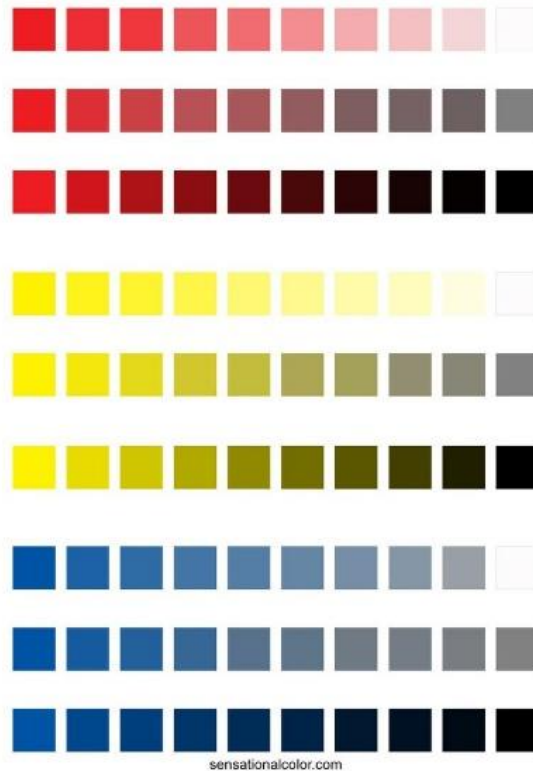
Render Different Shapes with Tints and Shades

Shapes: Circle, Cube, Cylinder, Sphere, Cone.

Technique:

- **Tint:** Add white to your color.
- **Shade:** Add black to your color.
- Use light source direction to create realistic shadows and highlights.
- **Medium:** Poster colors or pencil colors.

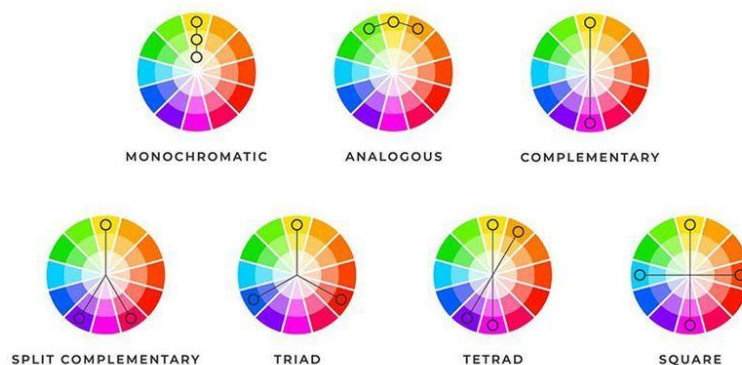
VALUE CHANGES OF THE PRIMARY COLORS



Render Design with Different Color Schemes

- Choose any simple design (like floral, geometric, or motif pattern).
- Apply different color schemes:
- **Monochromatic:** Different tints & shades of one color.
- **Analogous:** 3 colors side-by-side on the color wheel.
- **Complementary:** Opposite colors on the wheel (e.g., blue & orange).
- **Triadic:** 3 colors evenly spaced on the color wheel (e.g., red, yellow, blue).

Color Schemes

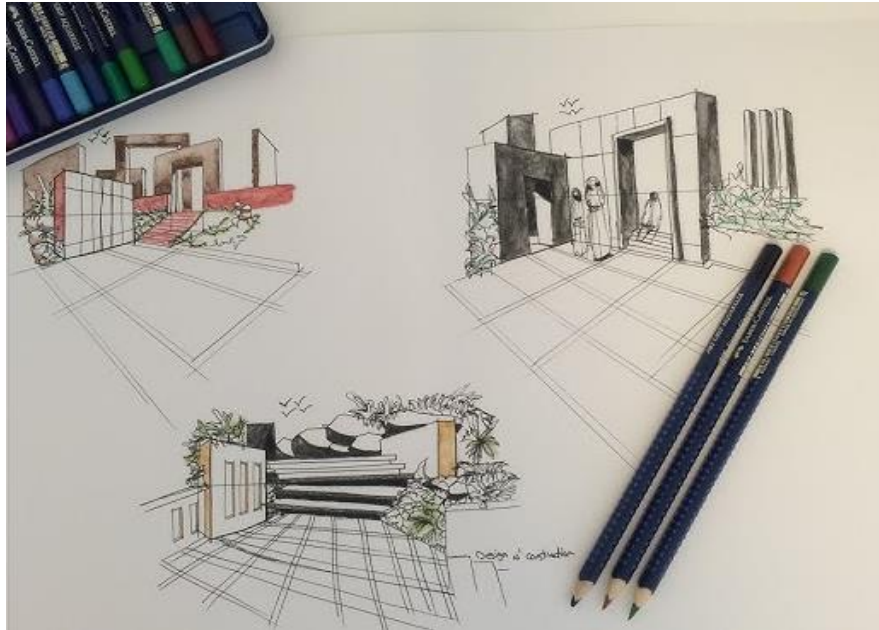


Render Design with Pencil Color Technique

Tools: Soft, high-quality colored pencils.

Tips:

- Use layering and blending techniques.
- Add textures, gradients, and shadows.
- Burnishing for smooth finish.
- Choose a theme (floral, fabric print, scenery) and fill with pencil colors.



Render Design with Poster Color Technique

Materials: Poster colors, flat & round brushes.

Method:

- Keep colors opaque.
- Apply base color first.
- Layer with details.
- Maintain brush control for clean lines and precision.

Render Design with Water colors Technique Materials:

Use watercolor paper, brushes, and either tubes or pans of watercolor paint.



Techniques:

- **Wet-on-Wet:** Apply paint to wet paper for soft, blended edges.
- **Wet-on-Dry:** Apply wet paint to dry paper for sharper details.

Steps:

- **Sketch:** Lightly outline your design.
- **Background:** Start with a light wash for the background.
- **Details:** Gradually build up layers for detail, letting each layer dry before adding the next.



Finishing:

Add contrast and final details once dry.

Render Design with Graphite Pencil Technique

- **Pencils:** Use a range of HB, 2B, 4B, 6B, and 8B.
- **Technique:**
 - Use shading, hatching, cross-hatching, and blending.
 - Erasers can be used for highlights.
 - Ideal for fashion illustration, still life, or object design in monochrome.

PENCIL GRADING CHART

9B	F
8B	H
7B	2H
6B	3H
5B	4H
4B	5H
3B	6H
2B	7H
B	8H
HB	9H

Activity: 1

Practice to draw color wheel with color tints and shades.

Steps

- Draw a Circle
- Divide it into 12 equal parts.
- Add Colors
- Primary: Red, Yellow, Blue

- Secondary: Orange, Green, Violet
- Tertiary: Mix of primary + secondary (e.g., Red-Orange)
- Add Tints & Shades
- Next to each color:
- Tint = Color + White (lighter)
- Original Color
- Shade = Color + Black (darker)

Practice to render building/interior sketches with following:

- pencil colors
- poster colors
- water colors
- graphite pencil
- Waste materials (paper, bottle caps, nut shells etc.)

Activity: 2

Steps:

Draw the Basic Outline

- Sketch the building or interior space using light pencil lines.
- Use 1-point or 2-point perspective for interiors (walls, furniture, doors, windows).

Define Surfaces

- Outline different areas: floor, walls, ceiling, furniture, decor items.

Apply Shading

- Use pencil shading (2B/4B) for depth and shadows.
- Shade one side of objects to show light direction.

Add Textures

- Show wood grain, brick, tiles, fabric patterns, etc.
- Use cross-hatching or stippling for realistic texture.

Add Colors

- Use neutral tones for walls and floors.
- Apply color harmony (based on color schemes).
- Blend colors for soft transitions.

Highlight & Final Touches

- Use white pencil or eraser for light reflections.
- Ink the outlines for a clean finish.

Summary

This module develops learners' skills in toning, shading, and manual rendering within architectural and design graphics. It focuses on building a strong understanding of light, shadow, and tonal value to create drawings with depth, texture, and realism. Through practical exercises, students will master techniques such as hatching, cross-hatching, stippling, and blending, enhancing their ability to communicate form and materiality effectively. By the end of the module, learners will confidently produce expressive and visually engaging hand-drawn illustrations, essential for creative presentation and professional design communication.

FAQs:

Q1: What is the role of line in design?

Ans. Line defines shapes, creates movement, and guides the viewer's eye through the composition. Lines can vary in width, length, direction, and texture.

Q2: How does shape function in design?

Ans. Shape is a two-dimensional area that defines objects and structure in a design. Shapes can be geometric (such as squares, circles, and triangles) or organic (irregular, free-form shapes). Shapes are used to create patterns, symbols, and compositions.

Q3: Why is color important in design?

Ans. Color adds visual interest and emotional impact to a design. It helps convey mood, create emphasis, and define relationships between elements.

Q4: What is texture in design?

Ans. Texture refers to the surface quality of an object. It can be actual texture (physical feel) or implied texture (how it looks it might feel). Texture adds depth and realism to a design.

Q5: How does space function in design?

Ans. Space refers to the area around, between, and within elements of a design. Use of space creates balance, avoids overcrowding, and can make a design feel more open or compact. Space is also used to create depth through techniques like perspective.

Q6: What does emphasis mean in design?

Ans. Emphasis refers to the focal point or area that draws the viewer's attention first. It is achieved by using techniques like contrast, color, size, or placement to highlight a particular part of the design.

Q7: How does pattern play a role in design?

Ans. Pattern refers to the repetition of visual elements like shapes, lines, or colors. It creates a sense of rhythm and consistency in the design.

Q8: What is manual rendering in architectural graphics?

Ans. Manual rendering is the process of creating hand-drawn visual representations of architectural forms using tools like pencils, pens, markers, or other media. It involves applying techniques such as toning, shading, and texture.

Q9: Why is manual rendering important in architectural design?

Ans. Manual rendering allows architects and designers to visually communicate ideas, explore design concepts, and present them in a more expressive and human-centered way.

Q10: Name three common techniques used in manual rendering.

Ans. Hatching, Cross-hatching, Stippling

Q11: What materials are commonly used for manual rendering?

Ans: Common materials include graphite pencils, ink pens, markers, colored pencils, charcoal, blending tools, and textured paper.

Q12: How does shading improve a hand-drawn architectural illustration?

Ans: Shading helps create the illusion of three-dimensionality, defines form and volume, and conveys the direction and intensity of light, making the drawing more realistic and visually engaging.

Q13: What is the role of tonal value in manual rendering?

Ans: Tonal value refers to the lightness or darkness of a shade. In manual rendering, it's used to define contrast, depth, and spatial relationships.

Q14: What are the advantages of manual rendering over digital rendering?

Ans: Manual rendering allows for more personal expression, spontaneity, and a tactile quality that digital tools sometimes lack. It also fosters stronger observational skills and a deeper connection with the design process.

MCQS

1. Which of the following is NOT an element of design?

- a. Line b. Balance c. Texture d. Space

2. The element of design that defines the surface quality (smooth/rough) is:

- a. Value b. Form c. Texture d. Color

3. Which element creates the illusion of depth in a drawing?

- a. Shape b. Form c. Color d. Line

4. Symmetrical and asymmetrical arrangements are types of?

- a. Rhythm b. Balance c. Variety d. Unity

5. In hatching, lines drawn closer together will make the area appear?

- a. Lighter b. Brighter c. Darker d. Textured
- 6. Which hatching technique is best for soft, smooth shading transitions?**
- a. Blending b. Dotting c. Cross Hatching d. Parallel Hatching
- 7. What is the darkest part of a shaded object called?**
- a. Highlight b. Core shadow c. Mid tone d. Light source
- 8. What does Sciography primarily deal with?**
- a. Representing shades and shadows in drawing b. Creating color palettes
c. Drawing Texture d. Designing patterns
- 9. What are the primary colors?**
- a. Red, Green, Blue b. Red, Yellow, Blue
c. Orange, Purple, Green d. Cyan, Magenta, Yellow
- 10. What is a monochromatic color scheme?**
- a. Using opposite colors b. Using three primary colors
c. Using tints and shades of one-color d. Using random colors

True Answer

1.	b	2.	c	3.	b	4.	b
5.	c	6.	a	7.	b	8.	a
9.	b	10.	c				

Learning Outcomes:

After Completion of this learning Units, trainee will be able to:

- Draw Basic 3D Surfaces
- Develop 3D Model
- Comprehend Complex 3D Surfaces
- Render 3D Model

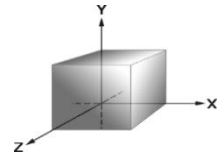
Learning Unit 3.1**Draw Basic 3D Surfaces****Learning Outcomes:**

After Completion of this learning outcomes, trainee will be able to:

- Setup & save 3D drawing interface for required specifications
- Locate Mesh tab from 3D Modelling dropdown option of solids panel
- Apply different Mesh primitive
- Apply smoothness and refinement on Meshes (even legacy 2D drawings)
- Add or Remove Mesh Creases
- Enable Mesh editing
- Perform convert Meshes

3.1.1 3D and its Concepts

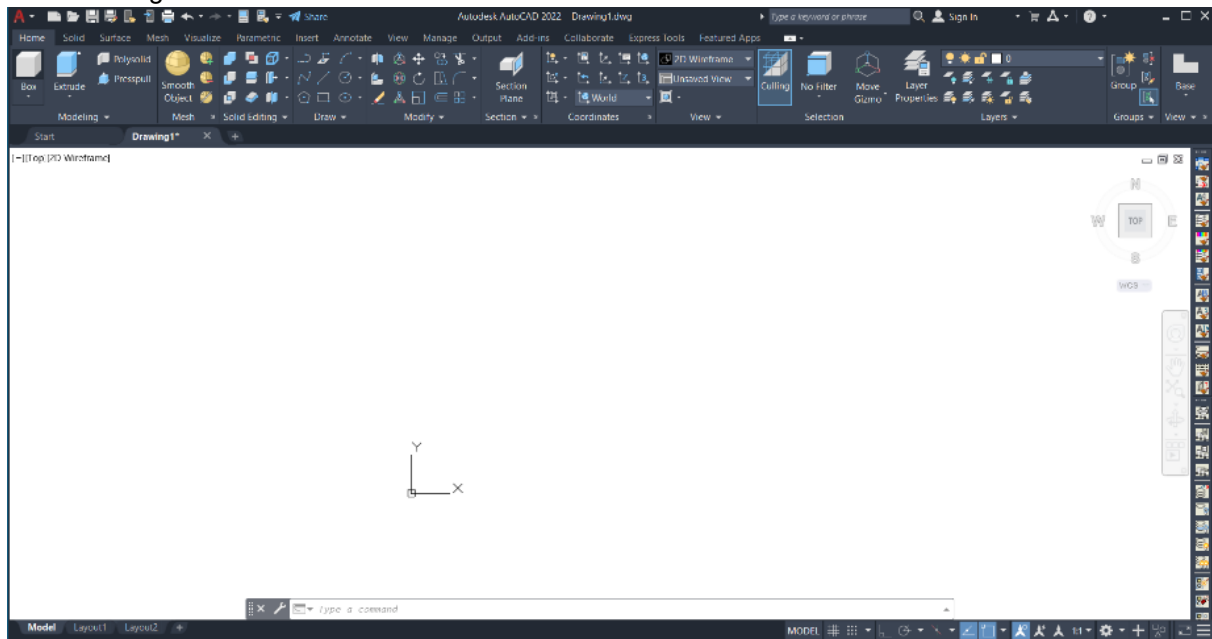
3D refers to objects or spaces that have three dimensions length, width, and depth. 3D Space defined by three axes X (horizontal), Y (vertical), and Z (depth). Coordinates: Points in 3D space are represented as (X, Y, Z).

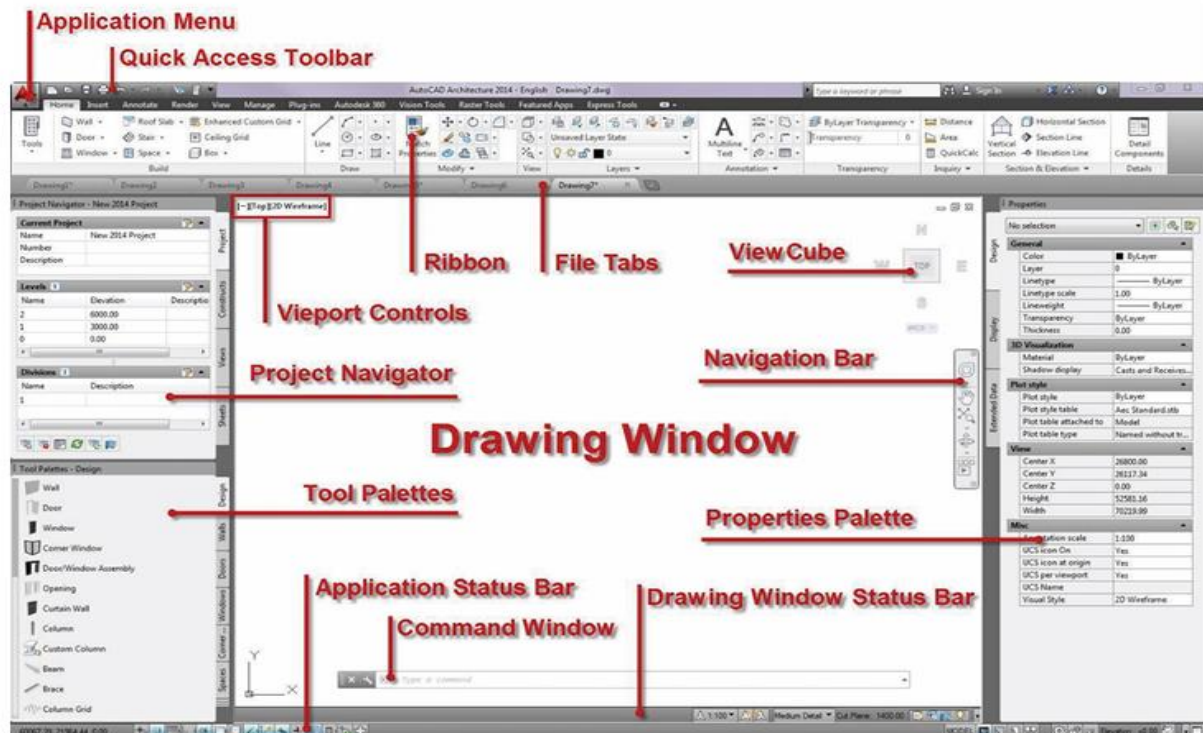
**3.1.2 Functions of 3D Tools and Commands**

The functions of 3D tools and commands in AutoCAD program is to create, modify, analyze, and visualize three-dimensional objects. These tools and commands enable users to design complex models, simulate real-world conditions, and produce accurate technical drawings or renderings.

3.1.3 Setup & Save 3D Drawing Interface for Required Specifications:

The following is AutoCAD's 3D Basic interface. The 3D Basic ribbons are as follows:





3.1.4 Changing 2D Drawings to 3D Drawings

You've been using the Drafting & Annotation workspace to create your drawings in 2D. Your first task in transitioning into 3D begins by switching to a new workspace for working in 3D and changing how AutoCAD displays the available tools.

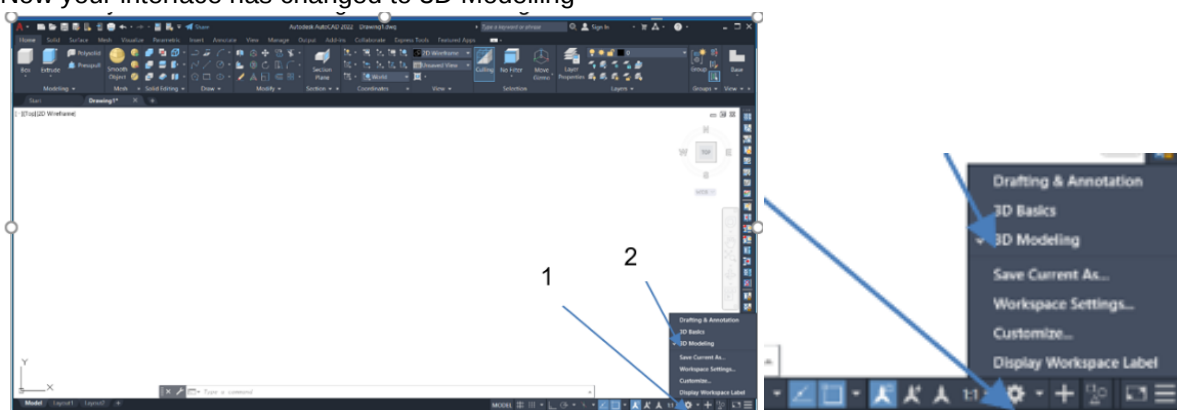
Step by Step Operation

Get ready before you begin these steps, be sure to turn on and/or log on to your computer.

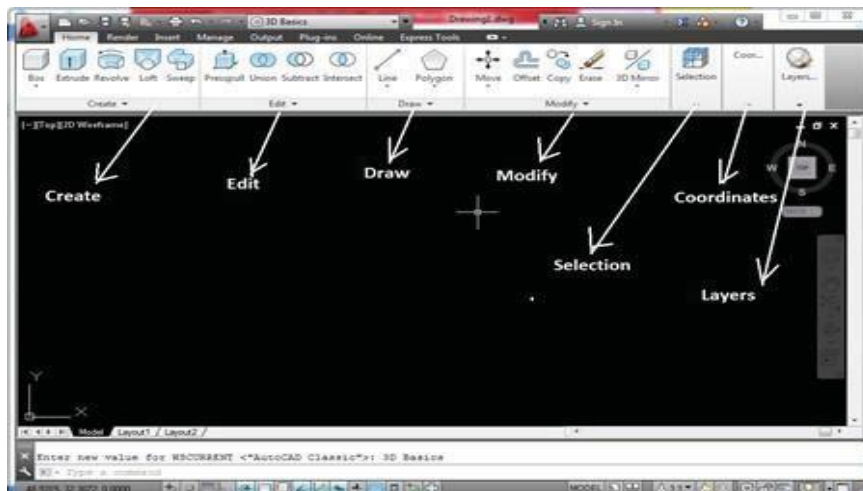
Procedure

- Click the Autodesk folder
- AutoCAD opens and a new blank drawing appears
- Click the workspace switching drop down arrow or icon.
- Click on workspace switching
- Click on 3D modeling

Now your interface has changed to 3D Modelling



The following figure show 3D Basic Ribbons.



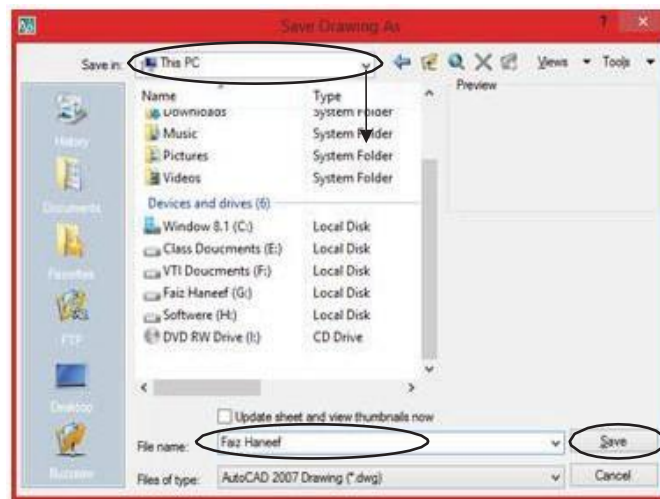
Remember

You can also change Version of file from Files of type in Save Drawing as dialogue box.

3.1.5 Save the file.

Short cut = **Ctrl+S**

File ☐ Save ☐ Open the Save window ☐ Select location ☐ Write the file Name ☐ Save



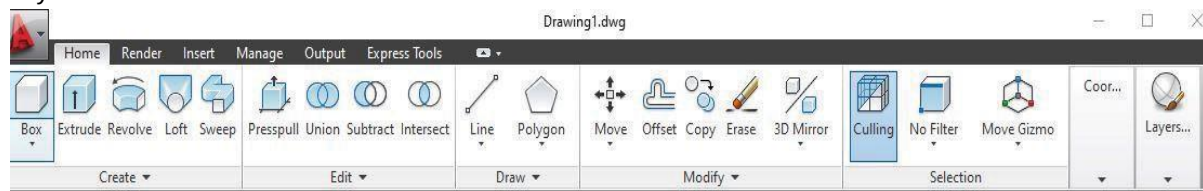
3.1.6 AutoCAD 3D Basic Ribbons

For the 3D Basics options, there are following tabs for ribbons.

HOME, RENDER, INSERT, MANAGE, OUTPUT and EXPRESS TOOLS.

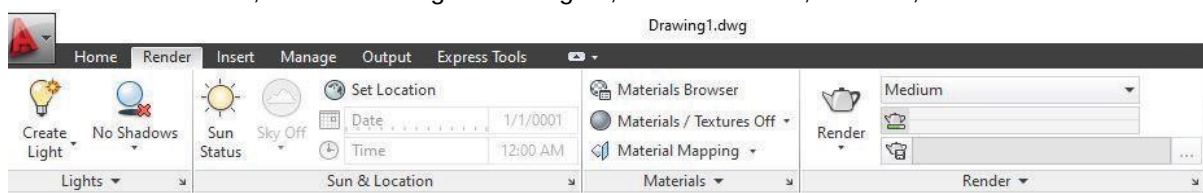
Home

For the HOME tab, there are categories of Create, Edit, Draw, Modify, Selection, Coordinates and Layers & Views.



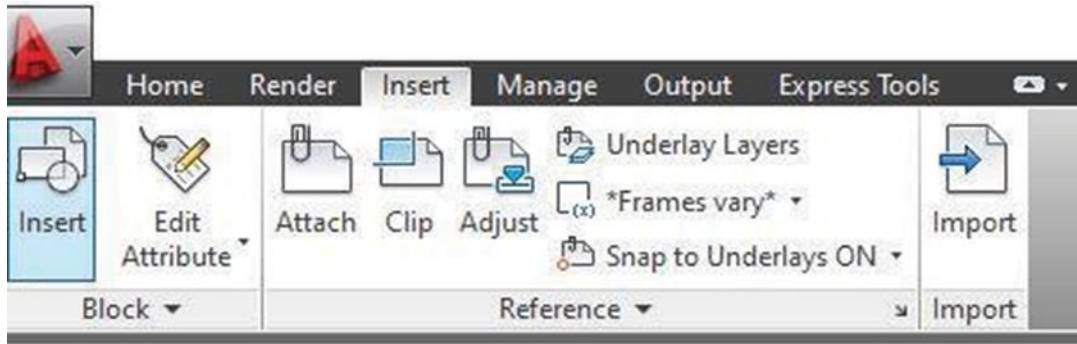
Render:

For the RENDER tab, there are categories of Lights, Sun & Location, Material, and Render.



Insert

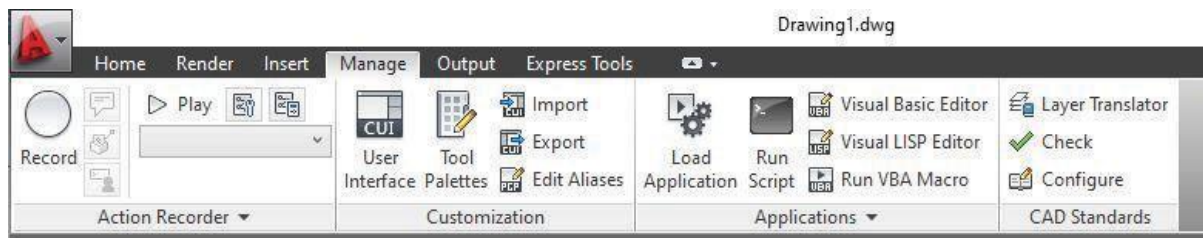
For the INSERT tab, there are categories of Block, Reference, and Import.



[1] [Top] [2D Wireframe]

Manage:

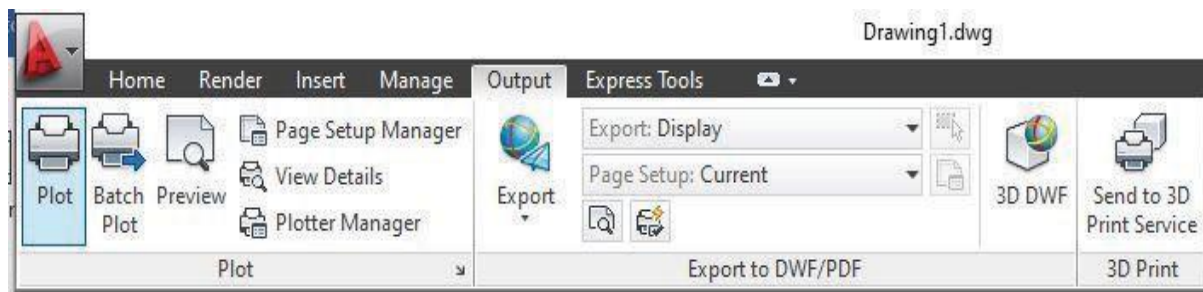
For the MANAGE tab, there are categories of Action Recorder, Customization, Applications, and CAD Standards.



[1] [Top] [2D Wireframe]

Output

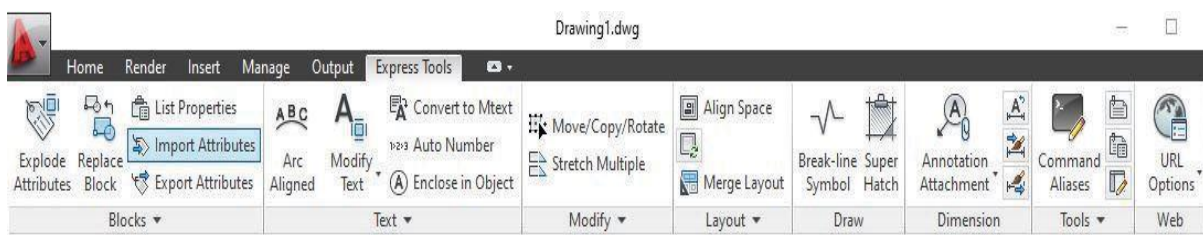
For the OUTPUT tab, there are categories of Plot, Export to DWF/ PDF, and 3D Print.



[1] [Top] [2D Wireframe]

Express Tools

For the EXPRESS TOOLS tab, there are categories of Blocks, Text, Modify, Layout, Draw, Dimension, Tools and Web.



3.1.7 Setup 3D User Interface Setting for Required Specifications.

Save drawing and Activate all Tabs required for 3D to work with 3D modeling. Important work after starting drawing.

We need following five steps to use before start of a drawing in Auto Cad Software. These steps are given below:

Open the AutoCAD.

There are three methods to open the Auto Cad.

- By Icon
- By Start Menu
- By Run

By Icon

- Go to the desktop è Double click on **Auto Cad** Software Icon.

By Start Menu

- Go to start è program è Auto desk è **Auto Cad**

By Run

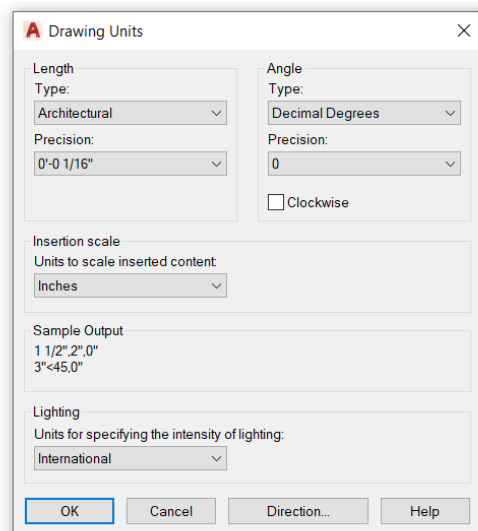
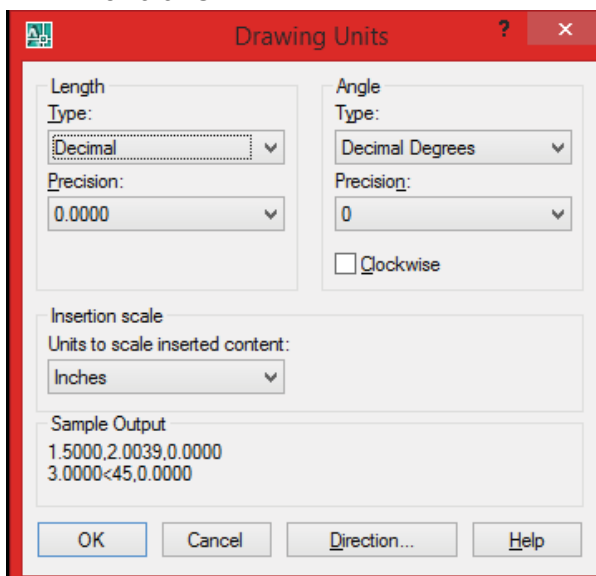
- Go to Start è Open the start window è write the Auto Cad in Run Window.

Set the Drawing Units.

Methods to set Drawing Units

By Dialog box UNIT

- Short cut = UN
- Change **type** to **Architectural**
- Change **precision** to 0'-0" 1/16"
- In intersection Scale:
- Units to scale inserted content to **inches**
- Then click **OK**



Drawing Limits

1. **Type** LIMITS in the command line and press **Enter**.
2. You'll be prompted to specify the **lower left corner** (usually 0,0).
3. Then specify the **upper right corner** (e.g., 420,297 for an A3 sheet in mm).
4. After that, type ZOOM → Enter → A (for **ALL**) to zoom to the limits.

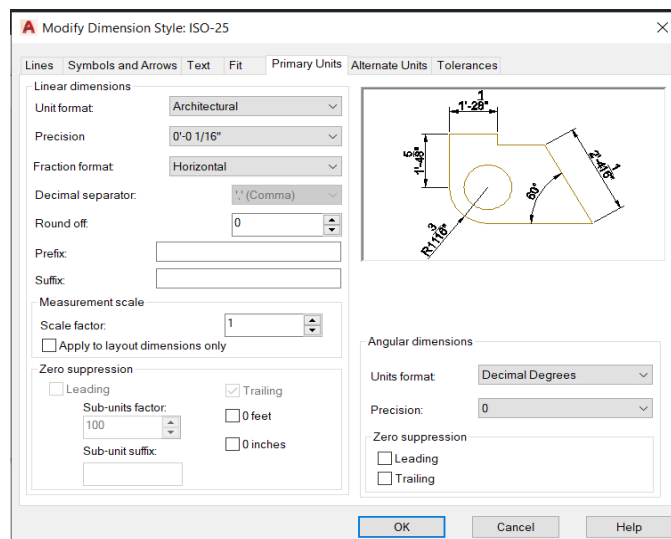
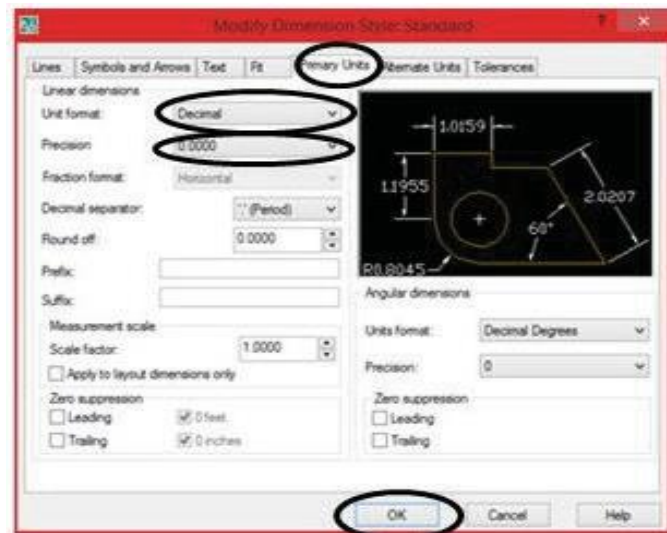
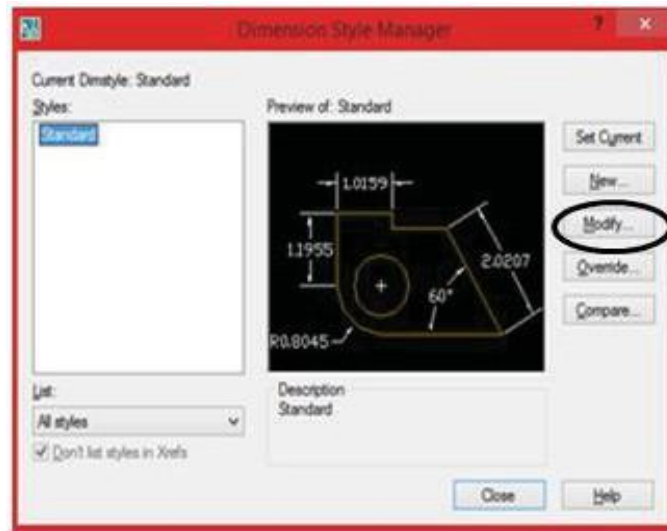
Snap on/off

- Type: SNAP → Press **Enter**
- Type ON or OFF to enable/disable snap

Set the Primary Unit

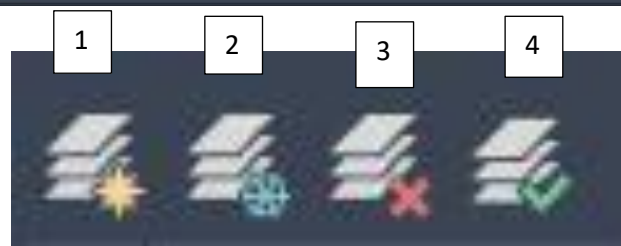
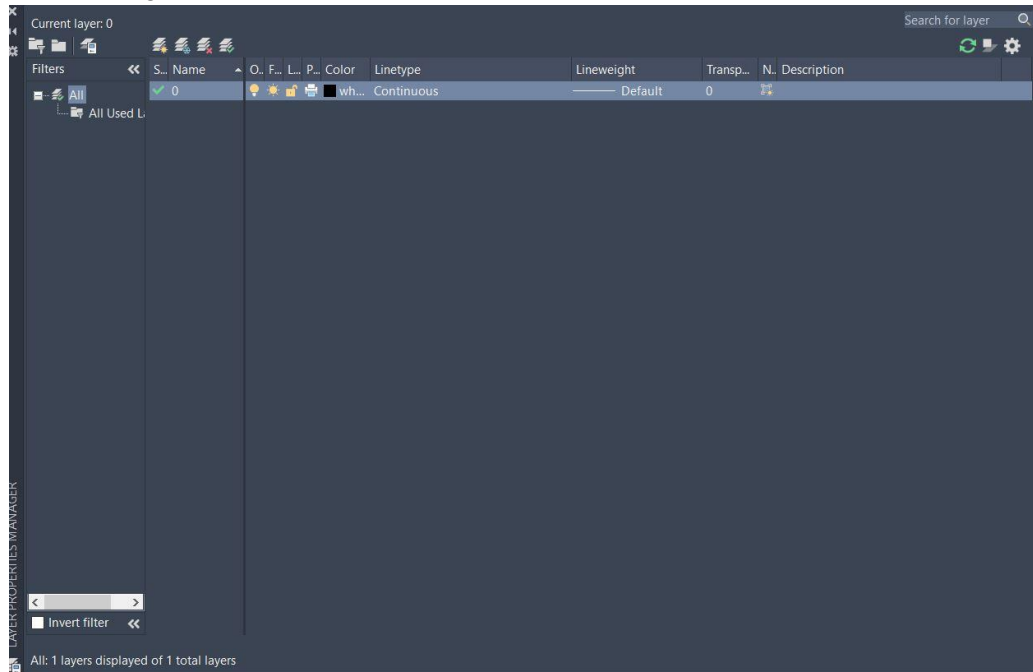
- Short cut = **D** □ (Enter)

- Modify ☐ Open sub window ☐ Go to primary unit Tab ☐ set the primary unit (Architectural) ☐ set the precision to 0'-0" 1/16" (as per Drawing units)
- ☐ OK ☐ Close.



Layer Options, Dimensioning & Text To Create & Manage Layers:

1. Type LA or click on Home > Layers > Layer Properties.
2. In the Layer Properties Manager:
 - Click New Layer
 - Name the layer (e.g., Walls, Text, Dimensions)
 - Set Color, Linetype, Lineweight as needed
 - Click the lightbulb to turn it on/off, sun to freeze/thaw, or lock to lock it



- Create New Layer (alt + N)
- Freeze layer
- Delete layer (alt + D)
- Set Current (alt + C)

To Change Object to a Specific Layer:

- Select the object
- Go to the **Layer dropdown** (on the Home tab)
- Pick the target layer

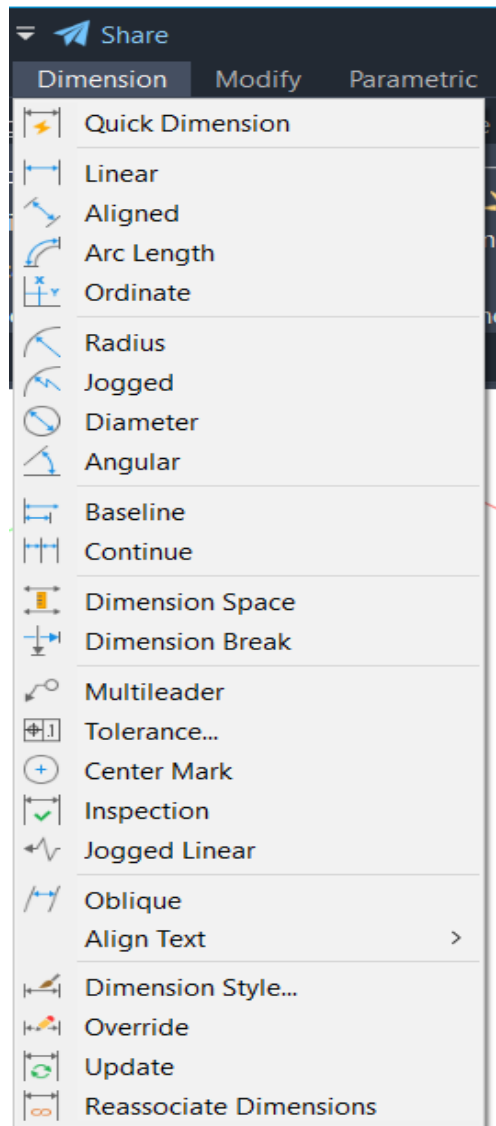
Useful Commands:

- LAYISO: Isolate selected layer(s)
- LAYUNISO: Undo isolation
- LAYMRG: Merge layers

Dimensioning – How to Add Dimensions

Method 1: Smart Dimension

- Type DIM → Press Enter
- Click two points (start & end of the line you want to measure)
- Place the dimension line where you want it



Method 2: Specific Dimension Types

Command	How to Use
DIMLINEAR	For straight horizontal/vertical lines
DIMALIGNED	For angled lines (follows the line's angle)
DIMANGULAR	Select two lines or an arc to show the angle
DIMRADIUS / DIMDIAMETER	Click a circle or arc
DIMCENTER	Marks the centre of circles or arcs

To Edit Dimension Style:

- Type DIMSTYLE or D
- Click **New** or **Modify**
- Change text size, arrow size, units, etc.
- Save it and set it as **Current**

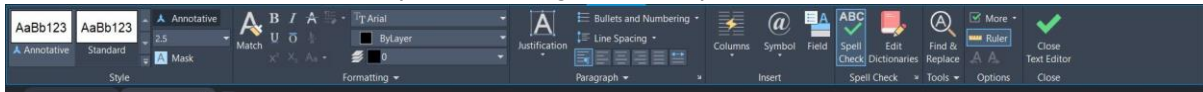
Text – How to Add Notes/Labels

Single-Line Text (TEXT):

- Type TEXT → Enter
- Click the start point
- Set height → Enter
- Set rotation (or Enter for 0°)
- Type your text → Enter → Enter to finish

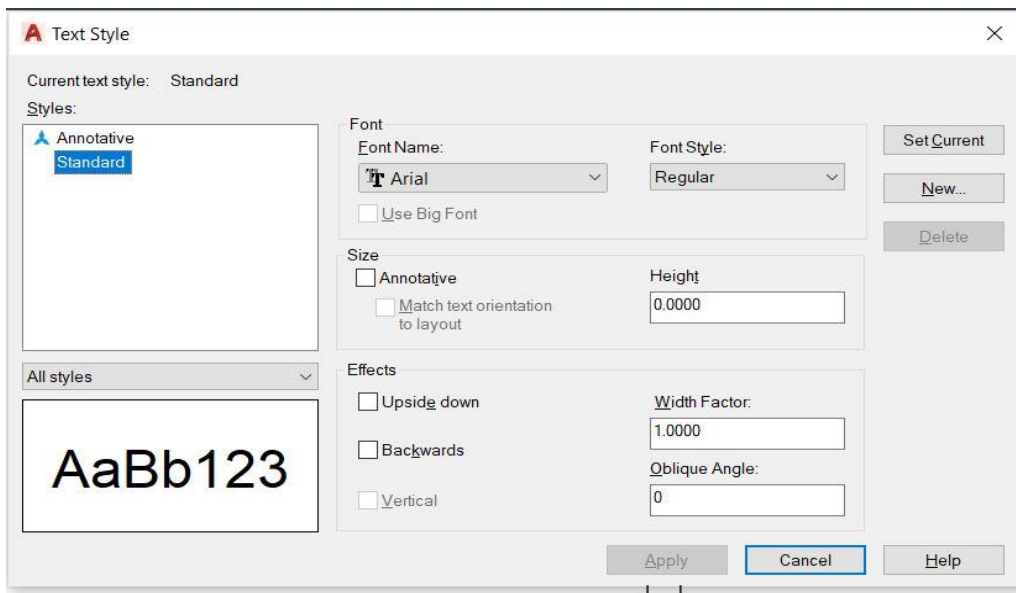
Multi-Line Text (MTEXT):

- Type MTEXT → Enter
- Click and drag a text box
- Type your paragraph or note
- Use the ribbon to format (font, bold, alignment, etc.)



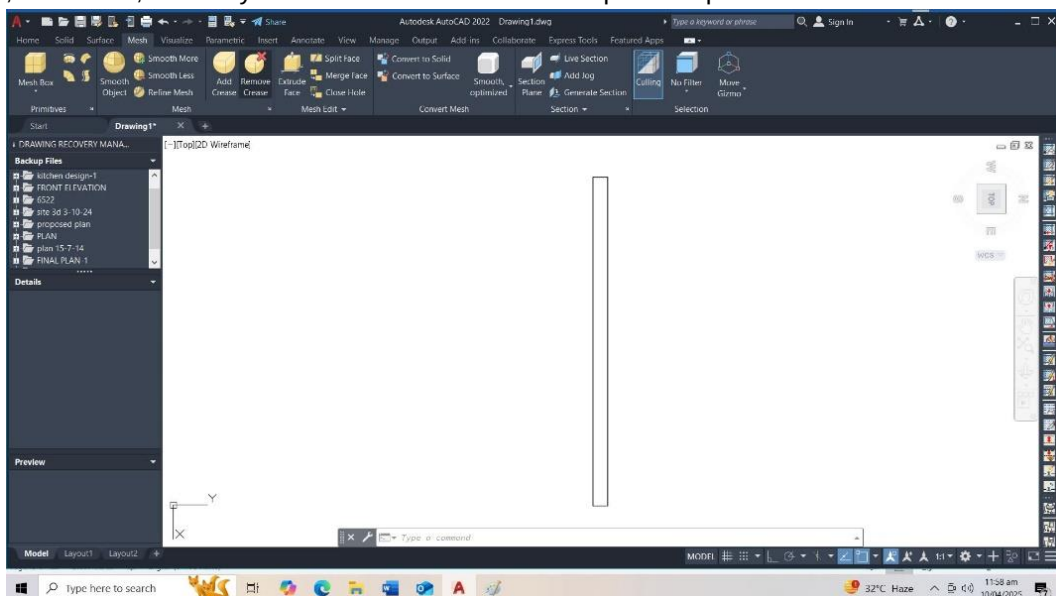
To Set Up Text Style:

- Type STYLE → Enter
- Click **New** or modify an existing one
- Choose font, height, width factor, etc.
- Save and set it as **Current**



Mesh Tab

The Mesh Tab in the ribbon (top menu bar) appears when you're working in a 3D modeling workspace. It gives access to tools to **create**, **refine**, and **edit** 3D mesh objects. Mesh objects are made of vertices, edges, and faces, and they are ideal for free-form or sculpted shapes.



Main Tools in the Mesh Tab

Mesh Primitives (Basic Shapes)

You can create base 3D shapes made of mesh:

Tool	Creates...
Mesh Box	A cube/rectangular solid
Mesh Cylinder	A mesh-based cylinder
Mesh Cone	A cone shape
Mesh Sphere	A sphere
Mesh Pyramid	A pyramid shape
Mesh Wedge	A wedge-like solid
Mesh Torus	Donut shape (ring)

You can adjust divisions (mesh density) while creating the shape.

Mesh Editing Tools

Tool	What it does
Refine Mesh	Adds more mesh faces (smoother shape)
Coarsen Mesh	Reduces mesh faces (less detail)
Convert to Solid	Turns mesh into a 3D solid object
Smooth More/Less	Makes the object rounder or sharper
Split Face	Splits a mesh face into two
Extrude Face	Pulls a selected face outward
Merge Faces	Combines faces into one

Mesh Utilities & Conversion

- **Convert to Surface** – Converts a mesh into a surface model.
- **Convert to Solid** – Makes your mesh into a regular 3D solid (for manufacturing or printing).
- **Crease Tool** – Sharpens the edges/faces (useful after smoothing).

Difference between Meshes vs Solids

Meshes	Solids
Freeform shapes (organic, smooth)	Precise geometry (engineering)
Editable by faces/edges/vertices	Parametric design
Used in 3D printing, animation	Used in architecture/mechanical

Edit Tools in 3D CAD

Edit tools in 3D CAD to shape, refine, and customize 3D models. While creating basic shapes (boxes, cylinders, etc.) is just the starting point, edit tools give you full control to turn those shapes into real-world objects, architectural elements, machine parts, etc.

Command	What It Does	
3DMOVE / 3DROTATE	Move or rotate objects in 3D space	To Modify Geometry (e.g., aligning holes, fittings, or parts of a machine).
3DSCALE	Scale in 3D (independently in X/Y/Z if needed)	
PRESSPULL	Extrudes or cuts based on selection of a 2D shape	To Shape Custom Designs (Cuts, fillets, holes, and unique forms.)
EXTRUDE	Creates 3D shape from 2D object	
SLICE	Slices a 3D solid into parts	
FILLET	Round the edges of 3D solids	
UNION	Joins two or more solids into one	To Assemble Parts When building assemblies or structures.
SUBTRACT	Cuts one solid from another	

Command	What It Does	
INTERSECT	Creates a solid from overlapping parts only	To create a 3D solid from the common volume of two or more existing 3D solids, surfaces, or regions.
SECTIONPLANE	Creates a section cut of a 3D model	To creates a cutting plane to view the section of 3D objects.
SMOOTH	It is used to reduce the number of faces (edges) on a mesh object, making it appear smoother.	To Clean Up or Refine
REFINE	Refine the section view itself after it's created.	

Layout Settings & Printing of CAD Drawings and their Application

A Layout is a virtual paper space in CAD where you arrange drawing for printing (aka plotting). Think of it like a sheet of paper where you place your drawings with title blocks, viewports, and annotations.

How to Set Up a Layout:

Step-by-Step:

Go to Layout Tab:

- Click on Layout1 or Layout2 (bottom tabs)
- Or type LAYOUT → Enter

Set Page Size:

- Right-click the Layout tab → Page Setup Manager
- Click Modify → Choose paper size (e.g., A4, A3, A1)
- Select printer/plotter
- Set plot area: Layout
- Choose scale: usually 1:1

Insert a Title Block:

- Use INSERT to place a block (your company title block or standard one)
- Align it to the sheet border

Create a Viewport:

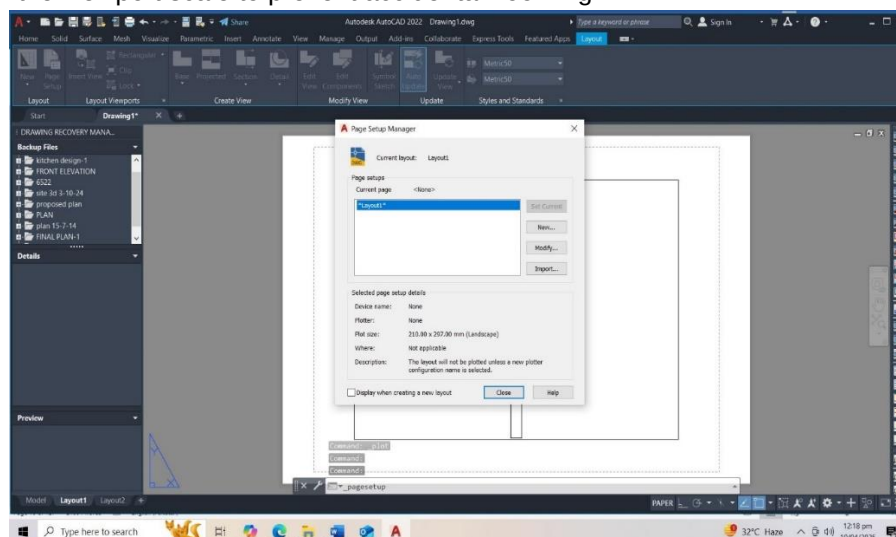
- Type MV (or MVIEW) → Draw a rectangle on the layout
- This creates a window into model space

Set Viewport Scale:

- Click inside the viewport → Select a scale from the bottom toolbar (e.g., 1:100, 1:50)
- Lock the viewport scale to prevent accidental zooming.

Remember

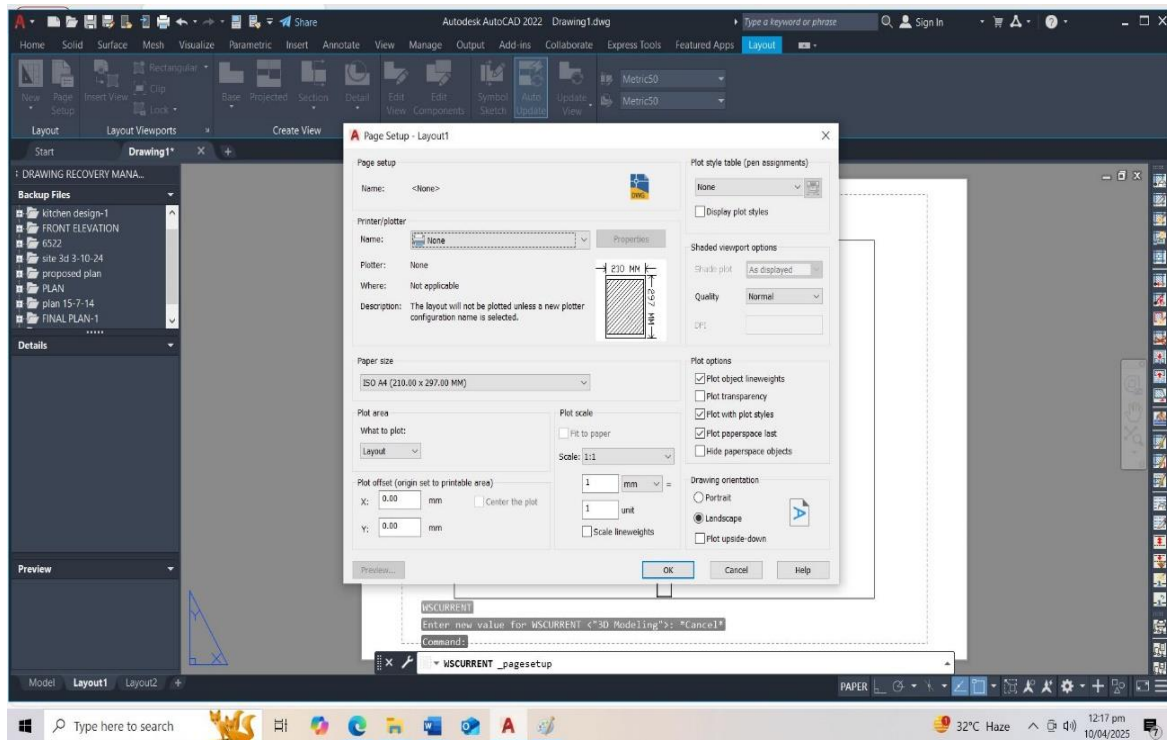
You'll often need to merge parts, check volume, or simplify the mesh/solid.



Printing / Plotting CAD Drawings

To Print a Drawing:

1. Type PLOT or click the **Print icon**
2. Choose printer/plotter (or PDF if saving digitally)
3. Plot area:
 - **Layout**: prints the paper space
 - **Window**: choose a specific area in model space
1. Choose plot style (monochrome, color, etc.)
2. Set paper size and orientation
3. Check **preview** to ensure layout is correct
4. Click **OK** to print or generate PDF



3.1.8 3D Blocks

The base of the box is always drawn parallel to the XY plane of the current UCS (work plane). The height of the box is specified in the Z-axis direction. You can enter both positive and negative values for the height.

Through Short Cut Key **BOX** enter

Application

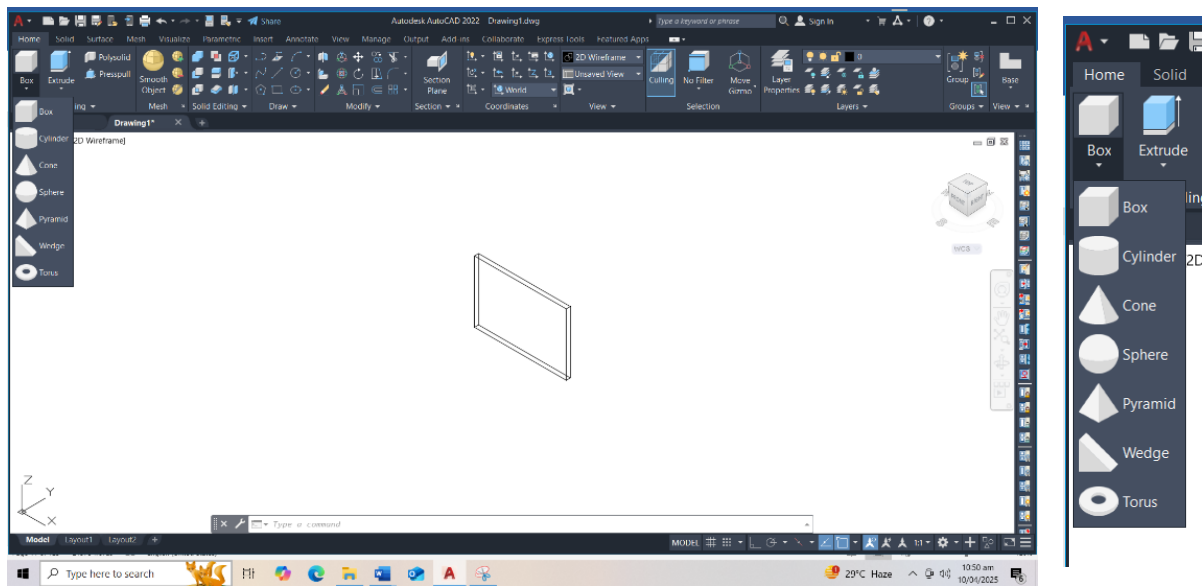
Type **Box** at the Command Prompt

- Specify Start point
- Put the Value of @ X and Y Co-ordinate
- Put the value of height
- Enter

Box Options

Use the following options to control the size and rotation of the boxes you create:

- i. Cube
- ii. Length
- iii. Center Point



Note: you can make Box, Cylinder, Cone , Sphere, Pyramid , Wedge, Torus from drop down menu of Box

Activity 1: Practice to Create and Edit Mesh Primitives

Create Mesh Primitives

- Go to the **Mesh** tab on the ribbon.
- Create the following mesh objects:
 - Mesh Box
 - Mesh Cylinder
 - Mesh Cone
 - Mesh Sphere
 - Place them separately in the drawing area.

Modify the Mesh Primitives

Use the following mesh editing tools:

- **Move and Rotate:** Arrange objects differently in 3D space.
- **Refine Mesh:** Increase the smoothness of one object (e.g., the sphere).
- **Split Face:** Select a mesh face and split it for detail.
- **Extrude Face:** Pull out a face from the mesh box or cylinder.
- **Coarsen Mesh:** Simplify another object (e.g., the cone).

Learning Unit 3.2

Develop 3D Model

Learning Outcomes:

After completion of this Learning Unit, trainee will be able to:

- Create 3D models
- Create opening (Door, windows & ventilated in 3D model as per requirements.
- Customize 3D object as per requirement
- Use AI Tools for assistance

3.2.1 Types of 3D Shapes

Basic Geometric Primitives

These are simple, fundamental 3D shapes that serve as building blocks for more complex models.

Cube

- A six-faced shape with all sides equal (e.g., a dice).
- Properties: 6 faces, 12 edges, 8 vertices.

Sphere

- A perfectly round shape with all points on its surface equidistant from the center (e.g., a ball).

- Properties: No edges or vertices, perfectly symmetrical.

Cylinder (CYL)

- A shape with two parallel circular bases connected by a curved surface (e.g., a can).
- Properties: 2 circular faces, 1 curved face, 2 edges.

Cone

- A shape with a circular base and a single vertex (apex) (e.g., an ice cream cone).
- Properties: 1 circular face, 1 curved face, 1 vertex.

Pyramid

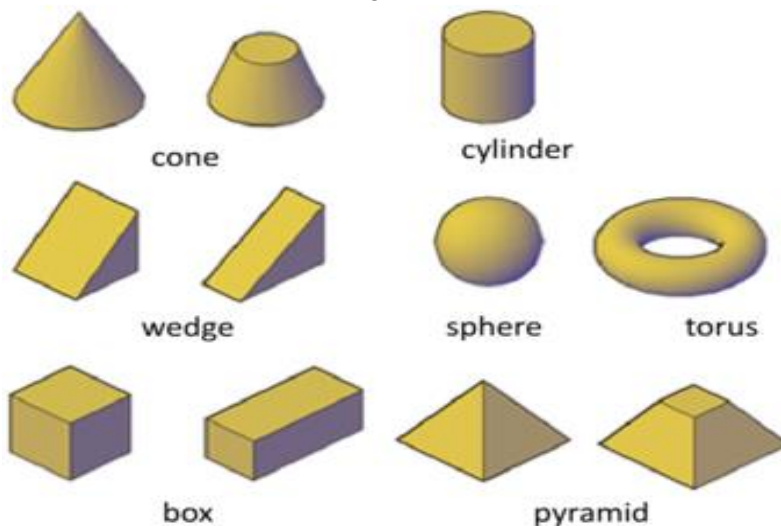
- A shape with a polygonal base and triangular faces meeting at a common vertex (e.g., the Great Pyramid of Giza).
- Properties: Base can be triangular, square, pentagonal, etc.

Rectangular Prism (Cuboid)

- A six-faced shape with rectangular faces (e.g., a box).
- Properties: 6 faces, 12 edges, 8 vertices (like a cube, but sides are not equal).

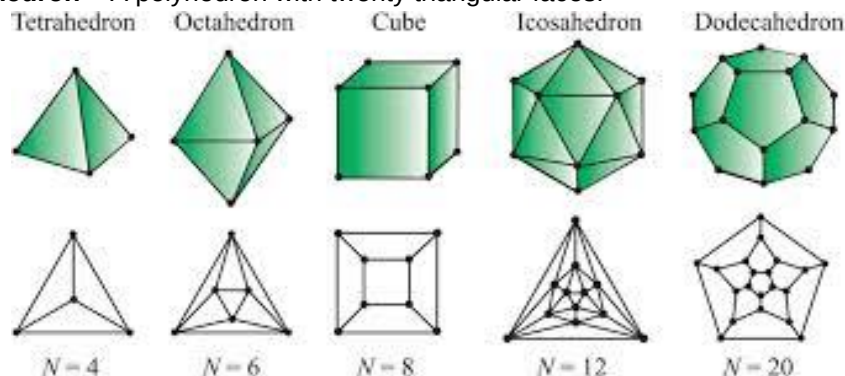
Torus

- A doughnut-shaped object with a hole in the center.
- Properties: Circular cross-section, no edges or vertices.



Polyhedral (3D shapes with flat polygonal faces)

- **Tetrahedron** – A polyhedron with four triangular faces.
- **Octahedron** – A polyhedron with eight triangular faces.
- **Dodecahedron** – A polyhedron with twelve pentagonal faces.
- **Icosahedron** – A polyhedron with twenty triangular faces.



3.2.2 Create 3D Building Model

Room Dimensions (Imperial Units):

Element	Dimension
Room Size	13' x 10'
Wall Thickness	6"
Wall Height	10'
Door	3' x 7'
Window	4' x 3', placed 3' above floor

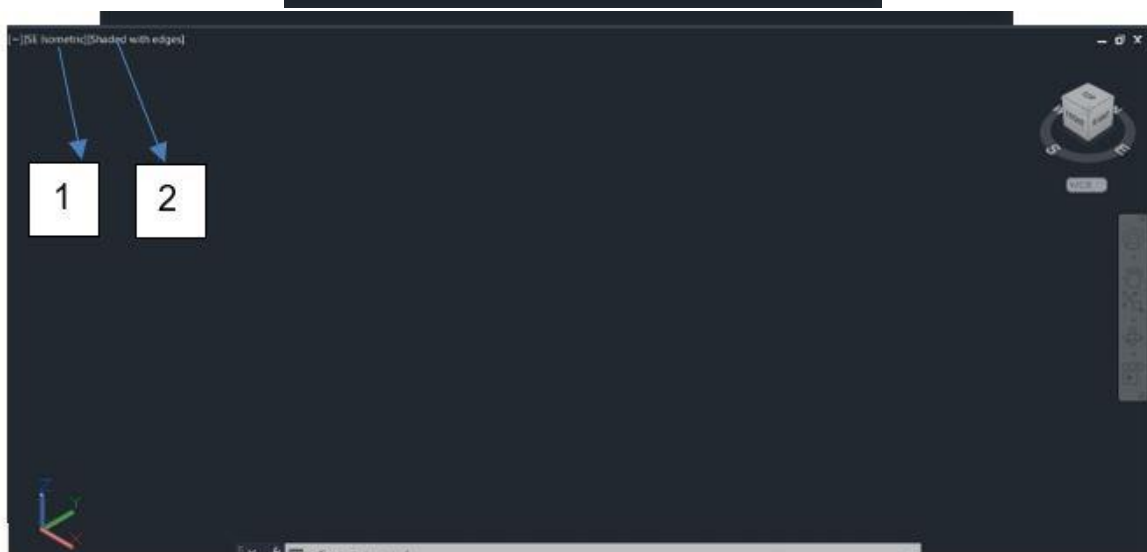
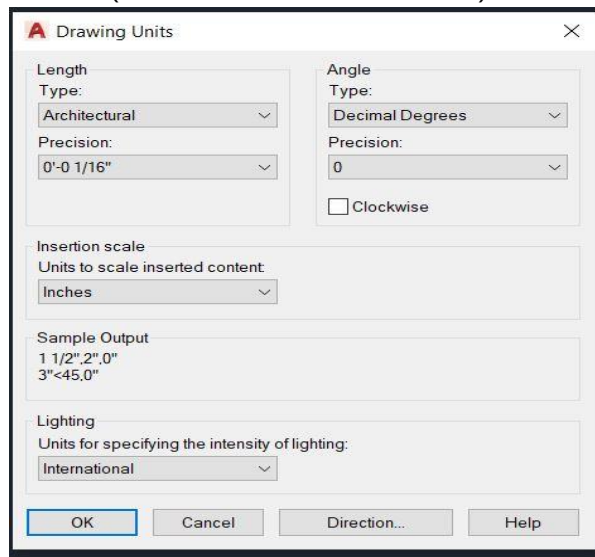
Tools/Commands will be used:

- RECTANGLE
- EXTRUDE
- SUBTRACT
- UNION
- OFFSET
- BOX
- MOVE

Step-by-Step Instructions (Feet & Inches)

Step 1: Set Up Your Drawing

- Open AutoCAD and switch to the 3D Modeling workspace.
- Set units:
 - Type UNITS → Set Type: Architectural, Precision: 1/16"
- Set Visual Style to Shaded with Edges.
- Set View to SW Isometric (VIEW command or View Cube).

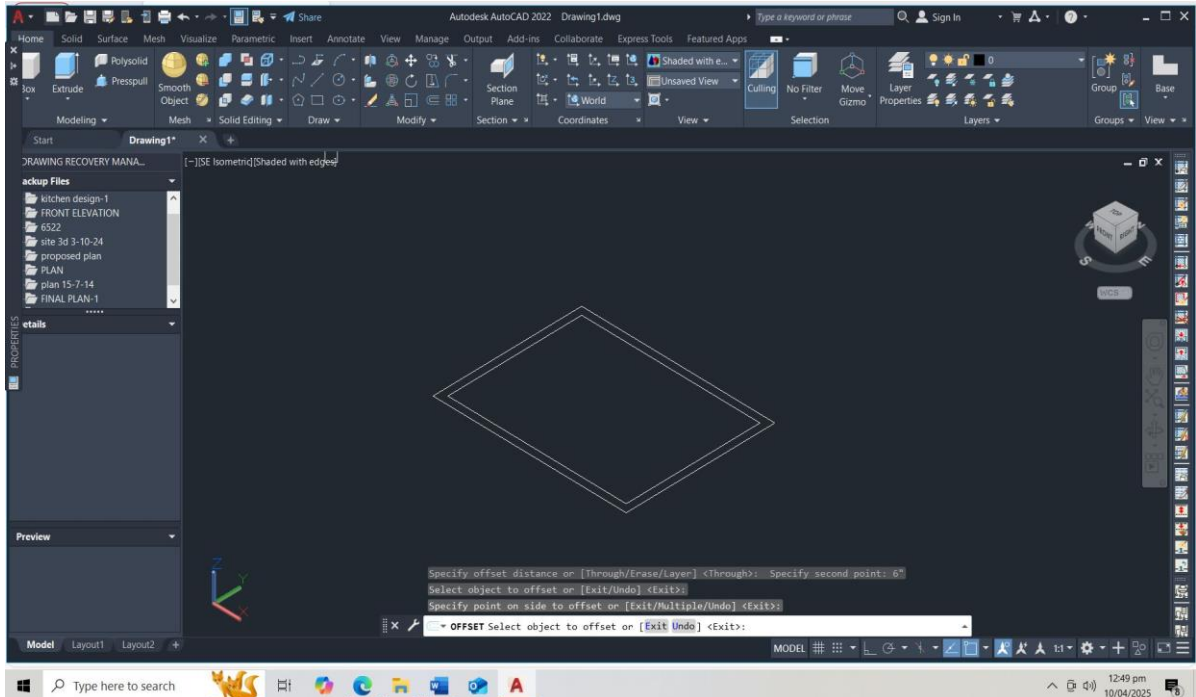


Step 2: Draw the Floor Plan (Base of the Room)

Type RECTANGLE → click anywhere → input:

- less
- CopyEdit
- @13',10'
- (Creates a 13ft x 10ft base)

Type OFFSET → select rectangle → enter 6"
(Offsets inward to create wall thickness)



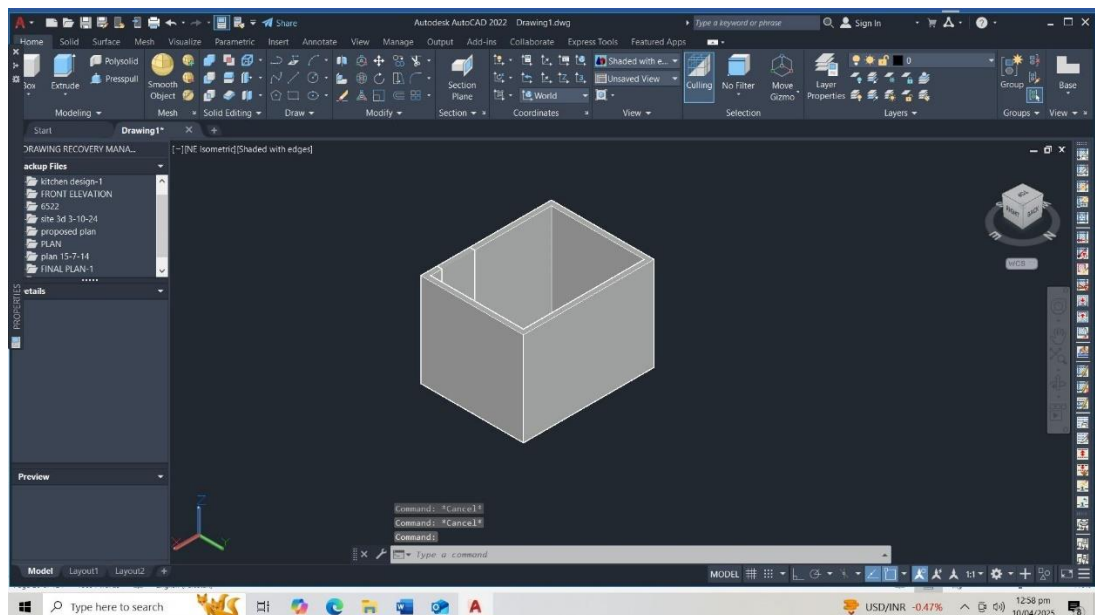
Step 3: Create the Wall Profile

Use REGION on both the outer and inner rectangles.

Use SUBTRACT:

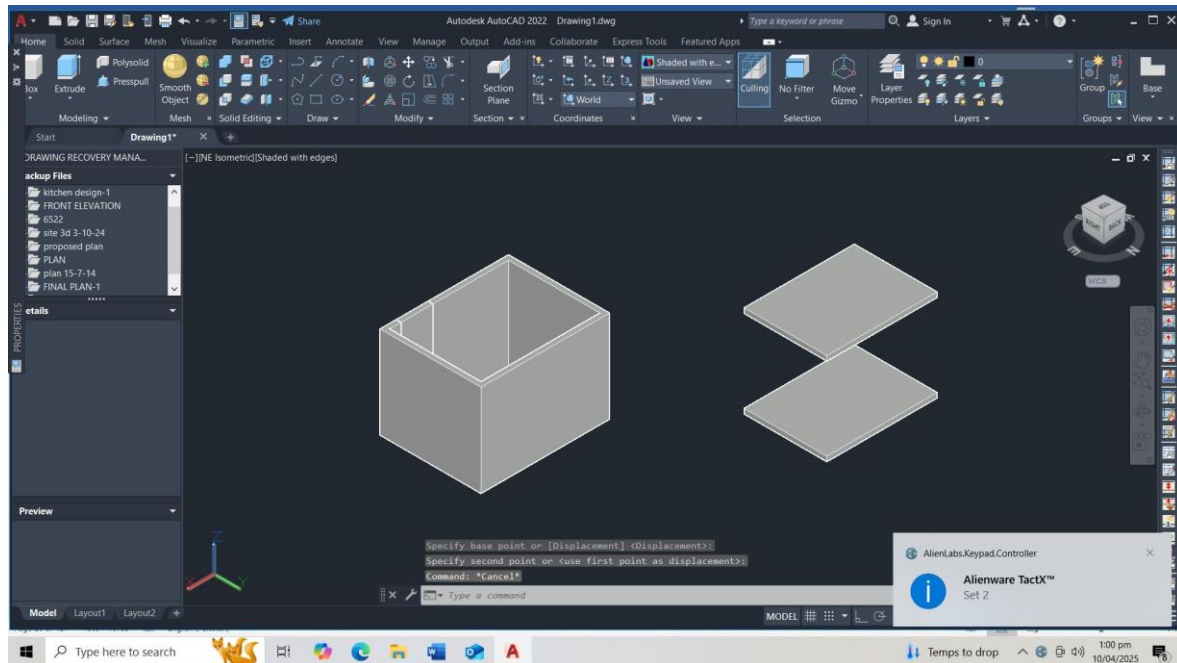
- Subtract inner region from outer region → gives you the wall outline.
- Type EXTRUDE → Select the wall region → enter height:
 - vbnet
 - CopyEdit
 - 10'

You now have 3D walls.



Step 4: Add the Floor and Ceiling

- i. Type BOX → Draw a box inside the wall base (use snap or offset):
 - Dimensions: 12' x 9' x 0.5' (or 6")
 - (This is the **floor**)
- ii. For ceiling, copy the floor:
 - Type COPY → select floor box → move it **10' up**
 - Now you have a **ceiling slab** too.



Step 5: Add a Door Opening

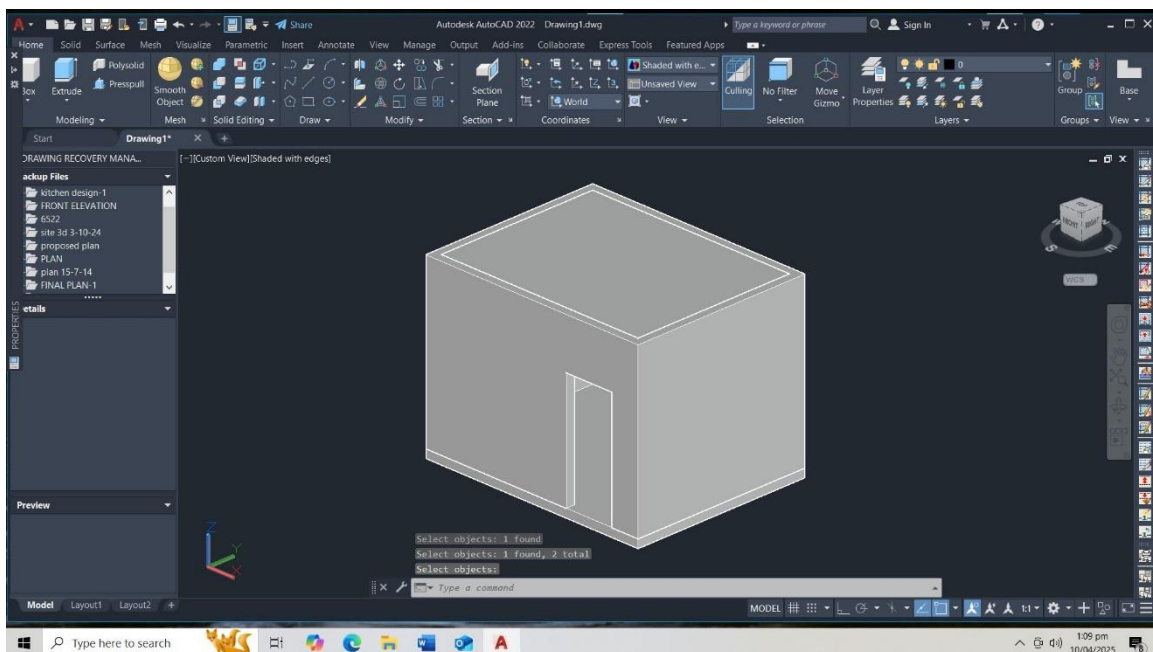
Type BOX → Position the door on one wall (e.g., near left side):

less

Copy Edit

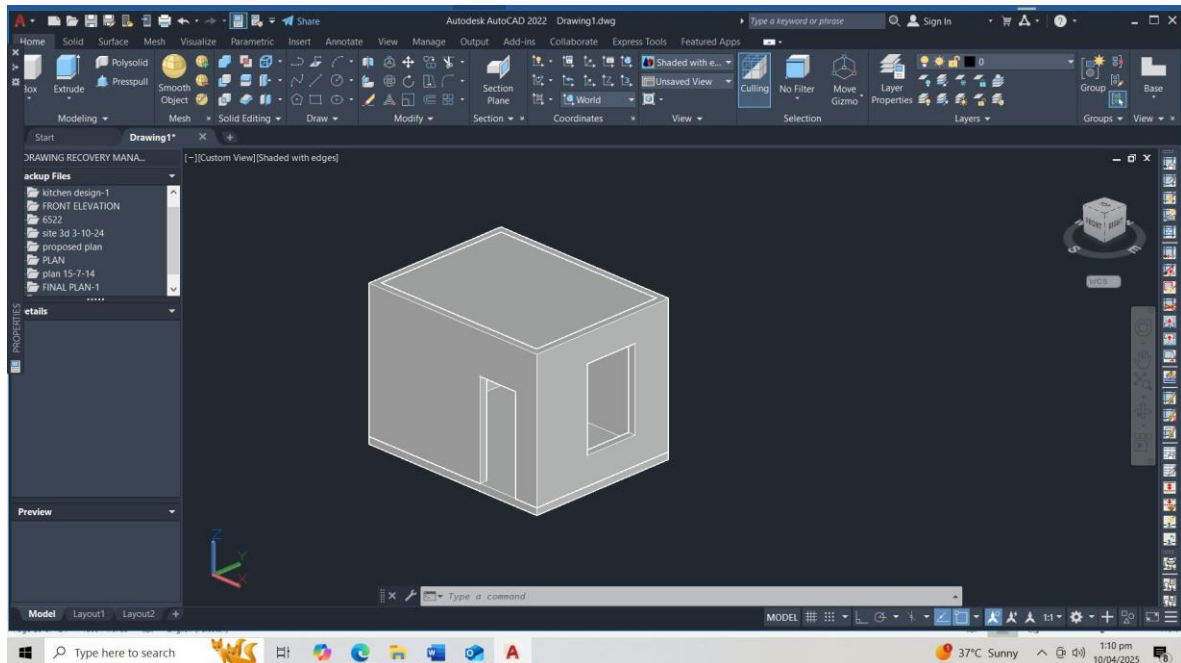
Width: 3', Height: 7', Depth: 6"

Use SUBTRACT → Select the wall → Subtract the door box



Step 6: Add a Window Opening

- i. Type BOX → Draw a box on one of the longer walls:
 - less
 - CopyEdit
 - Width: 4', Height: 3', Depth: 6"
- ii. Move the window box:
 - Use MOVE → Select window box → Base point bottom corner
 - Move **up by 3'** (to place it 3' from the floor)
- iii. Use SUBTRACT to cut the window from the wall



Final View and Save

Use ORBIT to view your 3D model from different angles.

Save your file as:

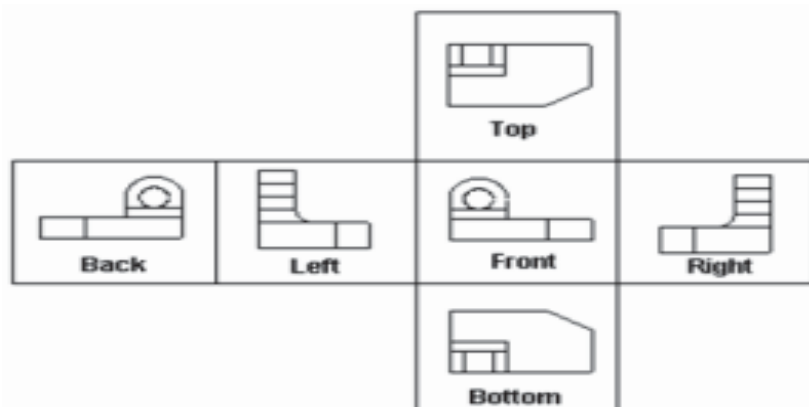
- Room3D_Model_Imperial.dwg

3.2.3 Types of views (Isometric, Top, Bottom, Front, Left, etc.)

In AutoCAD, different types of views are used to visualize a 3D model from different angles. These views help in designing, analyzing, and presenting a drawing accurately. Below are the common types of views in AutoCAD:

Orthographic Views:

The first six views on the toolbar are orthographic views - Top (World Plan), Left, Front, Bottom, Back, right. If your model was enclosed in a box, these views reflect how the model would appear by looking directly at each of the box faces. If you “unfold” the box, you can see the relationship between the views.



Front View: Looks at the XZ plane of the World Coordinate System, while facing +Y.

Top View: Looks at the XY plane while facing -Z (down). The **Top** view can be also obtained from the **Plan** view by using the **Roll** Walk through tool.

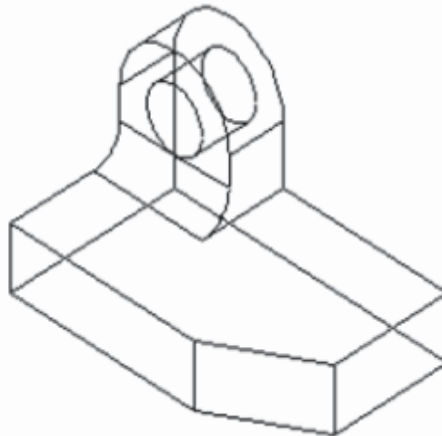
Left View: Looks at the YZ plane while facing +X.

Bottom View: Looks at the XY plane while facing +Z (up).

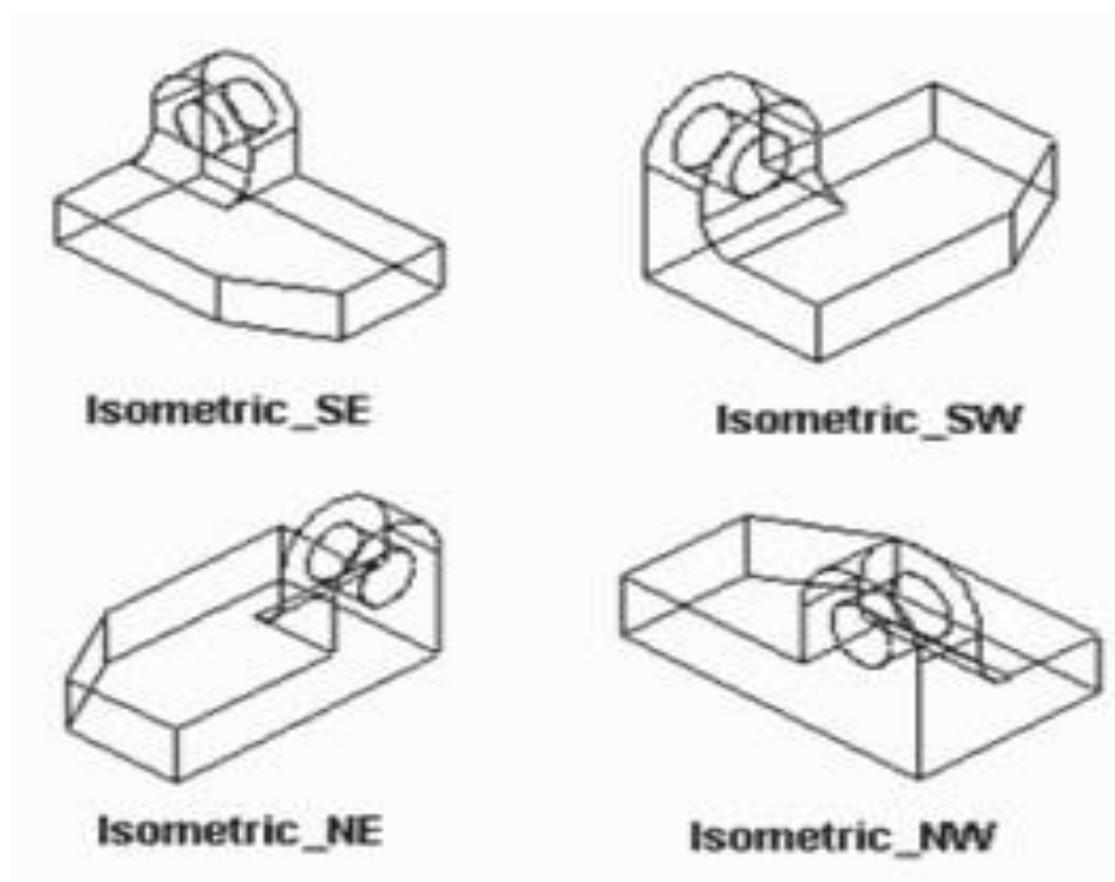
Back View: Looks at the XZ plane while facing -Y.

Right View: Looks at the YZ plane while facing -X.

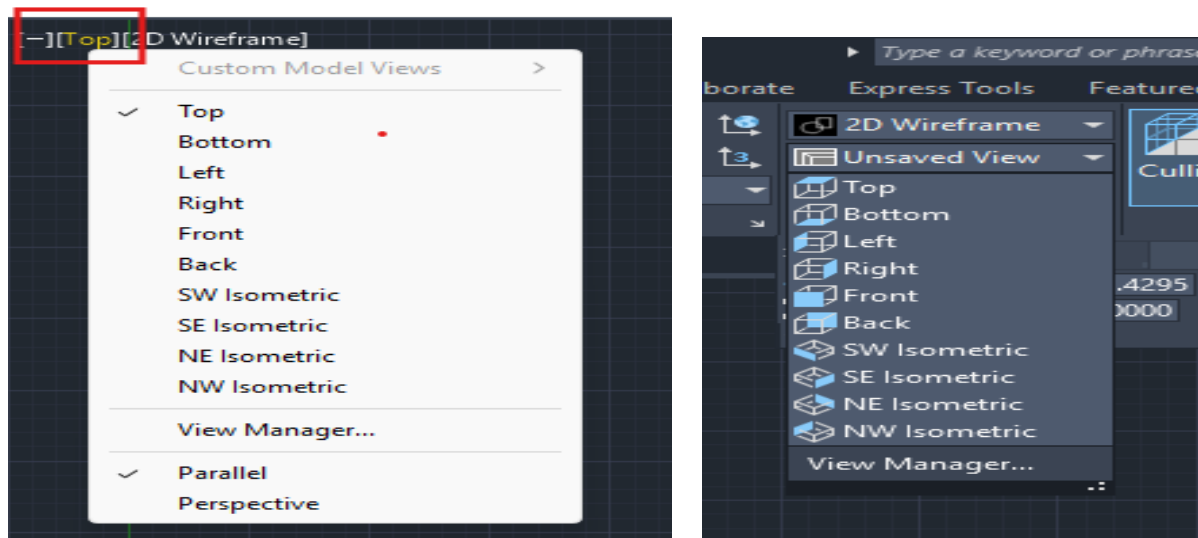
An **isometric view** represents a 3D object where all three axes (X, Y, and Z) are equally foreshortened.



- It provides a clear 3D representation without perspective distortion.
- It is often used for technical and engineering drawings.

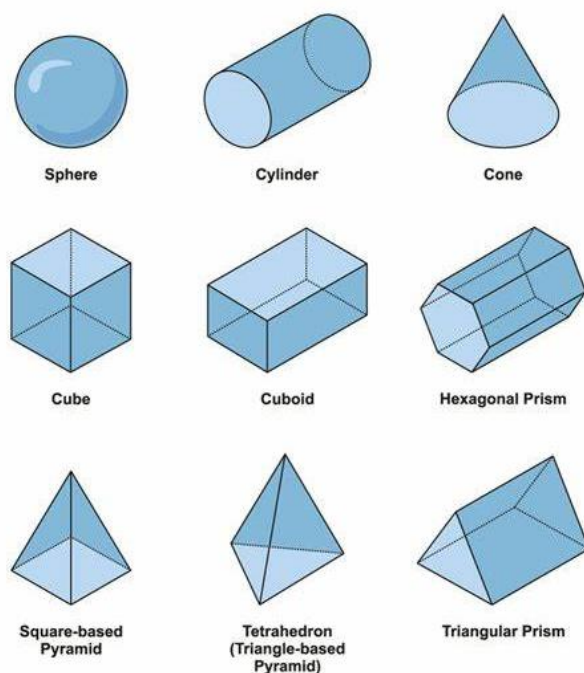


The last four views on the toolbar are isometric - angled views. The views are named for compass directions (Isometric SE is the view looking from the southeast). You can change the different view from view port, view control as well as from view tap



Activity 1:

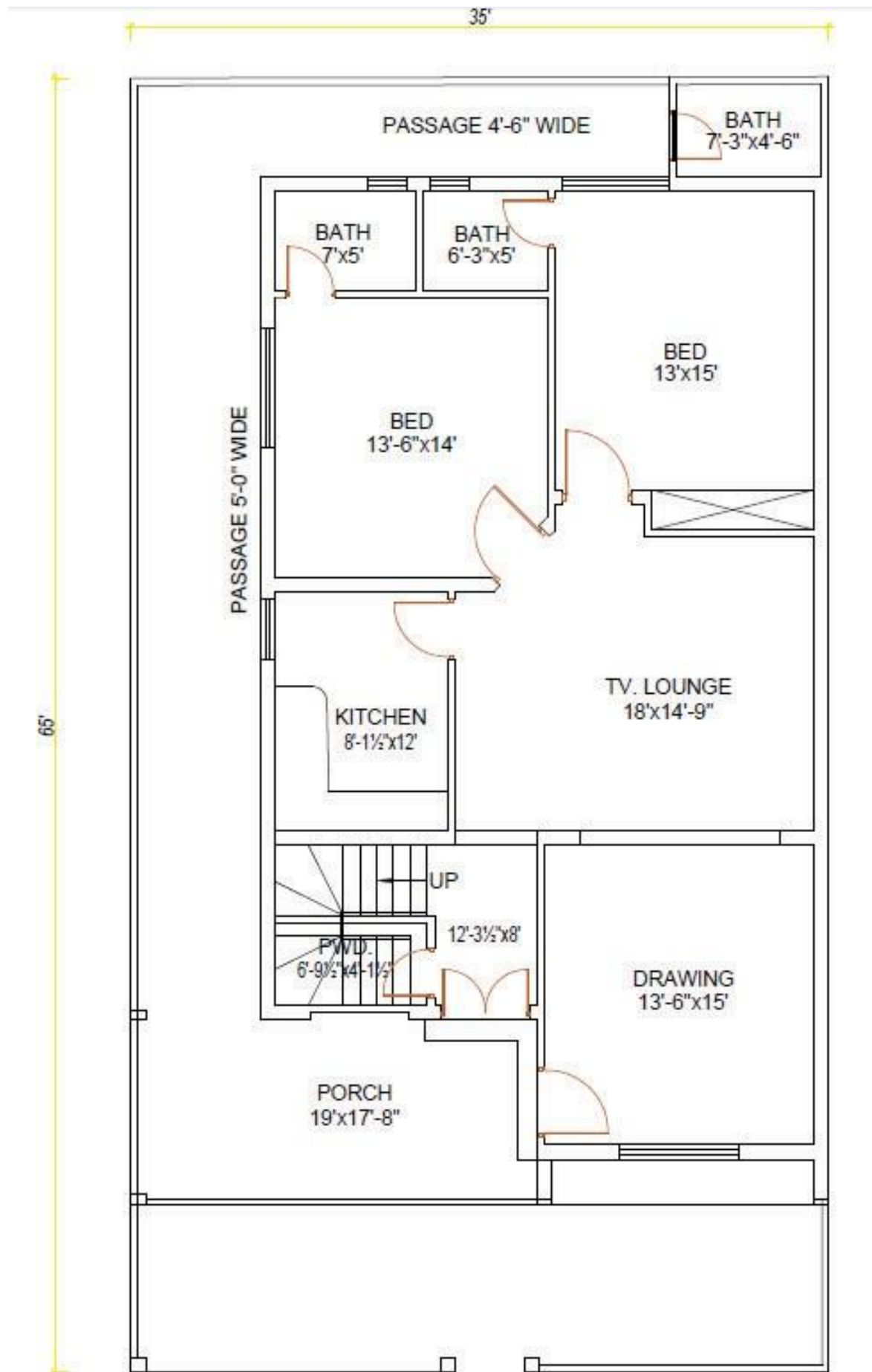
Draw and practice different 3D models



Activity 2:

Develop an architectural 3D model of 35' X 65' plot dimension as per the following requirements

- Two Rooms with attached bath
- Lounge
- Drawing
- Kitchen
- Powder Bath
- Store
- Servant Bath
- Porch.



Learning Outcome:

After Completion of this learning Units, trainee will be able to:

- Create 3D solid or surface in the space between several cross sections
- Create a blend surface between two existing surfaces
- Create a new surface or cap to close an open edge of an existing surface
- Create a parallel surface at a specified distance from original surface.
- Edit existing surfaces

3.3.1 Boolean operation on 3D Solid Model (Subtraction, Intersection, Union)

This learning element we will learn about the development of 3D solid composites. You can combine, subtract or intersect two or more 3D solids by using Boolean operating, able to adjust the thickness of 3D solid, you can draw a temporary 3D solid by interesting two sets of 3D solids.

Boolean Operations

The Boolean commands work only on solids or regions. To create a solid model at initial stage in obtaining one or more primitives. The next stage consists in using Boolean operations of Union, Subtract or intersect in order to create the solid model

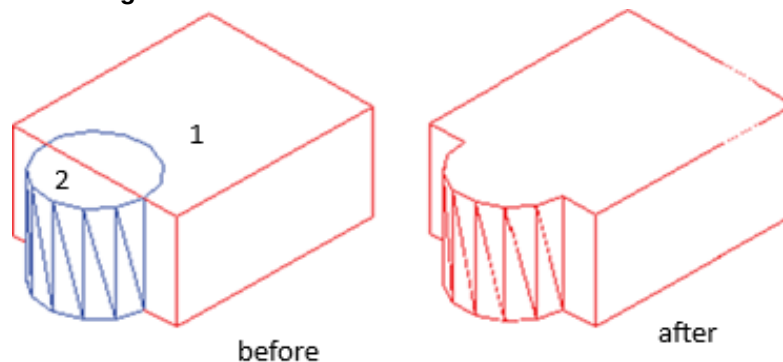
Union: (UNI)

Purpose: Combines two or more **3D solids**, **surfaces**, or **2D regions** into a single object.

Shortcut: UNI → Enter

Steps:

1. Type UNI
2. Select objects (one by one or all at once)
3. Press **Enter** or **Right-click**

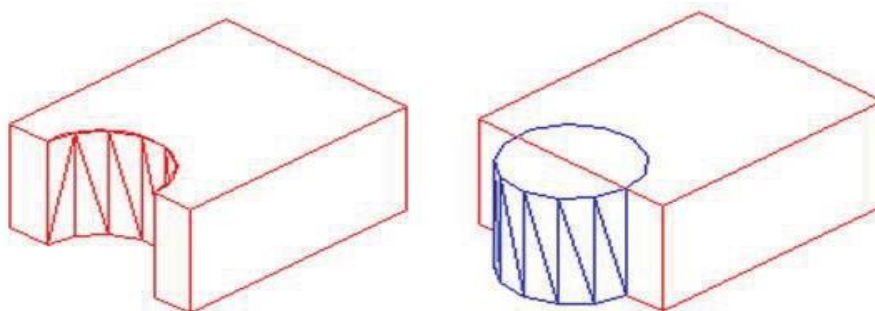
**Subtract (SU)**

Purpose: Removes one or more **3D solids** or **2D regions** from another overlapping solid/region. *Commonly used to create holes, cutouts, or custom shapes.*

Shortcut: SU → Enter

Steps:

1. Type SU
2. Select the **main object** (the one to subtract from) → Enter
3. Select the **object(s) to subtract** → Enter



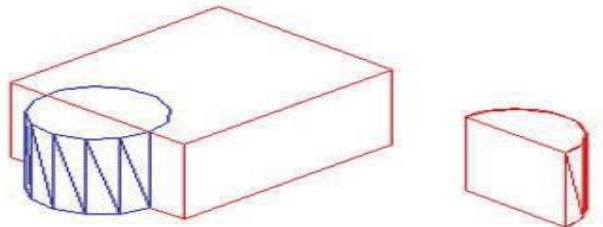
Intersect (IN)

Purpose: Creates a **3D solid, surface, or 2D region** from the **overlapping area** of selected objects. Useful for finding the common volume or shape between multiple objects.

Shortcut: IN → Enter

Steps:

1. Type IN
2. Select all overlapping objects
3. Press **Enter**



3.3.2 3D Navigate Control Pre-set views (Isometric, Top, Bottom, Front, Left, etc.)

Navigating in 3D within AutoCAD is crucial for effectively visualizing and manipulating 3D models. AutoCAD provides several tools to achieve this.

3D Navigation Tools:

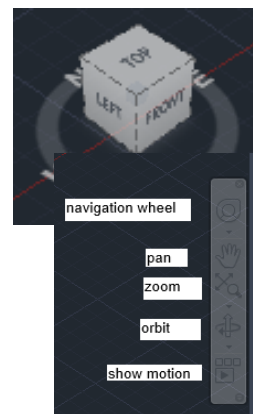
View Cube:

- Allows you to rotate your 3D view.
- Switch to standard orthographic and isometric views.
- Fast way to change between standard views.

Navigation Bar:

This bar provides access to various navigation tools, including:

- **Orbit:** Allows you to rotate the 3D view around a pivot point.
- **Pan:** Allows you to move the view horizontally and vertically.
- **Zoom:** Allows you to zoom in and out.
- This bar gives access to more fine-tuned controls.



3D Orbit (3DR)

1. The 3D Orbit command lets you dynamically rotate your view.
2. Holding down the Shift key and the middle mouse button is a quick way to activate 3D Orbit.
3. Free orbit allows for unrestricted 3d rotation.
4. right click of mouse to

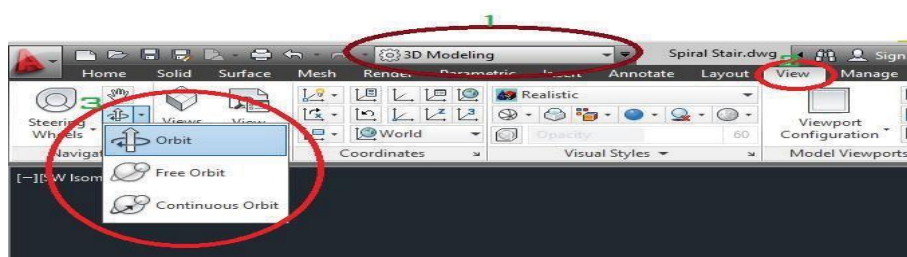
Mouse and Keyboard Shortcuts:

- As mentioned, Shift + middle mouse button is a popular shortcut for 3D Orbit.
- The mouse wheel is used for zooming.
- These are very important for efficient workflow



Steering Wheels:

Provides a set of navigation tools in a single interface, including Zoom, Orbit, Pan, and more. as shown in figure



Sr#	Name	Command	Description
1	Orbit	Orbit/3dorbit	Constrains orbiting to the XY plane or the Z direction.

2	Free Orbit	3dforbit	Allows orbiting in any direction, without being constrained to the XY plane or the Z direction.
3	Continuous Orbit	3dcorbit	Changes the cursor to a sphere with two continuous lines encircling it and enables you to set the objects into continuous motion.
4	Adjust Distance	3DDISTANCE	Simulates moving the camera closer to the object or farther away.
5	Walk	3DWALK	Changes the cursor to a plus sign and enables you to “walk through” a model at a fixed height above the XY plane, by dynamically controlling the location and target of the camera. Walk orbit works only in perspective view
6	Swivel	3DSWIVEL	Changes the cursor to an arched arrow and simulates the effect of swiveling the camera.
7	Fly	3DFLY.	Changes the cursor to a plus sign and enables you to “fly through” a model without being restricted to a fixed height above the XY plane. Fly orbit works only in perspective view
8	Zoom	3DZOOM	Changes the cursor to a magnifying glass with plus (+) and minus (-) sign and simulates moving the camera closer to an object or further away.
9	Pan	3DPAN	Changes the cursor to a hand cursor and moves the view in the direction that you drag.

3D Orbit on Selected Object

3D Orbit on selected object/s allows you to orbit / revolve the specific object within the drawing.

Procedure Apply Orbiting to Drawing

Before you going to begin these steps, make sure to set unit and you must have objects in your drawing. We are going to apply 3D Orbit on the following selected object within the drawing as shown in the figure below:

- **Step-1:** Select the object before applying the orbit command, as shown here
- **Step-2:** Type orbit/3dorbit command in command bar <Enter> you will get the only selected object to orbit as shown in the figure below
- **Step-3:** You can orbit/revolve the drawing according to XY plane or the Z direction.
- **Step-4:** When you press ECS button, you will get display the whole drawing again.

Developing Pan and Zoom in 3D Orbit

You can easily develop Zoom and Pan command during orbiting, but the only difference is to get Zoom and Pan after applying the orbit command then orbit/revolve that area .3D Orbit on selected object/s allows you to orbit / revolve the specific object within the drawing.

Walk and Fly (3D walk, 3D Fly)

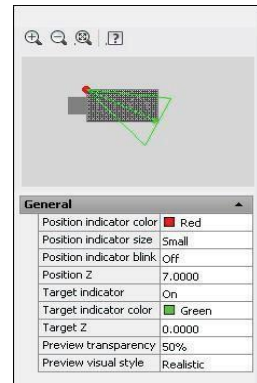
You can simulate walking and flying through a 3D drawing. When you walk through a model, you travel along the XY plane. When you fly through a model, you are not constrained by the XY plane, so you appear to “fly” over an area in a model.

Walk and Fly Navigation modes for the keyboard and mouse.



i.	Up arrow or W key	=	Move forward
ii.	Down arrow or S key	=	Move backward
iii.	Left arrow or A key	=	Move left
iv.	Right arrow or D key	=	Move right
v.	Drag mouse	=	look around and turn

- **Step-1:** Open a drawing with 3D objects and display in a 3D view
- **Step-2:** Create a camera anywhere in the drawing and set the view to that camera
- **Step-3:** 3DWalk or 3DFly at the command prompt. Command: **3DWALK**
- **Step-4:** Press the Up, Down, Left, and Right keys on the keyboard to see how the camera location moves in the drawing and Position Locator dialog box.
- **Step-5:** Move the camera and target in the Position Locator dialog box
- **Step-6:** Click and drag your mouse to “fly” through the drawing
- **Step-7:** Close the Position Locator dialog box and try walking and flying using only the keys on the keyboard and mouse



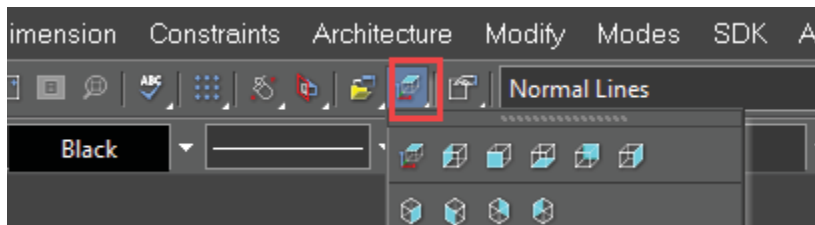
Preset Views

The view is the area of the drawing space that appears on your screen. As your drawing becomes larger and more complex, it's important to find views that let you work at the right location in your drawing, at an appropriate level of detail.

Tip: Layers are a useful way to change how objects. You can place objects on various layers and then manipulate layer visibility.

Saving 3D Views

You can use camera objects to save views with specific parameters and open them in their own windows. The ten standard views can be accessed from the **View / Camera** menu.



You can also display this toolbar separately by right-clicking in the toolbar area and selecting **Standard Views**.

And, by default, these tools are available on the local (right-click) menu.

Preset 3D Viewports

You can use Command to split the windows: by typing the **VPORTS** command in command line.

Step-1: Type: VPORTS

You will get the following figure

Step-2: Type the name for the new model space viewport

If you do not enter a name, the viewport configuration is applied but not saved.

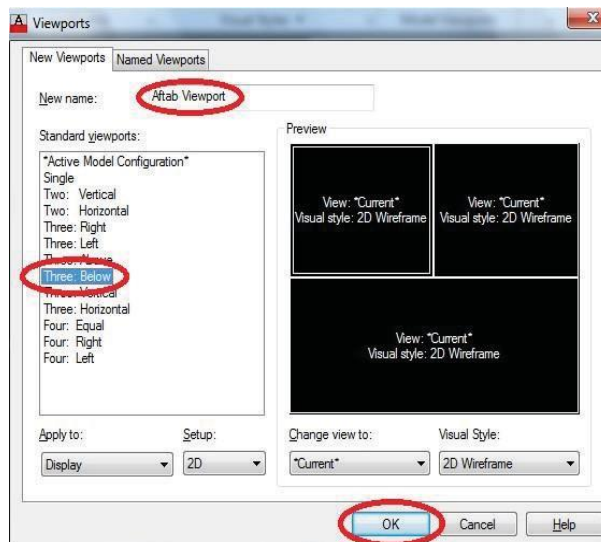
If a viewport configuration is not saved, it cannot be used in a layout.

If you specify a name, it can be Saved and can be used in a layout.

Step-3: Whenever you used the viewport again you will get the layout named Aftab Viewport as shown in figure below

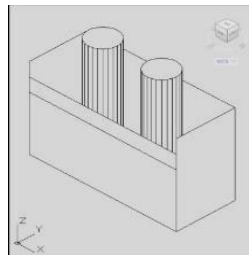
Visual Style:

Different styles are used to display/visualize in the drawing area.



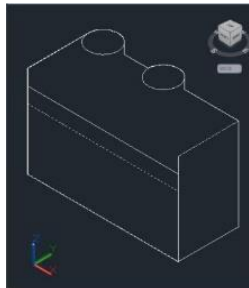
2D Wireframe

On applying this visual style, all hidden lines will be displayed along with the visible lines in the model. Sometimes, it becomes difficult to recognize the visible lines and hidden lines, if you set this visual style for complex models.



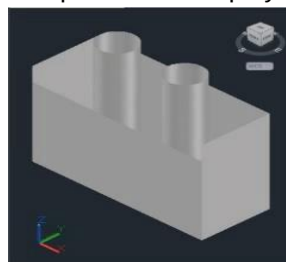
Conceptual

In this visual style, the model will be displayed as shaded and the edges of the visible faces of the model will also be displayed.



Hidden

On applying this visual style, the hidden lines in the model will not be displayed, and only the edges of the faces that are visible in the current viewport will be displayed.



Realistic

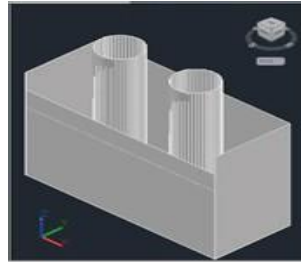
This visual style is the same as Conceptual, but with a more realistic appearance. Moreover, if materials are applied to a model, this visual style will display the model along with the material applied.

Shaded

In this visual style, smooth shading is applied to the faces of a model. In this case, the edges of the visible faces are not visible.

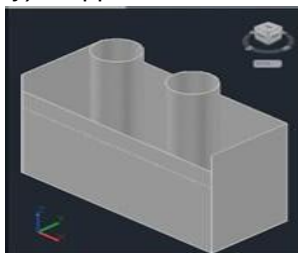
Shaded with edges

In this visual style, smooth shading is applied to the faces of a model and the edges of the visible faces are visible



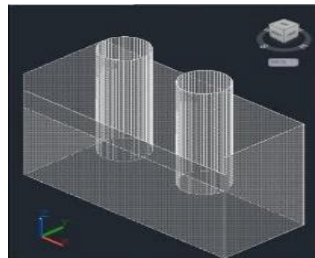
Shades of Gray

In this visual style, a single shade (grey) is applied to all faces of a model.



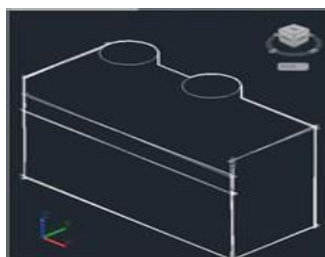
Sketchy

In this visual style, a model appears as if it is hand sketched.



Wireframe

This visual style is used to display a solid model as a wireframe model. You can see through the solid model while the model is being rotated in the 3D orbit view.



X-Ray

This visual style is used to display the model with shading and mild transparency. In this case, the hidden lines will be visible.

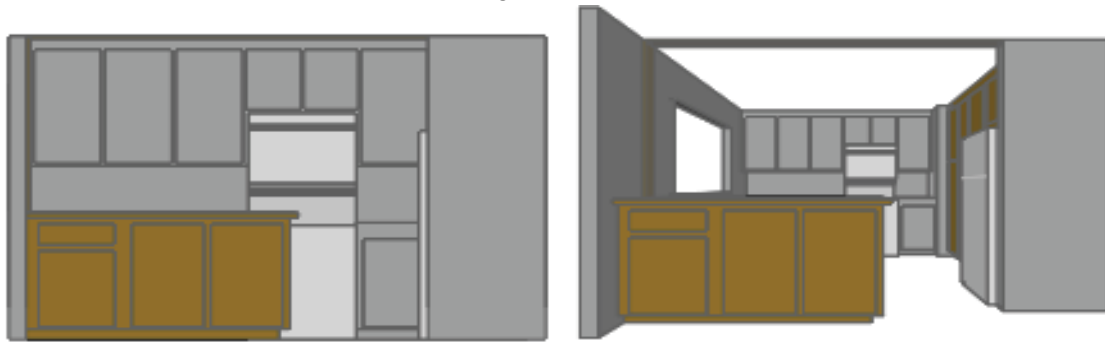
Perspective Projection and Parallel Projection

You can create realistic visual effects in a drawing by defining either parallel or perspective projections of a model. The difference between perspective views and parallel projections:

Perspective views require distance between a theoretical camera and target point. Small distances produce severe perspective effects; large distances produce mild effects.

A perspective view remains in effect until the perspective effect is turned off or until a new view is defined in its place.

The following illustration shows the same model in both a parallel projection and perspective projection. Both are based on the same viewing direction.



Parallel projection

Perspective projection

Parallel Projections

To determine the point or angle in model space, you can

- Choose a preset 3D view from the View toolbar.
- Enter a coordinate or angles that represent your viewing location in 3D.
- Change to a view of the **XY** plane of the current UCS, a saved UCS, or the WCS.
- Change the 3D view dynamically with your pointing device.
- Set front and back clipping planes to limit the objects being displayed.

Viewing in 3D is available only in model space. If you are working in paper space, you cannot use 3D viewing commands such as VPOINT, DVIEW, or PLAN to define paper space views. The view in paper space is always a plan view.

3.3.3 3D Primitives: Familiarity with Basic 3D Shapes (Boxes, Spheres, Cylinders and Cones.)

Solid Primitive Commands

The basic solid forms, known as solid primitives, are the equivalent of the primitive forms for 3D solids. By combining primitive shapes, you can create more complex solids. For example, you can join two solids, subtract one from the other, or create a shape based on the intersection of their volumes. Solid primitives can easily be drawn from the Home Tab & Solid Tab

• Box	• Cone
• Cylinder	• Pyramid
• Sphere	• Wedge
• Tours	•

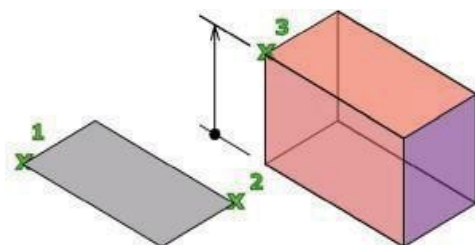
Box

The base of the box is always drawn parallel to the XY plane of the current UCS (work plane). The height of the box is specified in the Z-axis direction. You can enter both positive and negative values for the height.

Through Short Cut Key **BOX** enter

Type Box at the Command Line

- Specify Start point
- Put the Value of @ X and Y Co-ordinate
- Put the value of height
- enter



Cone

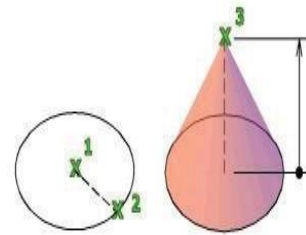
Create a 3D solid with a circular or elliptical base that tapers symmetrically to a point or circular or elliptical planar face. You can control the smoothness of 3D curved solids, such as a cone, in a shaded or hidden visual style with the FACETRES system variable.

Use the Top Radius option to create a cone frustum.

Through Short Cut Key **Cone** enter

Use the following options to control the size and rotation of the cones you create.

- Center Point
- Axis Endpoint
- Frustum
- 3P
- Elliptical
- TTR (Tangent, Tangent, Radius)



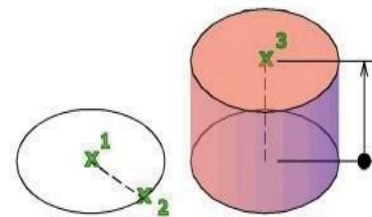
Cylinder

In the illustration, the cylinder was created using a center point (1), a point on the radius (2), and a point for the height (3). The base of the cylinder is always on a plane parallel with the work plane. You can control the smoothness of curved 3D solids, such as a cylinder, in a shaded or hidden visual style with the FACETRES system variable.

Through Short Cut Key **Cylinder** enter

Cylinder Options

- i. Axis Endpoint
- ii. 3P (Three Point)
- iii. Elliptical
- iv. TTR (Tangent, Tangent, Radius)



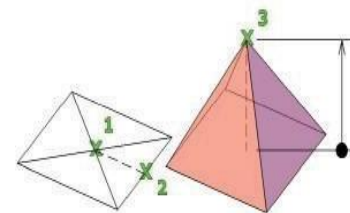
Pyramid

By default, a pyramid is defined by the center of the base point, a point on the middle of the edge, and another point that determines the height.

Through Short Cut Key **Pyr** enter

Application

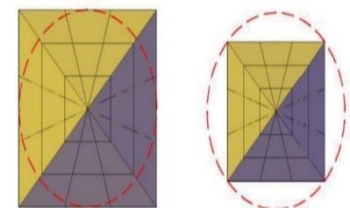
- i. Type **Pyr** at the Command Line
- ii. Specify center point of base put the base radius value
- iii. Put the Value of Height enter



Pyramid Option

The Pyramid option provides several methods for determining the size and rotation of the pyramids you create.

- i. Sides
- ii. Edges
- iii. Frustum
- iv. Axis Endpoint
- v. Inscribed or circumscribed perimeter



Sphere

You can create a torus by specifying the center, then the radius or diameter of the torus, and then the radius or diameter of the tube that surrounds the torus.

Through Short Cut Key **Sphere** enter

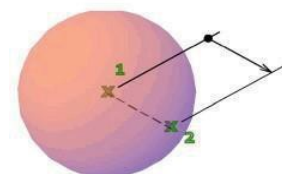
Application

Type Sphere at the Command Line Specify center point Put the radius value enter

Sphere Option

Use the following options to draw a sphere with the SPHERE command:

- i. Center point
- ii. 2p (Two Point)
- iii. 3p (Three Point)
- iv. TTR (Tangent, Tangent, Radius)



Wedge

The direction of the taper is always in the positive X-axis direction of the UCS. Entering a positive value draws the height along the positive Z axis of the current UCS. Entering a negative value draws the height along the negative Z axis

Through Short Cut Key **Wedge** enter

Application

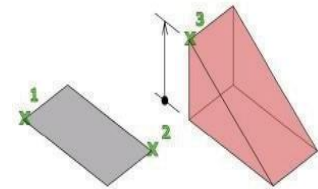
Type Wedge at the Command Line

1. Specify Start point
2. Put the Value of @ X and Y Co-ordinate
3. Put the Value of H
4. eight
5. enter

Wedge Option

The Wedge option provides several methods for determining the size and rotation of the wedges you create.

- Center
- Cube
- Length
- 2pints with weight)



Torus

You can create a torus by specifying the center, then the radius or diameter of the torus, and then the radius or diameter of the tube that surrounds the torus.

Through Short Cut Key **Tor** enter

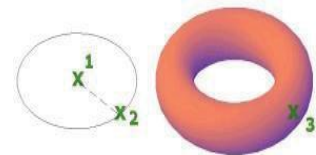
Application

1. Type Tor at the Command Line
2. Specify center point of Torus Put the radius value of Torus
3. Put the Tube radius Value enter

Torus Option

The Torus option provides several methods for Determining the size and rotation of the mesh tours you create.

1. 3p
2. 2p
3. TTR
4. Radius

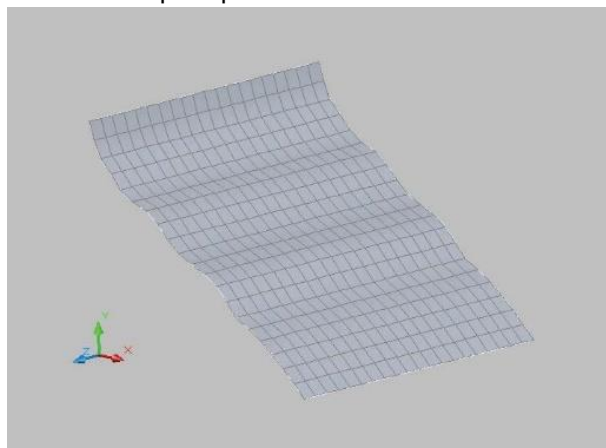


3.3.4 Surface Types: (e.g., planar, curved) & Surface Modeling Tools.

Edge Surfaces

Regenerates a three-dimensional model with hidden lines

Type **EDGESURF** at the command prompt.

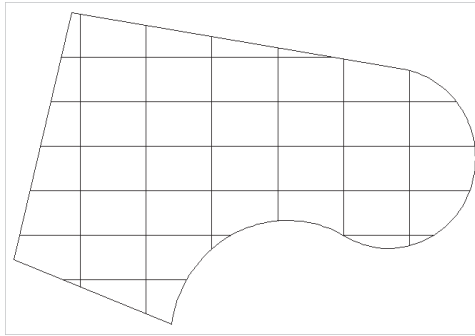


Command: EDGESURF

Current wire frame density: SURFTAB1=20 SURFTAB2=10

Plane Surface

Creates a planar surface by selecting a closed object or by creating a rectangular plane. Type **PLANESURF** at the command prompt.



Command: PLANESURF

Specify first corner or [Object] <Object>: **press enter**

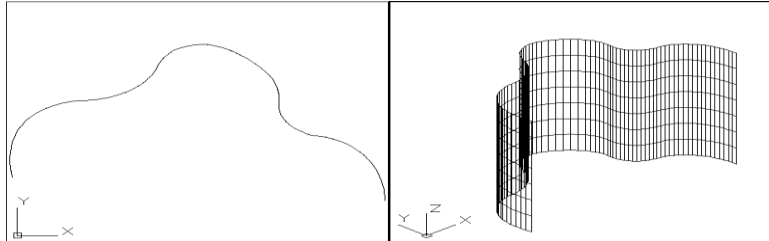
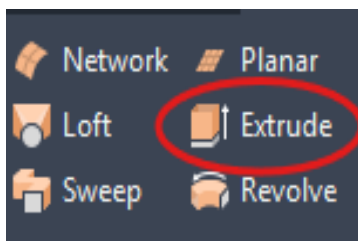
Select objects: **pick object** Select objects: **press enter** Planar surface

Extrude Surface

The **extrude** command creates a **3D surface** by extending a 2D object along a specified direction. Unlike extruded solids, extruded surfaces have no thickness unless later converted into solids.

Steps to Create an Extruded Surface:

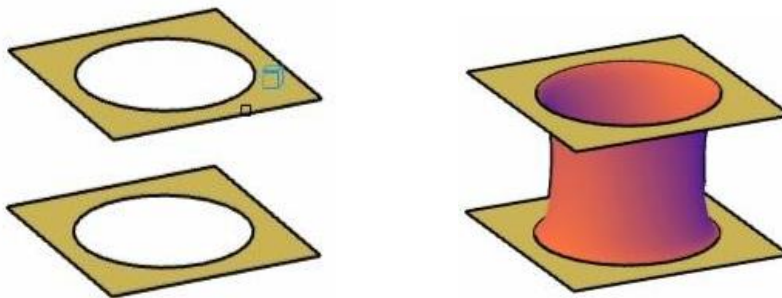
- **Draw a 2D Shape** (e.g., line, circle, spline, or polyline).
- Type EXTRUDE in the command line and press **Enter** or select extrude surface from ribbon
- Select the 2D shape. Specify the extrusion height or direction.



Surface Blend

The **Surface Blend** Tool creates a smooth transition between two existing surfaces.

- i. The surfaces should have an **open edge** where the blend will be applied.
- ii. Type BLENDSRF in the command line and press **Enter**.
- iii. Click on the open edges of the two surfaces that need to be blended.
- iv. **Position (G0)** – Basic connection between the surfaces.
- v. **Tangency (G1)** – Ensures a **smooth transition** with no sharp edges.
- vi. **Curvature (G2)** – Creates an **even smoother blend** with curvature continuity



Surface Patch

Surface Patch" command is used to create a surface that fills a gap or hole in an existing surface

- i. Type **"SURFPATCH"** or **"PATCH"** in the command line and press Enter.
- ii. Alternatively, locate the Patch command within the Surface tab of the ribbon.
- iii. Select the edges of the hole or gap that you want to patch.
- iv. Ensure you select all the edges that define the boundary of the hole.
- v. The order of selection is not usually important.

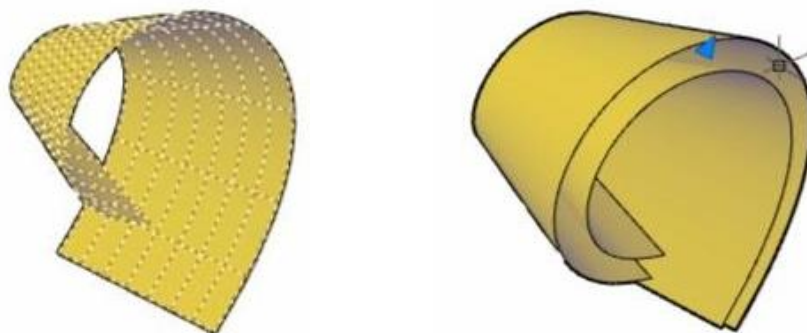
- vi. Once you've selected all the edges, press Enter to complete the selection.
- vii. AutoCAD will generate a surface that fills the hole or gap.
- viii. Inspect the patched surface to ensure it meets your requirements.



Offsetting Surfaces

Offsetting surfaces allows you to create a parallel surface at a specified distance from an existing one. This is a very useful function for creating things like the thickness of a part.

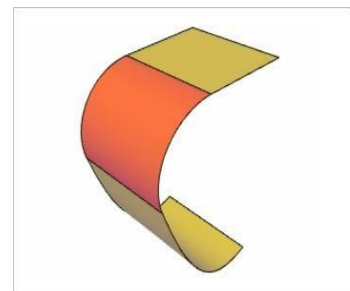
- Navigate to the "Surface" tab in the AutoCAD ribbon.
- Locate the "Create" panel and click on "Offset." You can also type "OFFSET" in the command line.
- In the drawing area, select the surface you want to offset.
- Press Enter to confirm your selection.
- Enter the desired distance for the offset.
- Pay attention to the arrows that appear, indicating the offset direction. You may have the option to "Flip Direction" if needed.
- Some versions of auto cad will give you the option to create a solid object from the offset. If this is desired, select the solid option.



Surface Fillet

When working with surfaces in AutoCAD, "filleting" refers to creating a smooth, rounded transition between two intersecting surfaces.

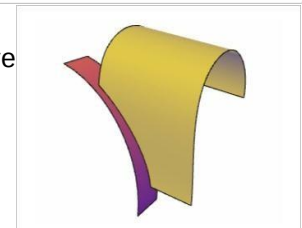
- Ensure the surfaces you want to fillet intersect or have edges that can be smoothly connected.
- It may be necessary to trim or extend surfaces to achieve a proper intersection.
- the object should not be a single entity
- activate fillet, select first object then second object.



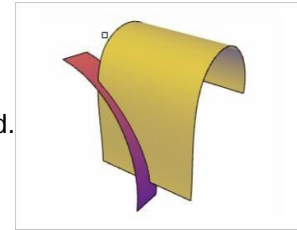
Surface Trim

Surface Trim removes portions of a surface by using another surface or a curve as a cutting edge.

- Type "SURFTRIM" in the command line and press Enter.
- or find it within the surface portion of the ribbon.
- Select the surface you want to trim.



- Press Enter to confirm.
- Select the surface or curve that will act as the cutting edge.
- Press Enter to confirm.
- AutoCAD will highlight the portions of the surface that will be removed.
- Click on the side of the surface that you want to keep.
- The unwanted portion of the surface will be removed



Surface Un Trim

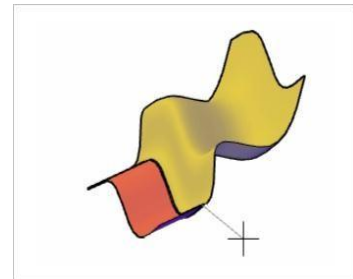
The “Surface Un Trim” command in AutoCAD is used to restore portions of a surface that have been previously trimmed. It essentially reverses the effects of the “Surface Trim” command.

- Type “SURFUNTRIM” in the command line and press Enter. or find it within the surface portion of the ribbon
- You may be prompted to select the edges of the trimmed areas you want to restore.
- Alternatively, you might have the option to select the entire surface to untrim all trimmed areas.
- Press Enter to finalize the “SURFUNTRIM” operation.

Surface Extend

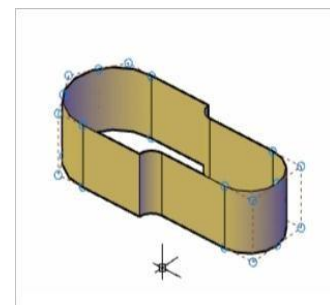
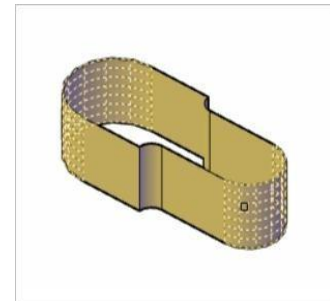
“Surface Extend” command is used to lengthen or expand the boundaries of a surface.

- Type SURFEXTEND (or EXTENDSURF) in the command line and press Enter.
- Or locate the Surface Extend command within the Surface tab on the ribbon.
- Select the surface you want to extend or select edge.
- Press Enter to confirm your selection.
- Select the edge(s) of the surface that you want to extend.
- Press Enter to confirm your selection.
- Enter the distance you want to extend the surface.
- You might be able to visually drag the edge to extend



Convert to NURBS and Surface CV - Show

- NURBS (Non-Uniform Rational B-Splines) surfaces are mathematically defined, allowing for smooth, complex curves and surfaces.
- CVs act as the “control points” that influence the shape of these.
- Begin by creating a NURBS surface using commands like “SURFACE,” “LOFT,” or “NETWORK SURFACE.”
- If you have an existing surface, you might need to convert it to a NURBS surface using the “CONVTONURBS” command.
- **CVSHOW:** Use the “CVSHOW” command to make the CVs visible. This command toggles the display of CVs.
- Sometimes, simply selecting the NURBS surface will automatically display its CVs. Click on individual CVs to select them.
- Use window or crossing selection to select multiple CVs.
- Hold down the Shift key to add or remove CVs from the selection.
- Once selected, CVs display grips.
- Click and drag grips to move CVs, directly manipulating the surface.
- The Properties panel allows for numerical input of CV coordinates, providing precise control



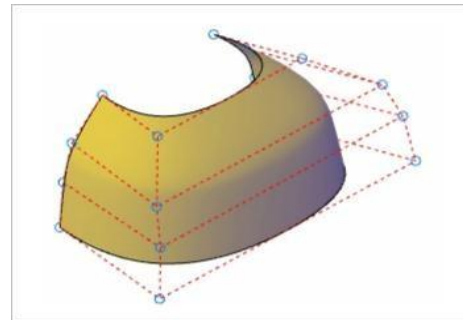
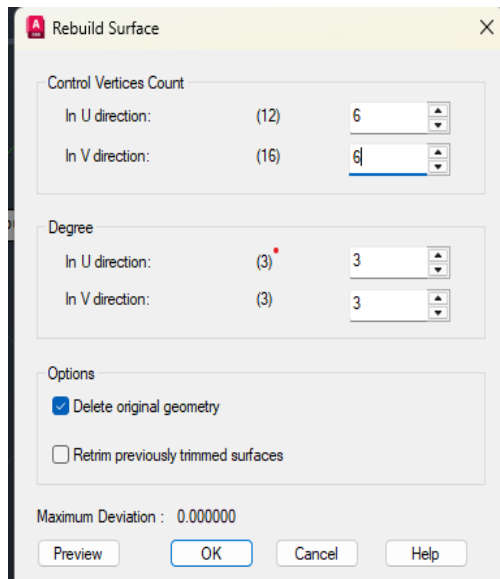
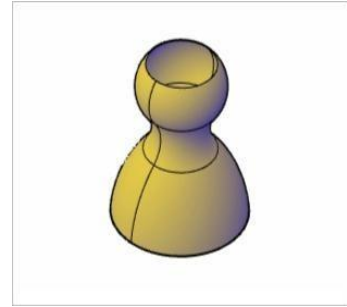
Shows NURB vertices and Surface CV – Hide

Shows NURB is use to show NURB surface and Hide CV is Use for hide NURB Vertices use CVSHOW at the command prompt. or activate from ribbon. For CV Hide Use CVHIDE or activate from ribbon.

Surface CV Rebuild

The “Surface CV Rebuild” (CVREBUILD) command is a valuable tool for optimizing NURBS surfaces. It allows you to redistribute control vertices, change the degree of the surface, and ultimately achieve a smoother or more manageable surface.

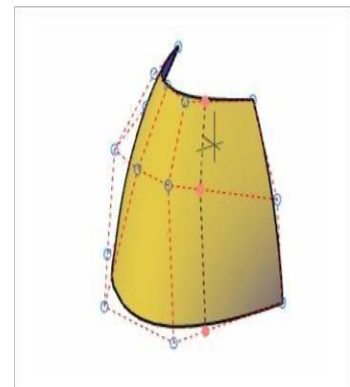
- Begin by selecting the NURBS surface that you want to rebuild.
- Type “CVREBUILD” in the command line and press Enter.
- Alternatively, you can find the command within the Surface editing sections of the ribbon.
- The “Rebuild Surface” dialog box will appear.
- This dialog box provides options for:
- Specifies the number of control vertices in the U direction.
- You can also change the degree of the surface in the U direction.
- Specifies the number of control vertices in the V direction.
- You can also change the degree of the surface in the V direction



Surface CV Add

The “Surface CV Add” command allows you to add control vertices (CVs) to a NURBS surface, providing finer control over its shape.

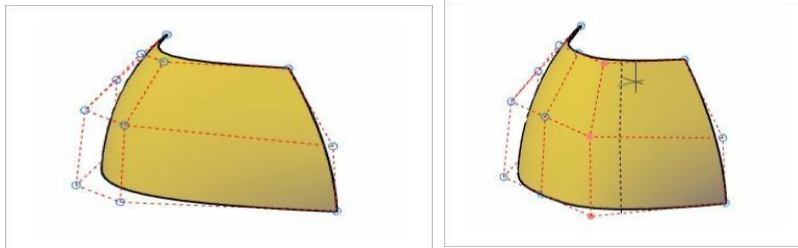
- Begin by selecting the NURBS surface to which you want to add CVs
- Type “CVADD” in the command line and press Enter.
- or locate the command within the surface editing portion of the ribbon.
- AutoCAD will prompt you to specify the location where you want to add the CV.
- Click on the surface at the desired location.
- You may be able to add multiple points, depending on the command line options.
- After placing the CV(s), press Enter to complete the command.
- After the CV is added, you can now move the new CV to get the desired shape.



Surface Remove

- Type “CVREMOVE” in the command line and press Enter.
- or locate the command within the surface editing portion of the ribbon.
- AutoCAD will prompt you to specify the location where you want to remove point the CV.

- Click on the surface at the desired location.
- After the click on CV (s), press Enter to complete the command.



Activity 1:

Practice to create cylindrical shape object with Radius of 6" and Height 12" by using cylinder command.

Step 1: Set Up the Drawing Environment

- Open your CAD software (e.g., AutoCAD).
- Switch to the **3D Modeling** workspace.
- Type UNITS → Set **Type: Architectural** or **Decimal** → Set **Units to Inches**.
- Set your visual style to **Shaded with Edges**.
- Set the view to **SW Isometric** using VIEW or the ViewCube.

Step 2: Start the CYLINDER Command

- Type CYLINDER in the command line → Press **Enter**.

Step 3: Specify the Base Center Point

- Click anywhere in the drawing area (or type coordinates like 0,0,0).

Step 4: Specify the Radius

- Type: 6 → Press **Enter**
(This sets the base radius to 6 inches)

Step 5: Specify the Height

- Type: 12 → Press **Enter**
(This sets the vertical height of the cylinder to 12 inches)

Activity 2:

Practice to create surfaces by revolving a 2D profile around an axis.

Step 1: Set Up the Drawing

- Open your CAD software (AutoCAD or similar).
- Switch to the **3D Modeling workspace**.
- Type UNITS → Set to **Inches** or **Decimal** as preferred.
- Set **View** to **SW Isometric**.
- Set **Visual Style** to **Shaded with Edges**.

Step 2: Create the 2D Profile

We'll create a simple vase profile.

Use the LINE command:

- Start at 0,0
- Go up vertically 8 units
- Then move right and create a smooth vase outline using LINE and/or SPLINE
- Make sure the shape stays on one side of the vertical axis.

Close the bottom of the shape with a horizontal line (if not already).

Step 3: Define the Axis of Revolution

- Use a **straight vertical line** as the axis (e.g., the line from 0,0 to 0,8)
- You can create this using LINE.

Step 4: Use the REVOLVE Command

- Type REVOLVE → Press **Enter**
- Select the **entire 2D profile** → **Enter**
- Select the **axis of revolution** (click on the vertical line)
- Specify angle of revolution:

Type 360 → Press **Enter**

Activity 3:

Practice to generate surface by transitioning between multiple cross-sectional profile

Step 1: Set Up the Drawing

- Open your CAD software (AutoCAD or similar).
- Switch to the **3D Modeling workspace**.
- Type UNITS → Set to **Inches** or **Decimal** as preferred.
- Set **View** to **SW Isometric**.
- Set **Visual Style** to **Shaded with Edges**.

Step 2: Create the 2D Profile

We'll create a simple vase profile.

Use the **LINE** command:

- Start at 0,0
- Go up vertically 8 units
- Then move right and create a smooth vase outline using **LINE** and/or **SPLINE**
- Make sure the shape stays on one side of the vertical axis.

Close the bottom of the shape with a horizontal line (if not already).

Step 3: Define the Axis of Revolution

- Use a **straight vertical line** as the axis (e.g., the line from 0,0 to 0,8)
- You can create this using **LINE**.

Step 4: Use the **REVOLVE** Command

- Type **REVOLVE** → Press **Enter**
- Select the **entire 2D profile** → **Enter**
- Select the **axis of revolution** (click on the vertical line)
- Specify angle of revolution:
 - Type 360 → Press **Enter**

Learning Unit 3.4	Render 3D Model
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Learning Outcomes:

After completion of this learning unit, you will be able to understand following.

- Assign material to required 3D Model as per given specification
- Install lights to get requisite scene of required 3D model
- Assign cameras to execute different views of required 3D Model.
- Render and print 3D images according to required size & orientation.
- Create portfolio in pdf format (soft form)
- Use both sides of paper for portfolio printing (if necessary)

3.4.1 Introduction to Rendering

Rendering can be time-consuming, especially with adjustments to camera, lighting, and materials. AutoCAD's new tools allow you to preview aspects of the final image, speeding up the process. You can also render at lower quality or in sections to test changes before committing to a high-res final render. The process of creating a computerized rendering involves four steps:

- Create the actual model
- Place lights
- Attach materials to objects in the model
- Render the image

Other than creating the model, these procedures are conceptual rather than discrete sequential steps, and often are performed in an iterative process. For example, you may place some lights and create a test rendering. Then, after viewing the results of your test, you may change some of the lights and render the image again.

3.4.2 Rendering Tools and Commands

Rendering is the process of creating a raster image based on the 3D objects in a scene.

Rendering Tools

- **Materials and Textures**
 - Material Browser (MATERIALS) – Opens the material library to assign materials like metal, wood, glass, etc.
 - Material Mapping (MATERIALMAP) – Adjusts how textures wrap around 3D objects.
- **Lighting and Shadows**
 - Light (LIGHT) – Creates and places different types of lights.
 - Sun Properties (SUNPROPERTIES) – Simulates real-world sunlight based on location and time.
 - Shadows (SHADOWDISPLAY) – Toggles shadow display in the viewport.
- **Cameras and Views**
 - Camera (CAMERA) – Creates a camera to define the view for rendering.
 - Perspective View (PERSPECTIVE) – Enables perspective projection for realistic views.
- **Rendering Settings**
 - Render Presets (RPREF) – Opens the rendering settings to adjust quality and output format.
 - Render Environment (RENDERENVIRONMENT) – Controls background and sky settings.

AutoCAD Rendering Commands

Command	Description
RENDER	Renders the current view with applied materials and lighting.
RENDERPRESETS	Opens rendering settings and quality options.
MATERIALS	Opens the material browser to apply and edit materials.
LIGHT	Creates lights like point, spotlight, and distant lights.
SUNPROPERTIES	Adjusts sunlight settings based on geographic location and time.
CAMERA	Places a camera for better control over the rendering view.
RPREF	Opens the Render Presets Manager to set rendering quality.
RENDERWIN	Opens a separate rendering window.
RENDERCROP	Renders only a selected portion of the view.
VISUALSTYLES	Switches between visual styles like Realistic, Conceptual, and Shaded.

Rendering Process in AutoCAD

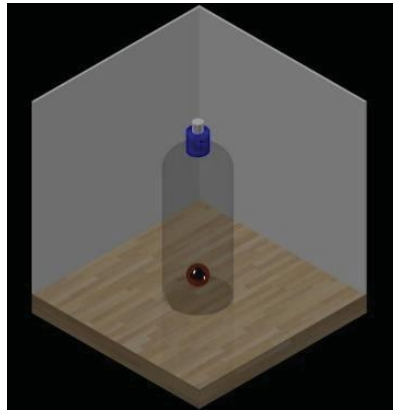
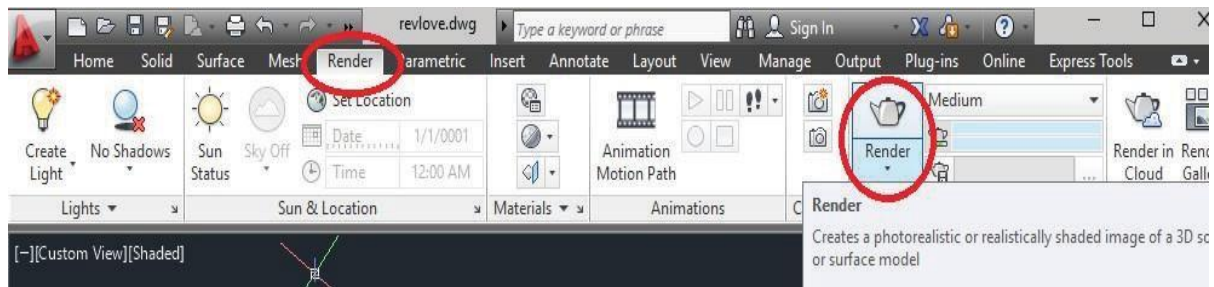
- ✓ **Set Up the Model**
 - Ensure your 3D model is complete.
- ✓ **Apply Materials (MATERIALS)**
 - Assign materials to different surfaces.
- ✓ **Set Up Lighting (LIGHT or SUNPROPERTIES)**
 - Use artificial lights or sun settings for better effects.
- ✓ **Create a Camera View (CAMERA)**
 - Define the best angle for rendering.
- ✓ **Adjust Rendering Settings (RPREF)**
 - Set quality, resolution

Types of Material/Texture and Light

Material and texture define the surface appearance of a 3D model, while light dictates how those surfaces interact with a virtual environment.

3.4.3 Render Tab

Render is used to get the most realistic and photorealistic view of your 3D drawing by adding realistic materials.



Texture Map

Texture maps are useful for creating many kinds of materials, such as wood grains and wall surfaces. You can use the following file types to create texture maps:

- BMP, RLE, or DIB
- GIF
- JFIF, JPG, or JPEG
- PCX
- PNG
- TGA
- TIFF

To display the Texture Map Property Settings specific to Texture map, click the Click for Texture Map Settings button

Procedure

Command entry: materials

Controls the property settings for Texture Map.

Click for Texture Map Settings

Displays a window with property settings to adjust the appearance of the texture. This button appears once an image is selected for the Texture Map.

Collapse/Expand Display Panel

Collapses (up arrows) and expands (down arrows) the display panel.

Texture Map Slider

Controls the blending of the texture map with the assigned control properties for the material.

Scaling & Tiling

Provides settings to adjust the scaling and tiling for the map.

Offset & Preview

Provides settings to adjust the material offset and preview for the map.

Adding Material to a Drawing

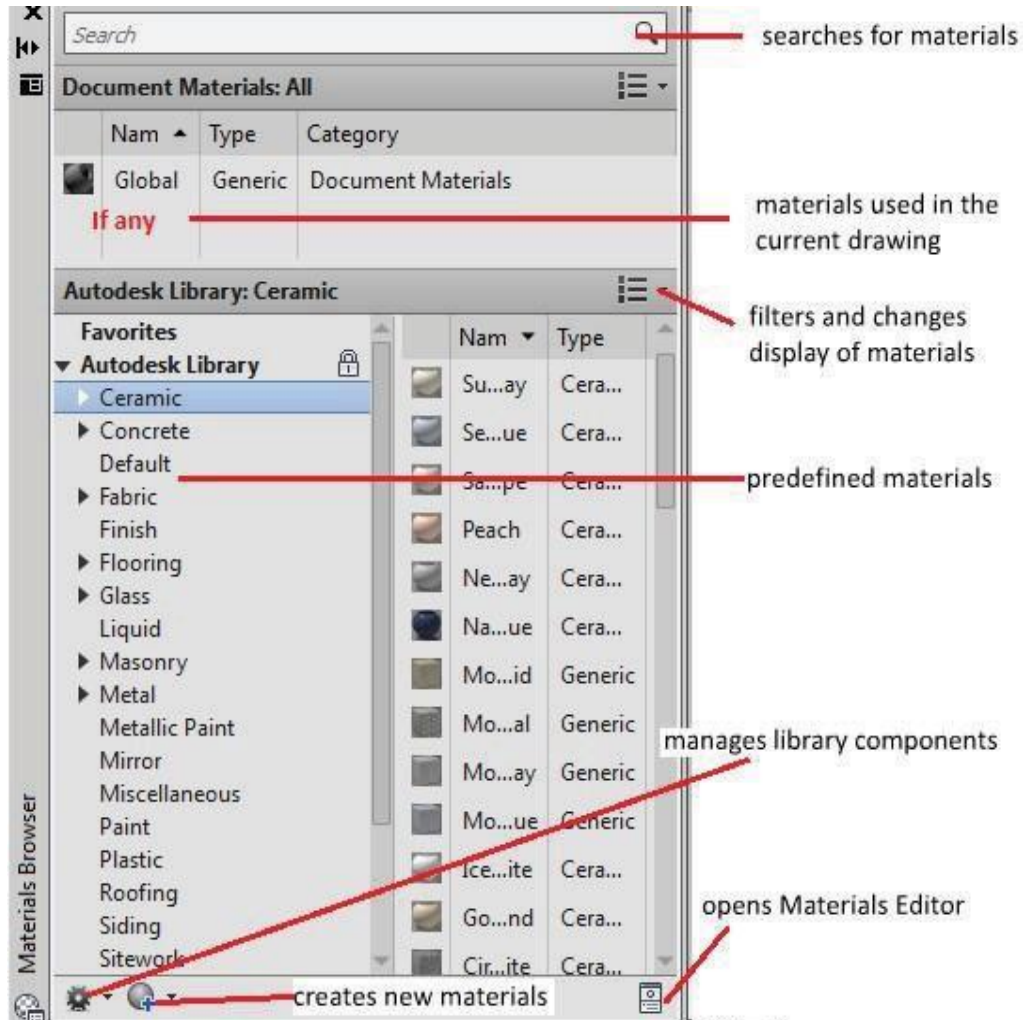
A material is simply an image stretched over an object to make it appear as if the object is made out of various materials such as wood, marble, brick, metal, plastic, glass, and so on.

To Browse Material

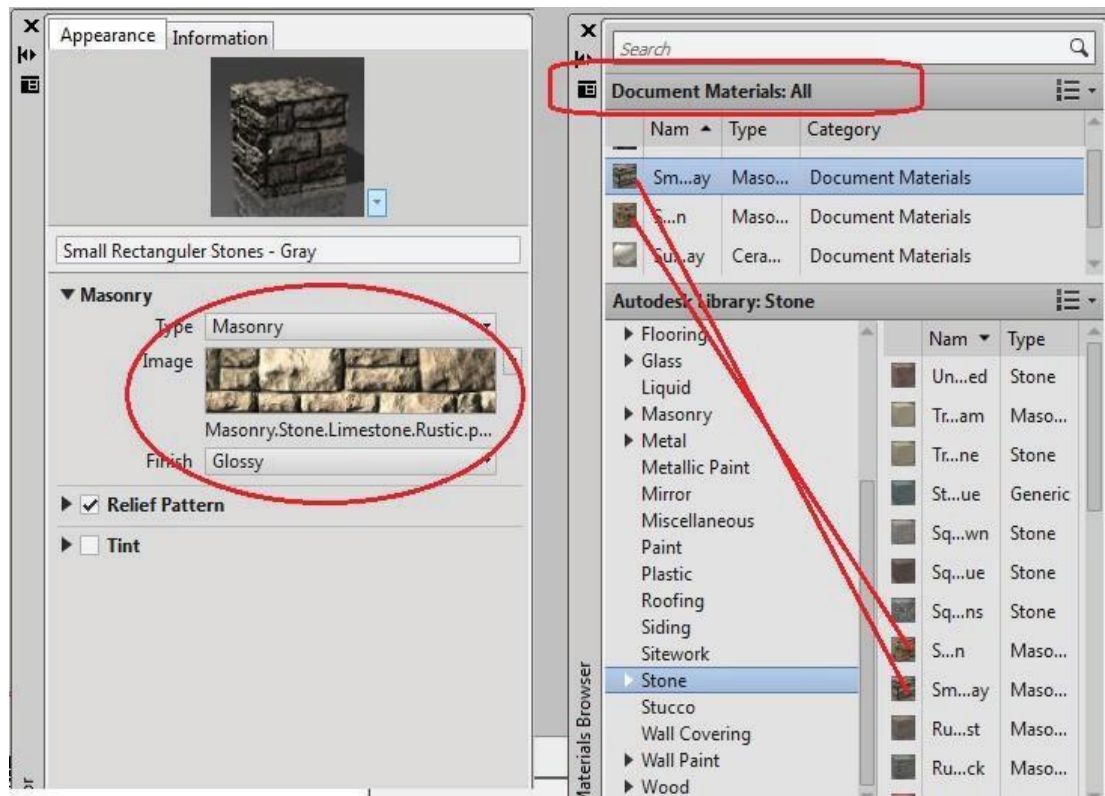
Render Tab	Button	Command Entry
Material ☐ Browse Material.		MARBROWSEROPEN

Step -1

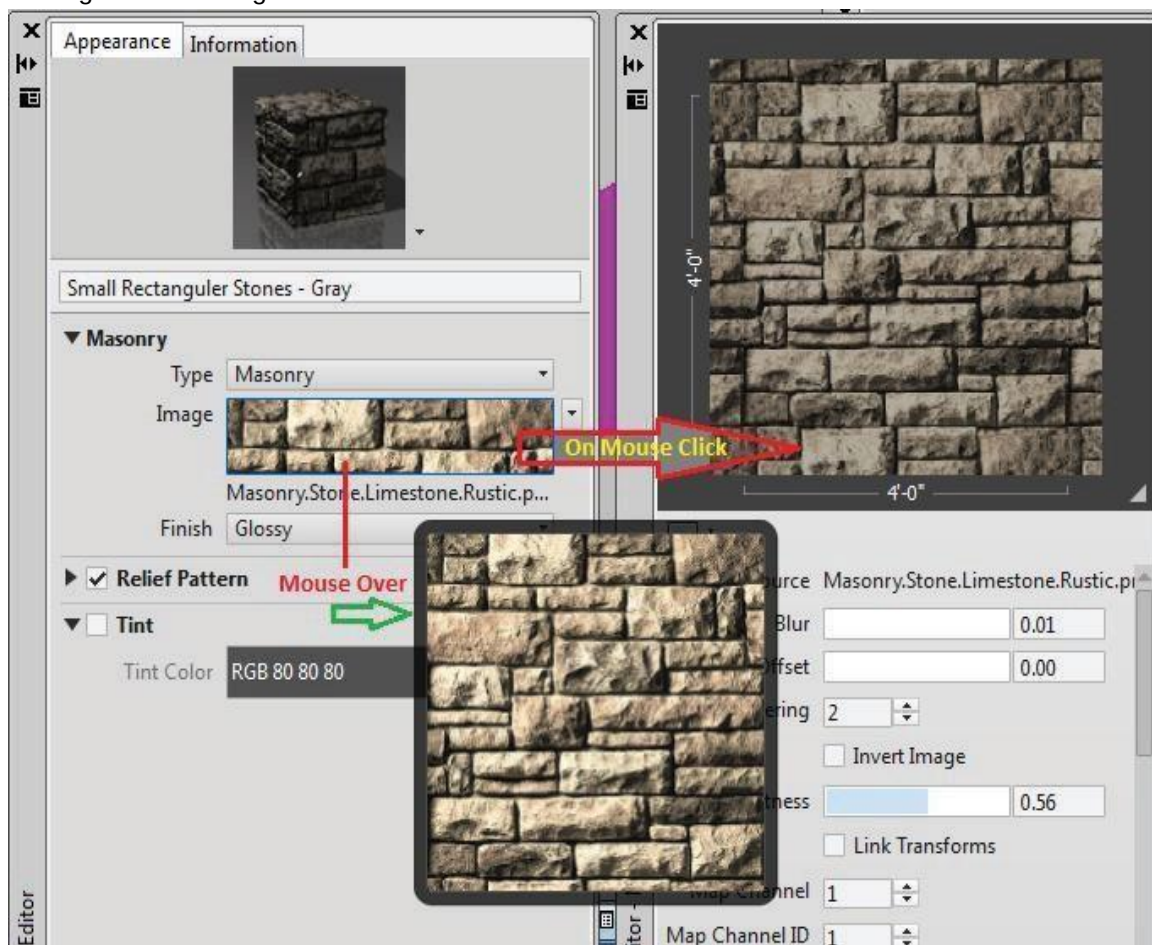
View ☐ Render ☐ Materials Brower



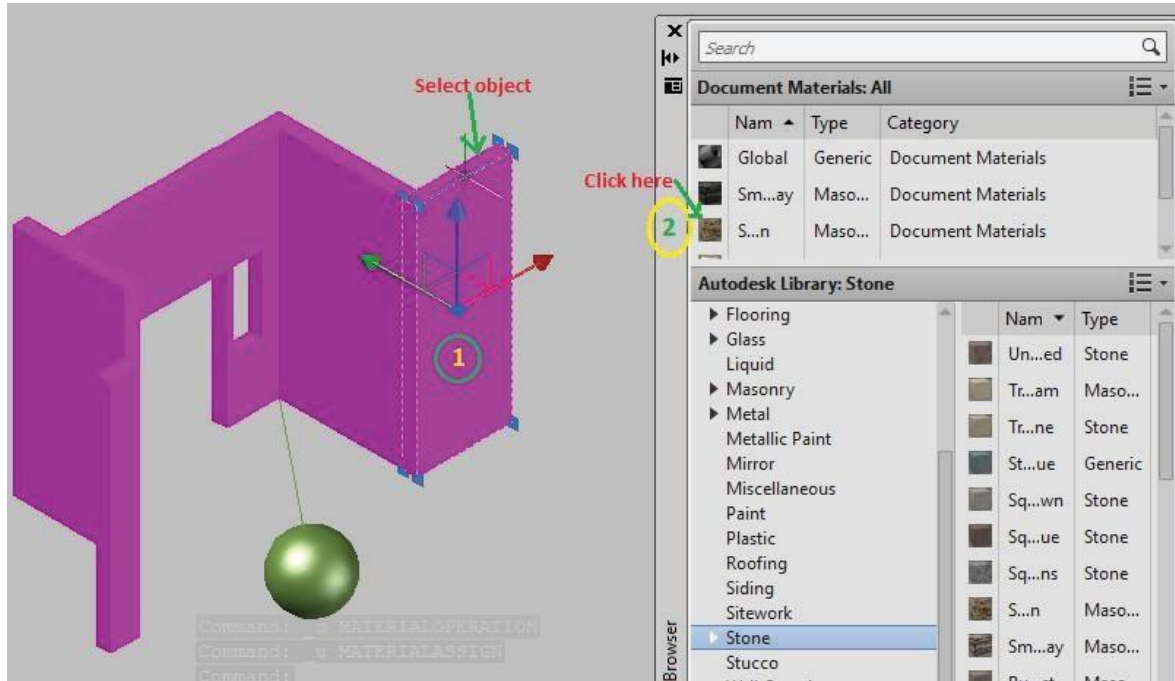
Double Click or drag any of the material from material library into the document material list as show in the figure below



Step-3: Go to the Material list and apply material as shown in the figure
 You will get the following.

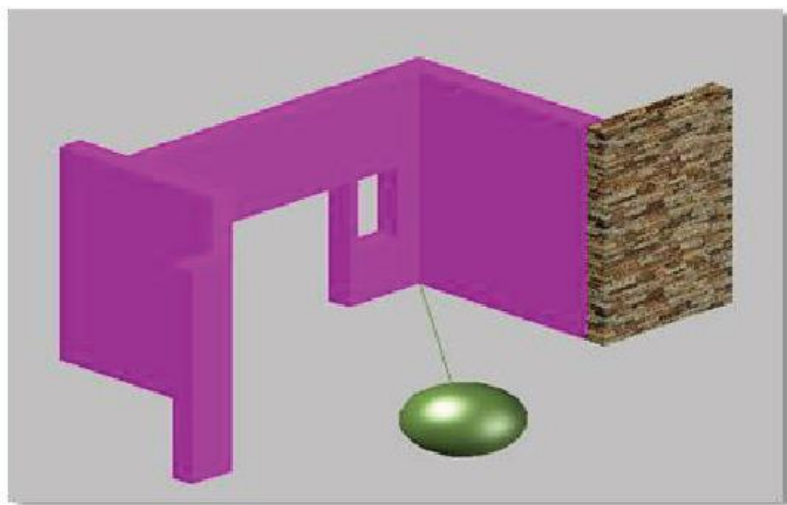


Blank space showing the following



Step 4: Type **render** command in command bar to view the render with applied material. Past picture here

Materials



Material contains settings that affect how materials are handled by the renderer.

Apply Materials

Apply the surface materials that you define and attach to an object in the drawing. If Apply Materials is not selected, all objects in the drawing assume the color, ambient, diffuse, reflection, roughness, transparency, refraction, and bump map attribute values defined for the GLOBAL material.

Texture Filtering / Texture Mapping

Specify how texture maps are filtered.

Force 2-Sided

Control if both sides of faces are rendered.

3.4.4 Control Sampling

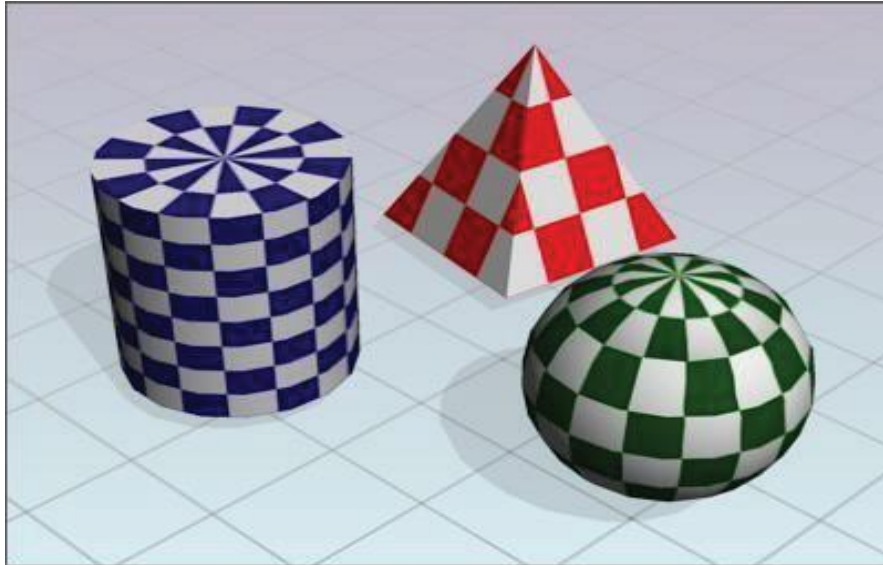
Sampling provides a “best guess” color for each rendered pixel. The renderer first sample the scene color at locations within the pixel or along the pixel's edge, then uses a filter to combine the samples into a single pixel color. Increasing the minimum and maximum sample ranges greatly improves the quality of a rendering.

If image quality is highly degraded

- Min. Samples = 1/64;
- Max. Samples = ¼.

In the following example, increased sampling smooth's edges

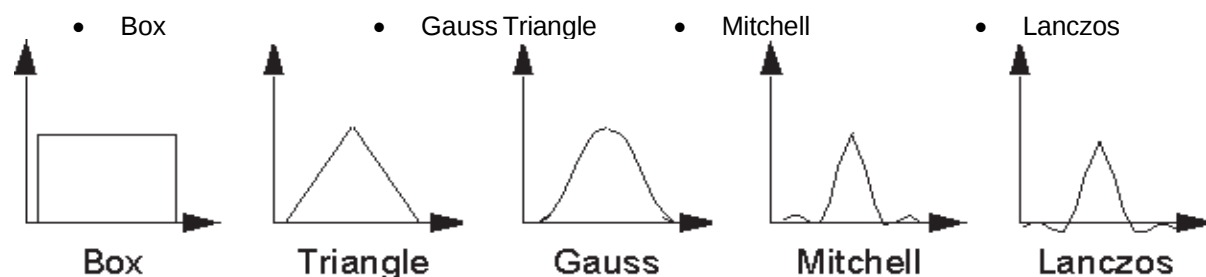
- Min. Samples = 1;
- Max. Samples = 16.



Note: Controls Sampling can be applied

Filter Type

There are five filter methods:



Shadow:

Contains settings that affect how shadows appear in the rendered image.

Mode

Simple

- Generates shadow shaders in a random order.

Sort

- Generates shadow shaders in order, from the object to the light.

Segments

- Generates shadow shaders in order along the light ray from the volume shaders to the segments of the light ray between the object and the light.

Shadow Map

Control if shadow mapping is used to render shadows. When on, the renderer, renders shadow-mapped shadow. When off, all shadows are ray-traced.

Sampling Multiplier

Globally limits shadow sampling for area lights.

Ray Tracing

Ray tracing contains settings that affect the shading of a rendered image, which effects of reflection and refraction.

Max Depth

Limit the combination of reflection and refraction.

Max Reflections

Set the number of times a ray can be reflected.

Max Refractions

Set the number of times a ray can be refracted

3.4.5 Illumination

Indirect illumination techniques, like global illumination and final gathering, enhance the realism of a scene by simulating radiosity, or the inter-reflection of light in a scene.

Enable

Specify if lights should cast indirect light into the scene.

Photons/Samples

Set how many photons are used to compute the intensity of the global illumination. Increasing this value makes global illumination less noisy but also more blurry. Decreasing this value makes global illumination more noisy but less blurry. The larger the Samples value, the greater the rendering time.

Determine the size of photons. When on, the spinner value set the size of photon. When off, each photon is calculated to be 1/10 of the radius of the full scene.

Radios

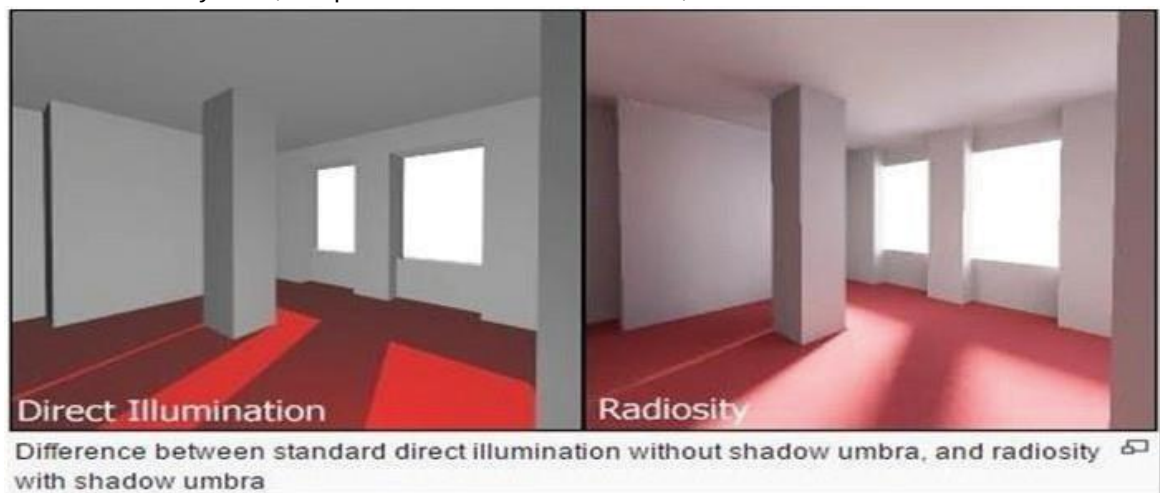
Specifies the area within which photons will be used when luminance is computed.

Max Depth

Limit the combination of reflection and refraction. Reflection and refraction of a photon stop when the total number of both equals the Max Depth setting. For example, if Max Depth equals 3 and the trace depths each equal 2, a photon can be reflected twice and refracted once, or vice versa, but it can't be reflected and refracted four times.

Max Reflections

Set the number of times a photon can be reflected. At 0, no reflection occurs. At 1, the photon can be reflected once only. At 2, the photon can be reflected twice, and so on.



Diagnostic

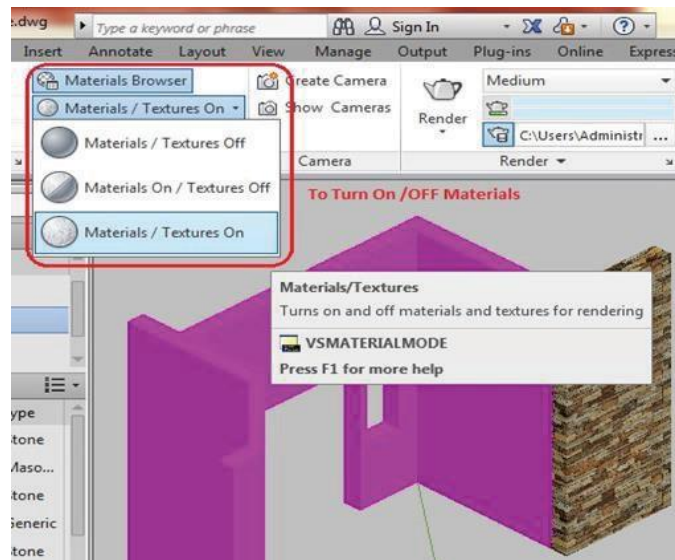
Diagnostic also called visual to help you understand why the renderer is behaving in a certain way.

- i. Grid: Render an image that shows the coordinate space of objects, the world, or camera.
- ii. Object. Shows local coordinates (UVW). Each object has its own coordinate space.
- iii. World. Shows world coordinates (XYZ). The same coordinate system applies to all objects.
- iv. Camera. Shows camera coordinates, which appear as a rectangular grid super imposed on the view.

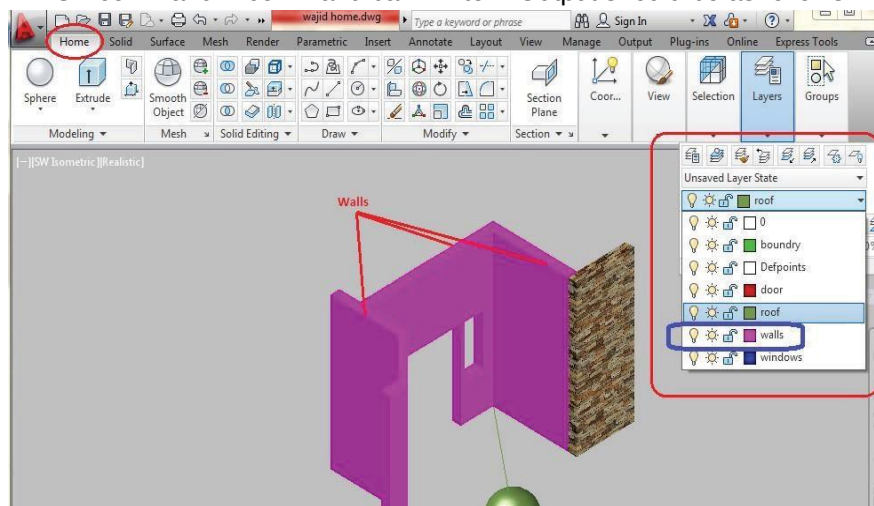
3.4.6 Material by Layers

You can apply material by layer but the layer must be defined before apply “**Material by layer**”. In this example we have already defined layer for the drawing as shown in the figure below.

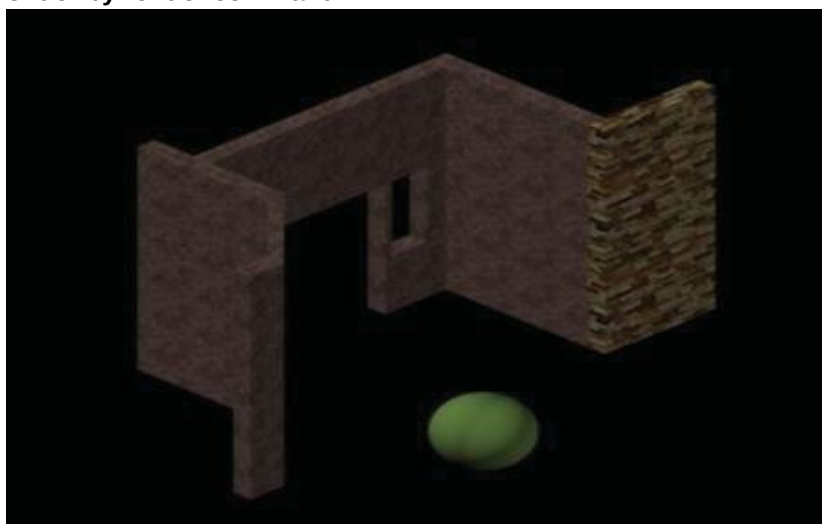
Step-1: You can attach a material to an entire layer using the Material Attach command.



MATERIALATTACH command in command bar <Enter> Output should be as follows



Step-2: Apply render by render command



Create own Material

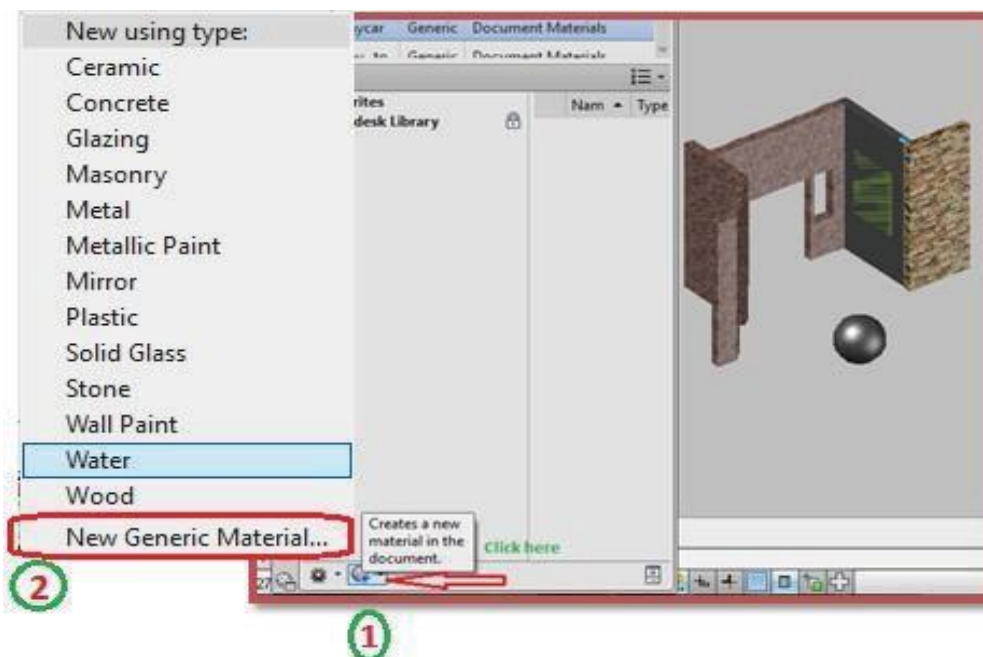
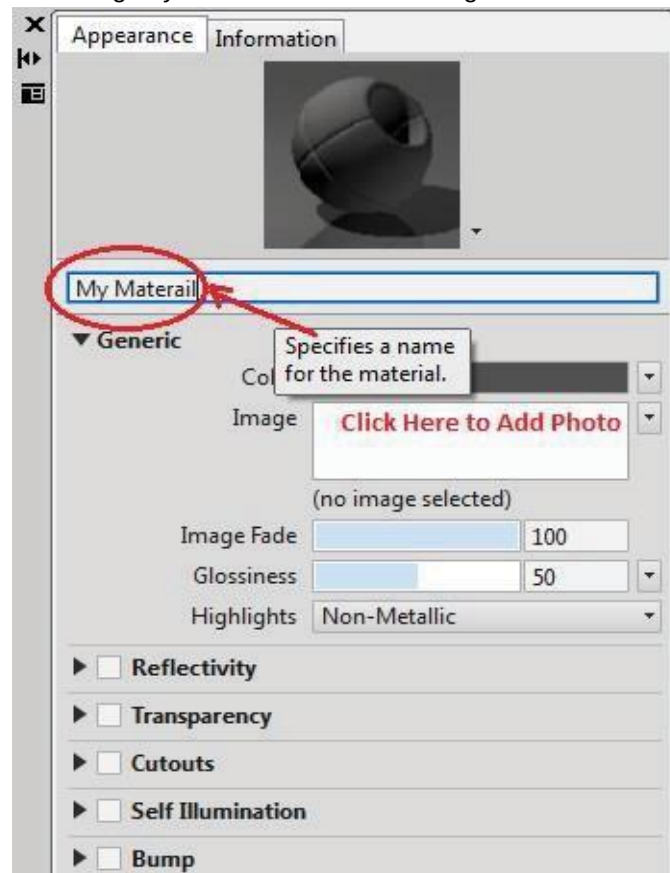
You can create your own material to apply photo and images.

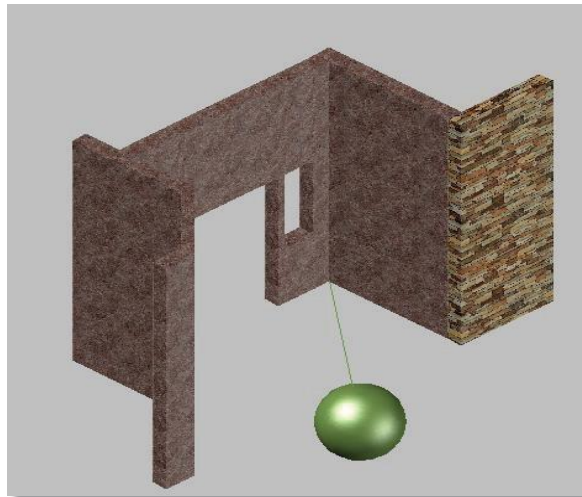
Step-1: Type materials command in command bar or click Browse Material

Step-2: Click Create **New Material** Option as shown in the figure below

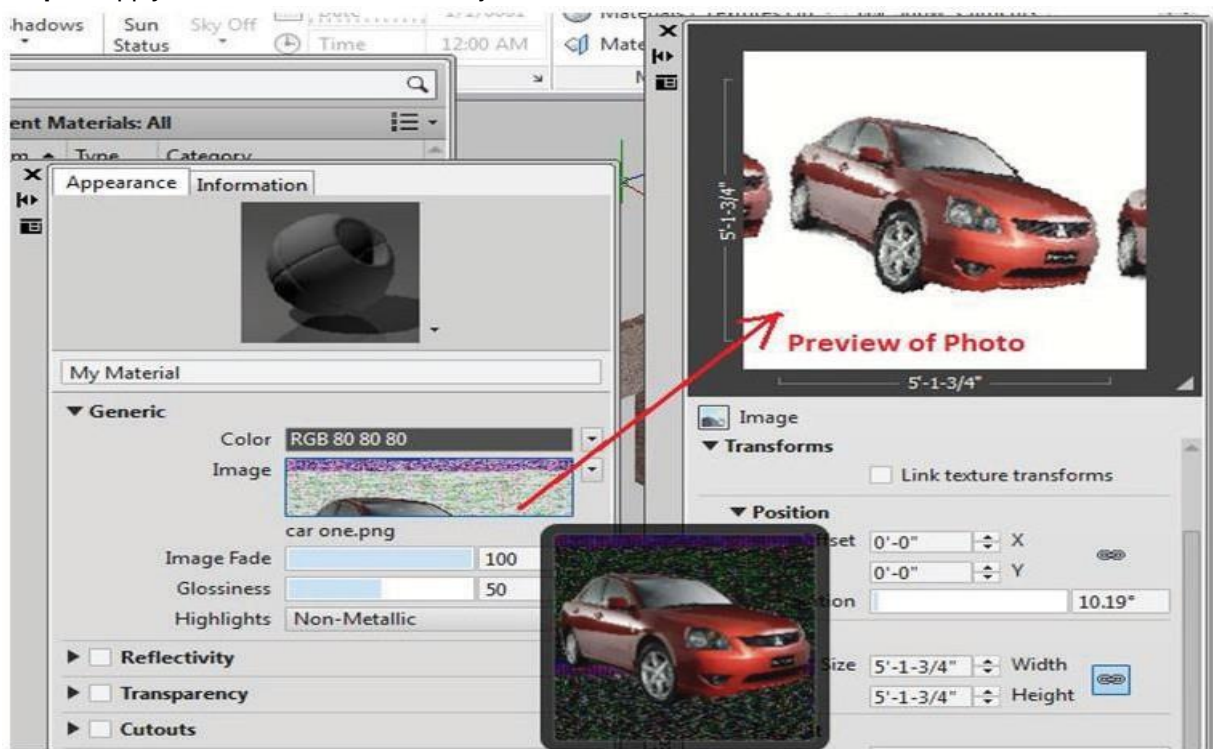
Step-3: Click a **New Generic Material** and then follow steps as described in the figure below

Step-4: Browse to file for adding any Photo as shown in the figure below.

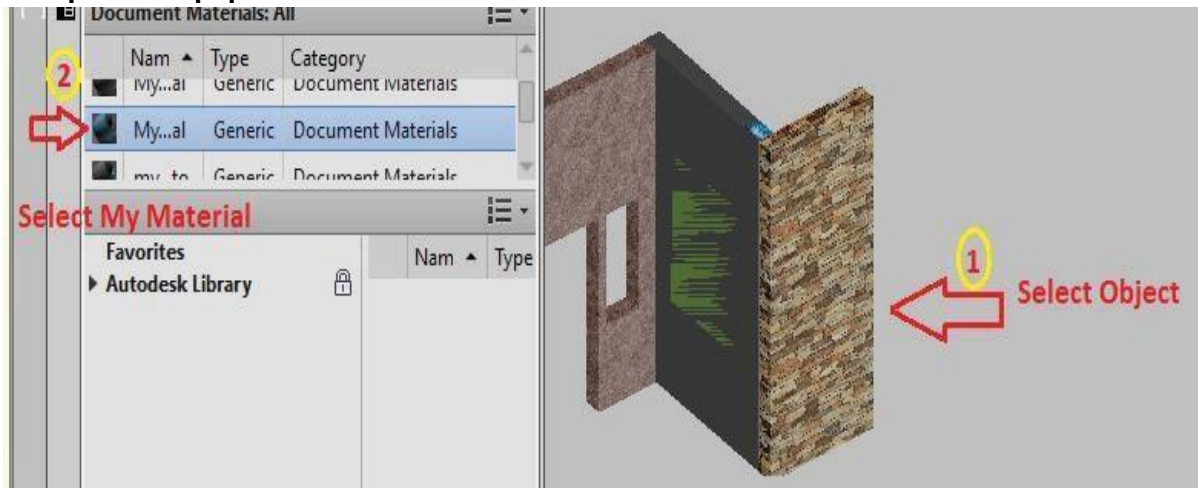




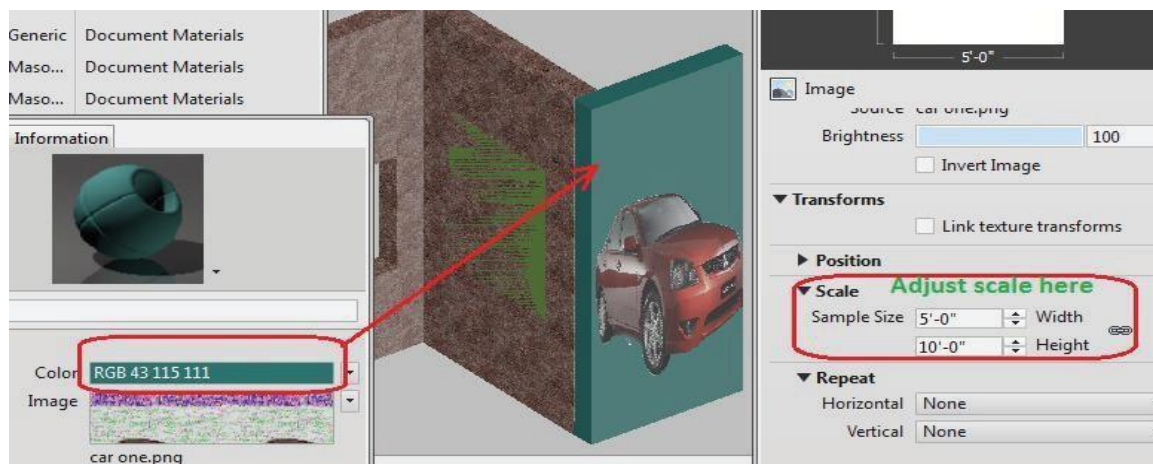
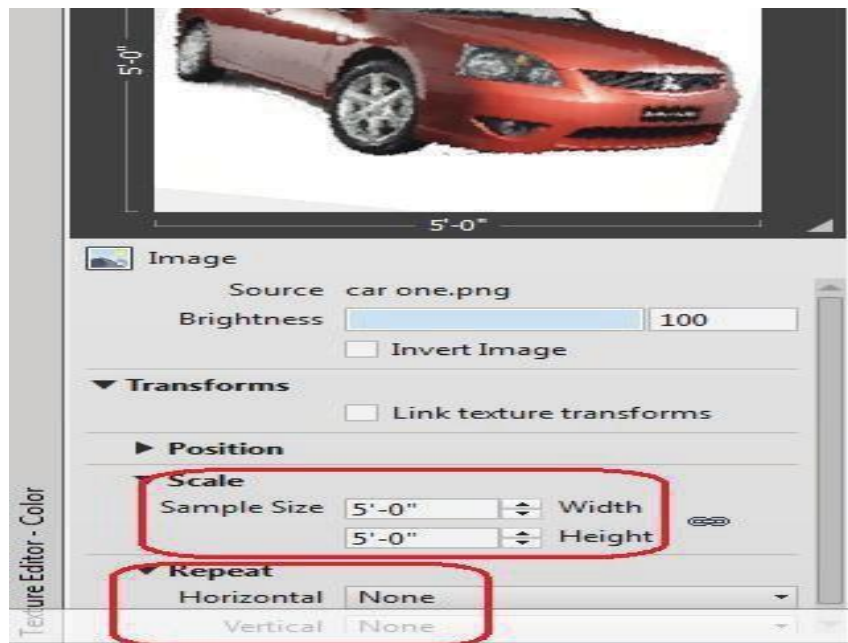
Step-5: Apply material to the selected object.



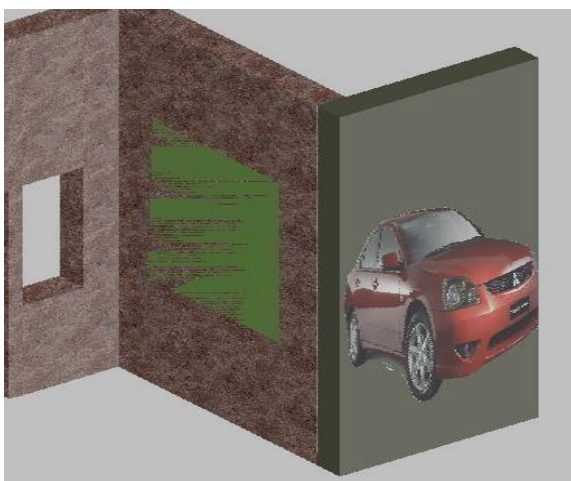
Compose the papers



Final Out Put



Step-6: Apply render command to display render



3.4.7 Material Mapping

You can map material to an object by using “**MATERIALMAP**” command.

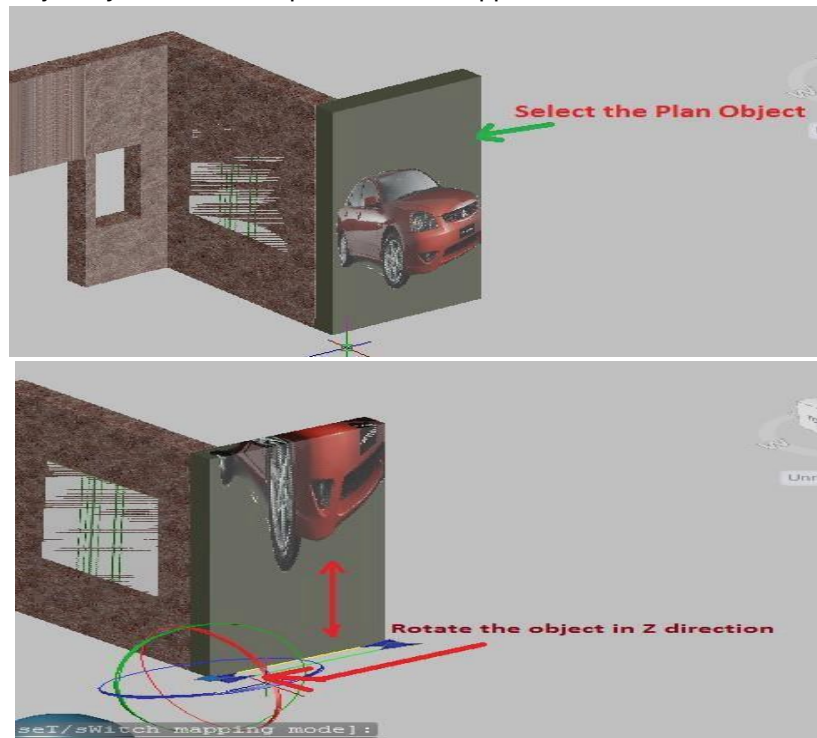
Step-1: Type **MATERIALMAP** command in command bar <Enter>

Step-2: Select an option [Box/Planar/Spherical/Cylindrical/copy mapping to/Reset mapping]<Box>: **p**

Step-3: Select faces or objects: 1 found

Step-4: Select faces or objects: <Enter>

Step-5: Accept the mapping or [Move/Rotate/reset/switch mapping mode]: **R** enter **Step-6:** Rotate the selected face or object by **GIZMO** to map the material applied.



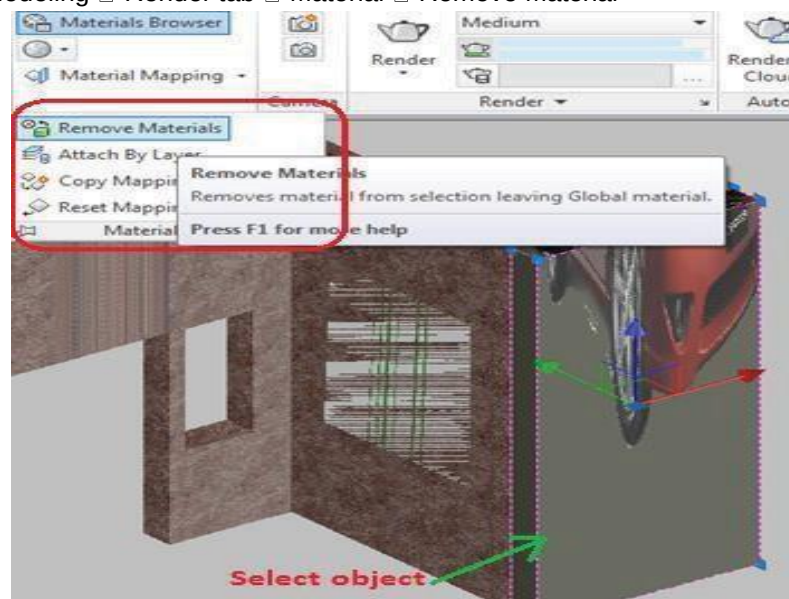
3.4.8 Remove Material

You can remove Material from an object by using the following method.

Method:

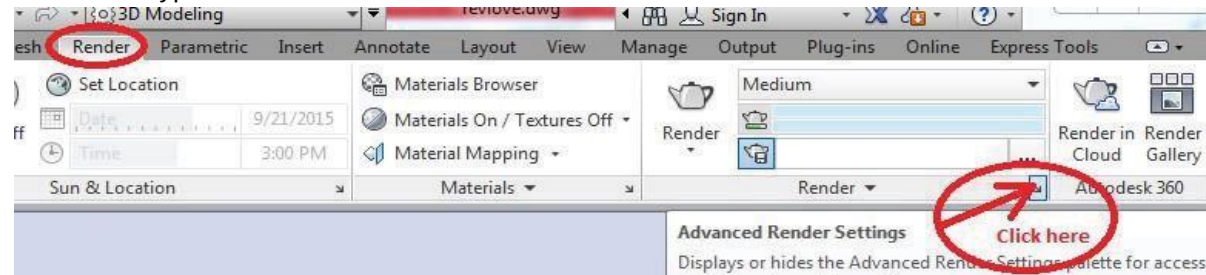
Select the object

Go through 3D Modeling □ Render tab □ Material □ Remove Material



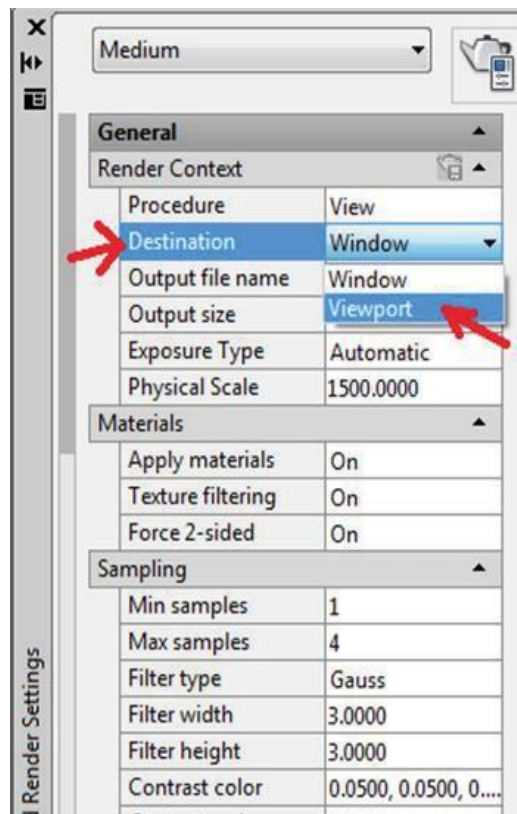
Access Advance Render Settings by the following methods

Method-1: Type RPERF in command bar.



Method-2: Procedure Apply Advanced Render Settings

STEP BY STEP Operation on AutoCAD



GET READY. Before you begin these steps, be sure to set unit and you must have an object in your drawing to apply rendering.

Step-1: Type **RPERF** command in command bar <Enter>

Step-2: Select destination field and switch into viewport as shown below

Step-3: Type **render** command in command bar.

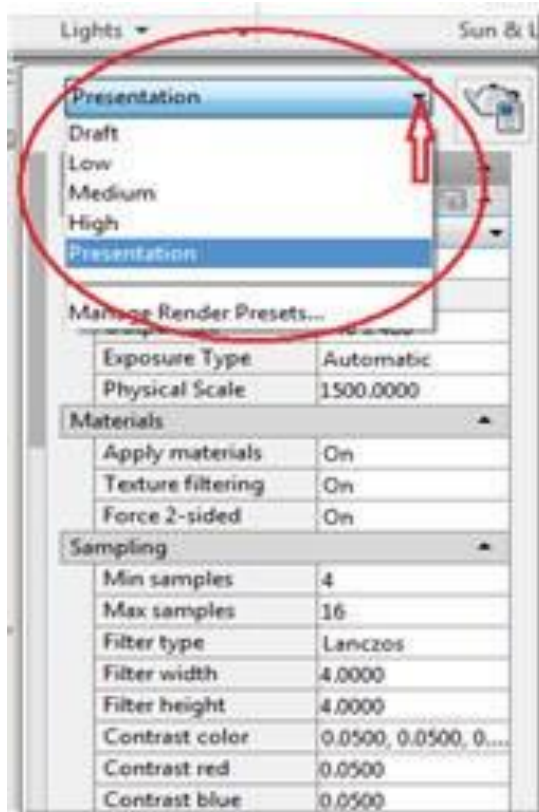
Step-4: Repeat the above steps for Window destination

Deference between window and viewport:

A separate window is open for window destination which you can save for future use while viewport destination rendered the drawing in the same window, which cannot be save and for temporary display

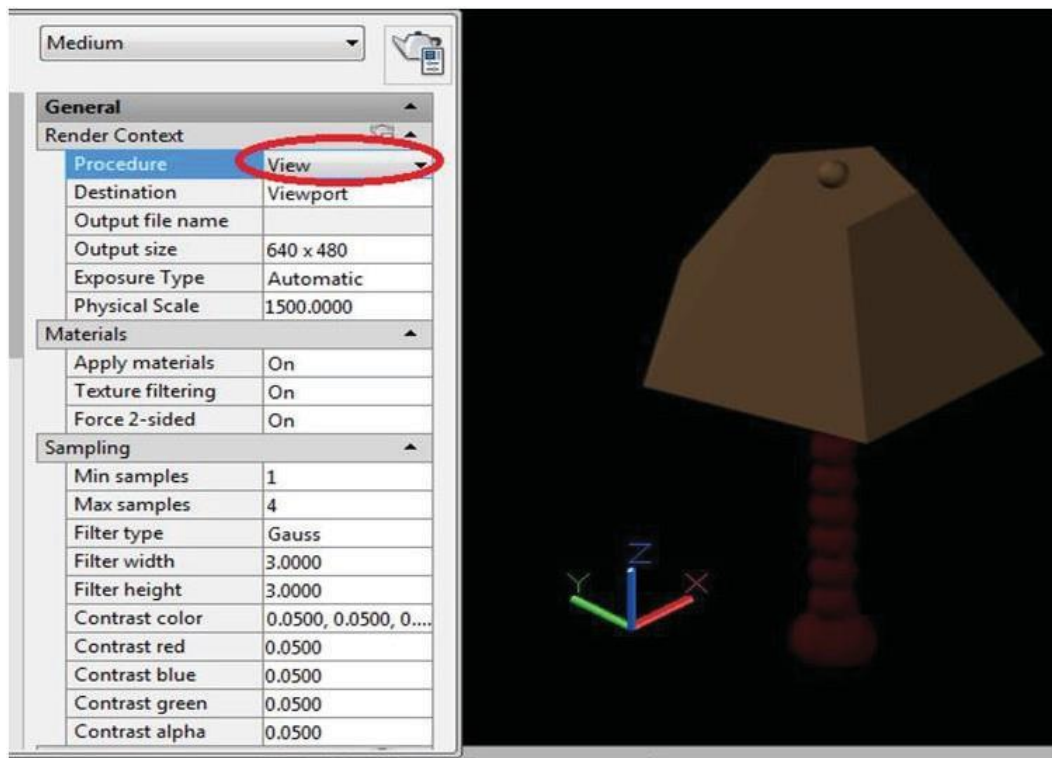
Quality Setting

You can set the quality of image for rendering by using Advance Render Setting as shown in figure below



Note: Quality of the rendering to be open takes time according to material, lighting etc.

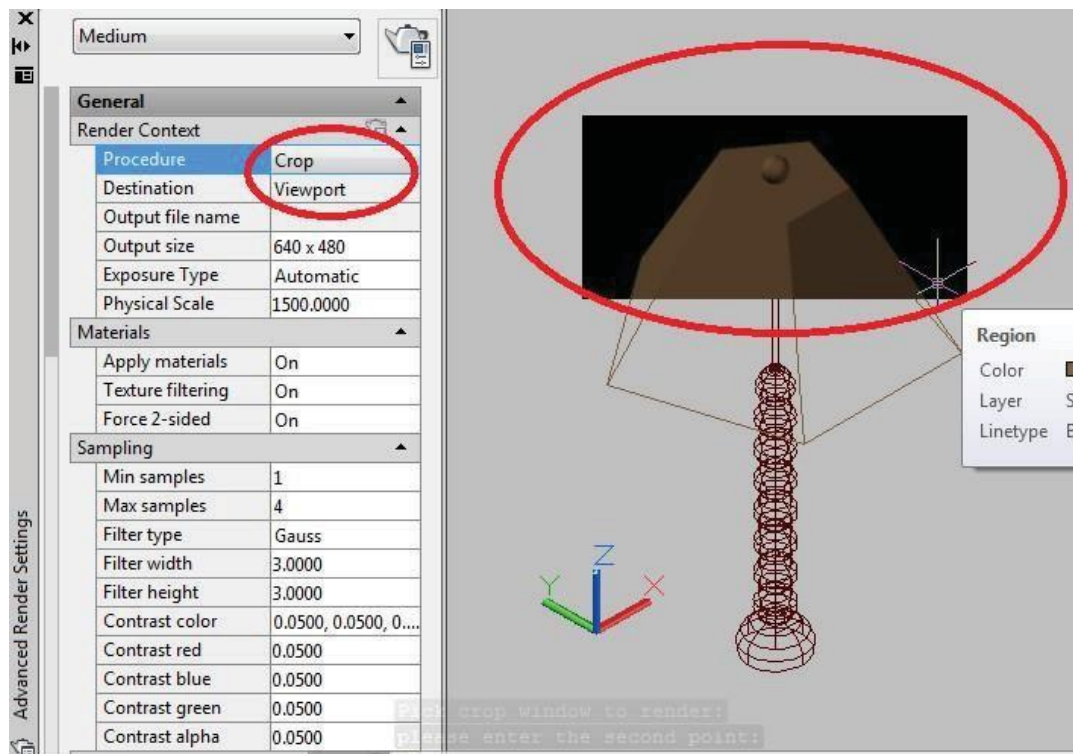
Crop Procedure



Step-1: Type **RPERF** command in command bar <Enter>

Step-2: Select Procedure field and switch into crop as shown below

Step-3: Apply render by using **render** command

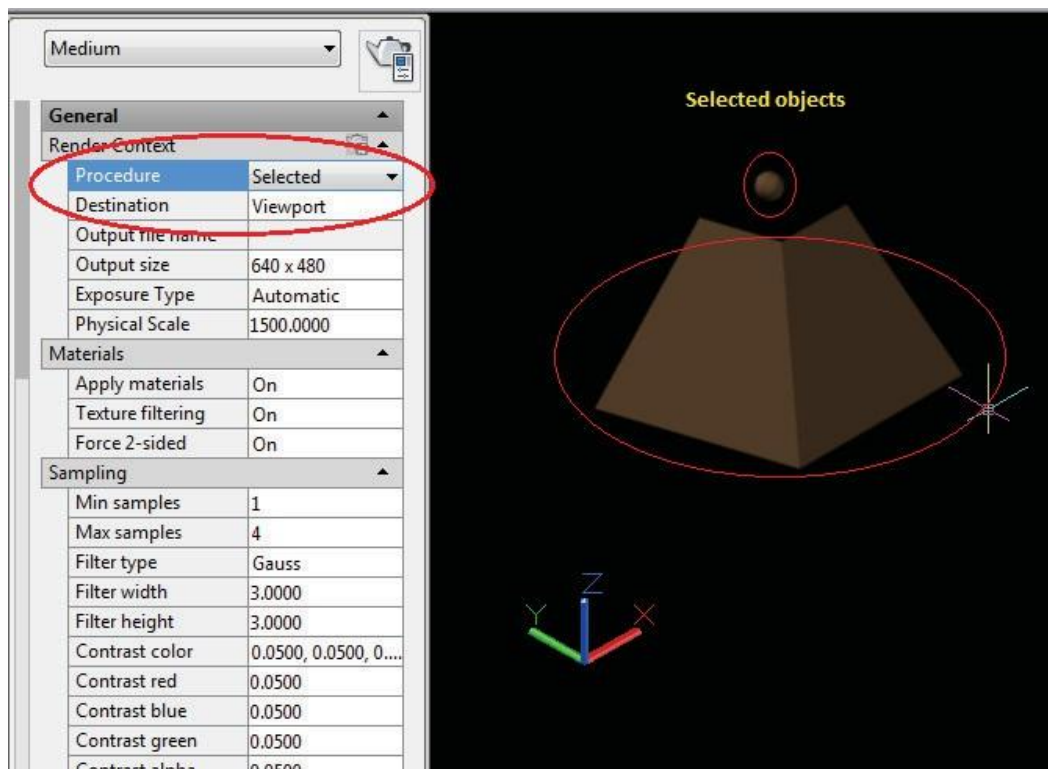


Select Procedure

Step-1: Type **RPERF** command in command bar <Enter>.

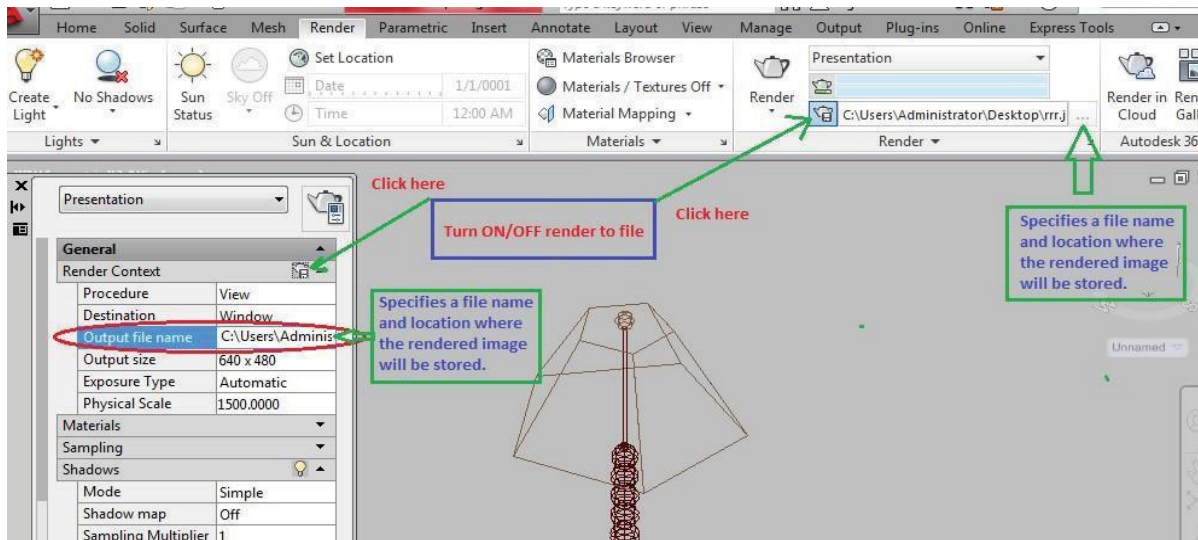
Step-2: Select Procedure field and switch into Selected as shown below.

Step-3: Apply render by using **render** command.



Render to File and Turn off Render to File.

- You can turn **on/off** Render to file by the following procedure.

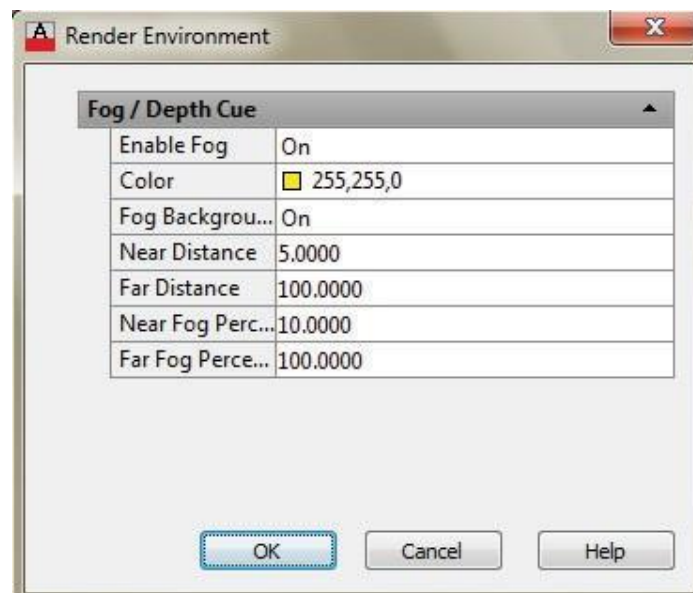


3.4.9 RENDER ENVIRONMENT

Create **fog** effect to enhance sense of distance.

Step-1: Type **RENDERENVIRONMENT** command in command bar <Enter>

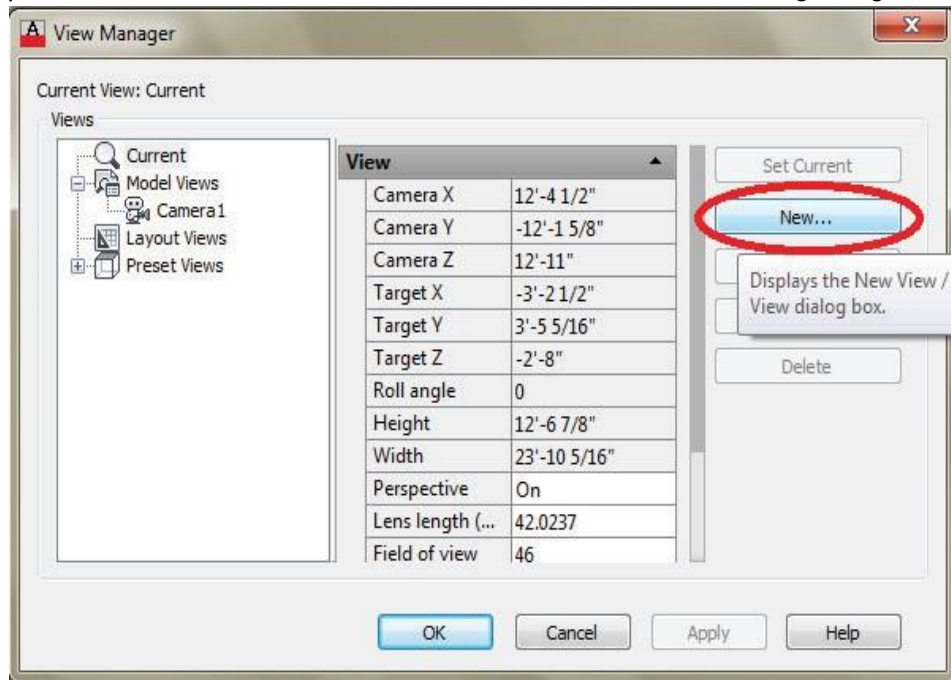
Step-2: Apply render



Creating Views and Applying Background

View is used to create, set, rename, modify, and delete named view, including model named views and camera views, layout views, and preset view. Here we are using view command or view manager to set different background.

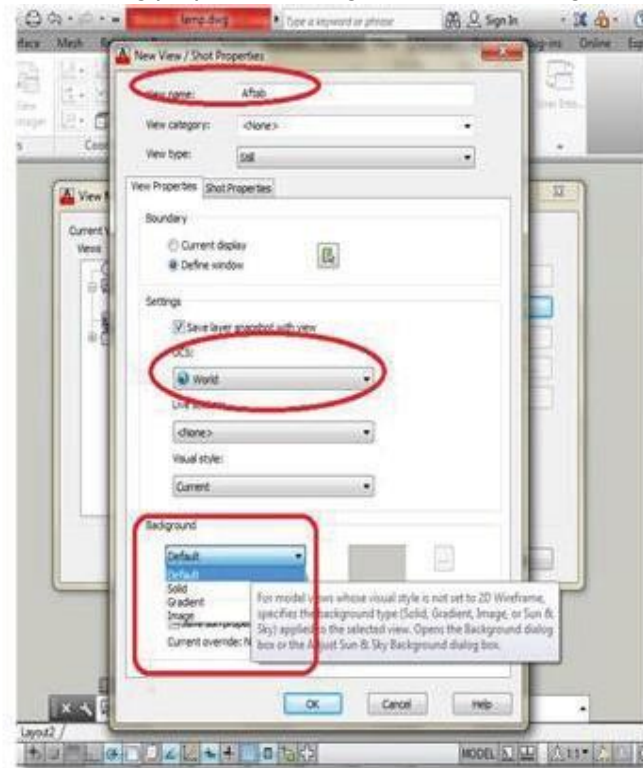
Step-1: Type **view** command in command bar or click View tab ▢views Manager to get the following.



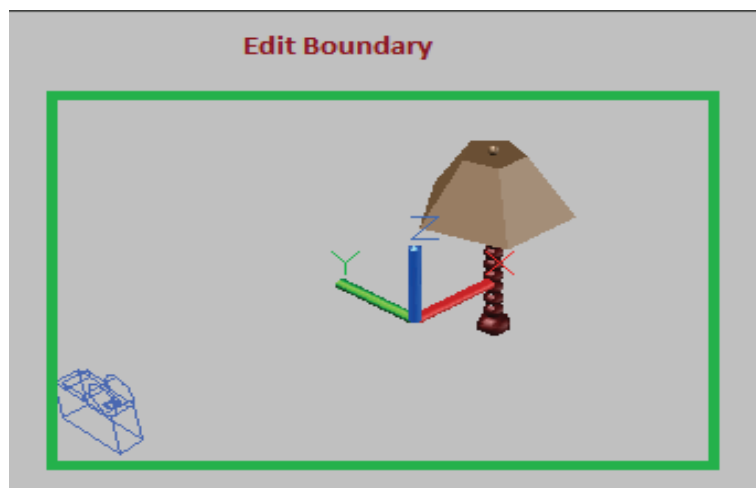
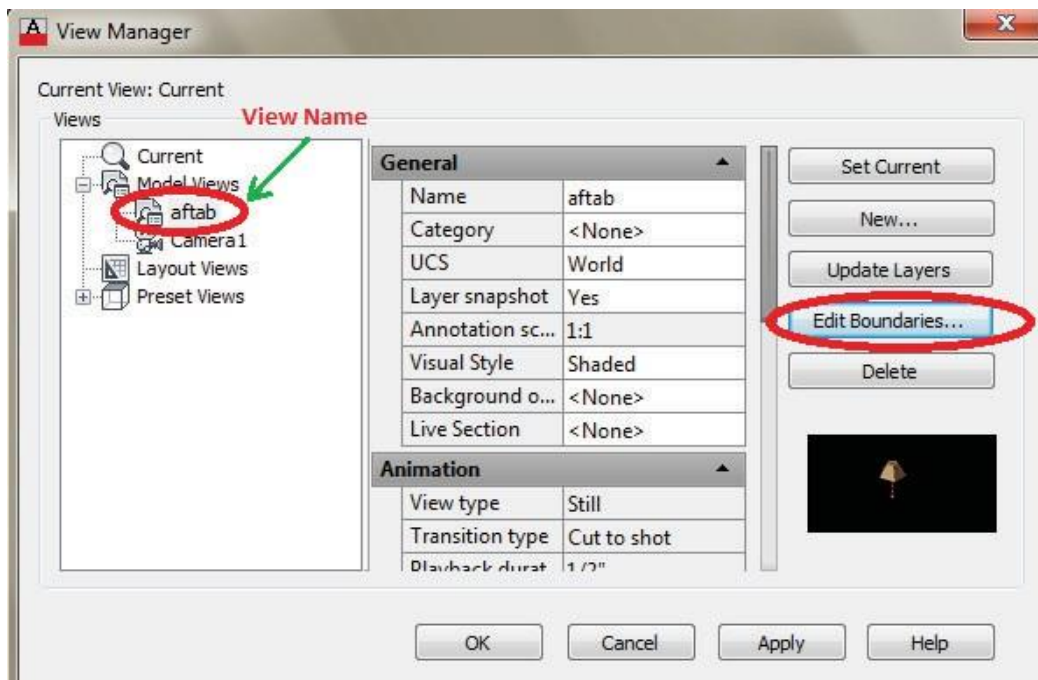
Step-2: Click the new button and get the following properties setting as shown in the figure below.

Note:
You can change the setting according to your View.

Here we applied:
View Name: Aftab
UCS: World

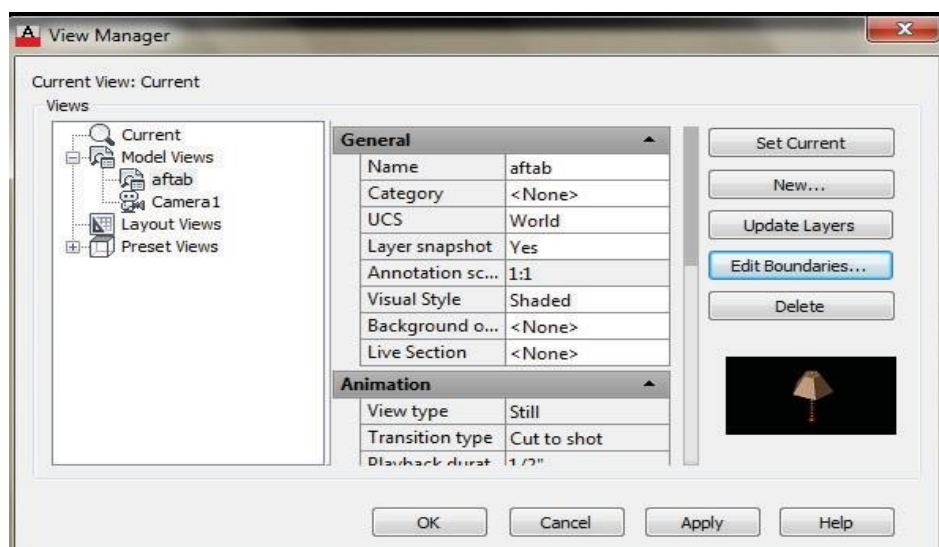


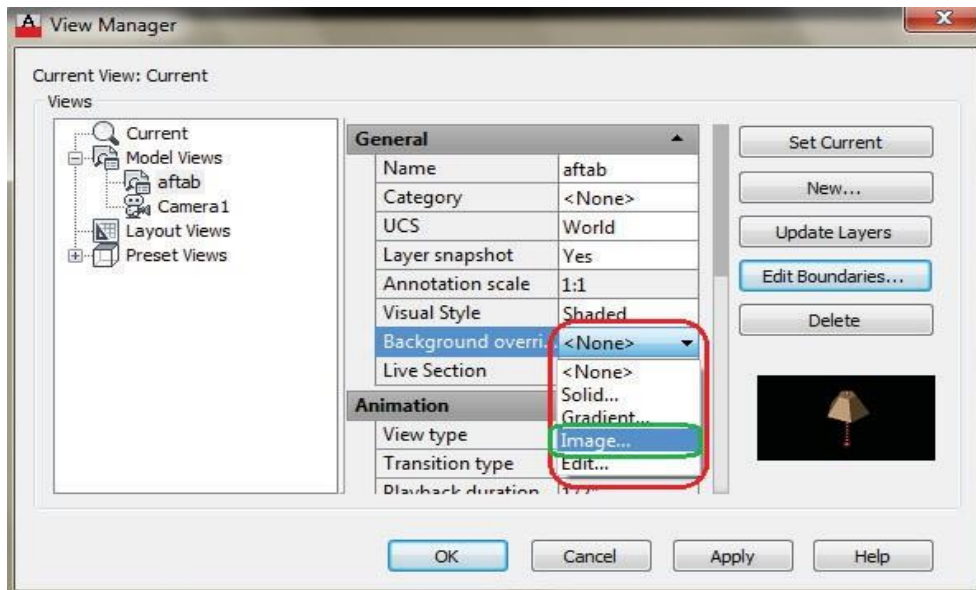
Step-3: Click the Edit Boundary option to define your own boundary for the background as shown in the figure below.



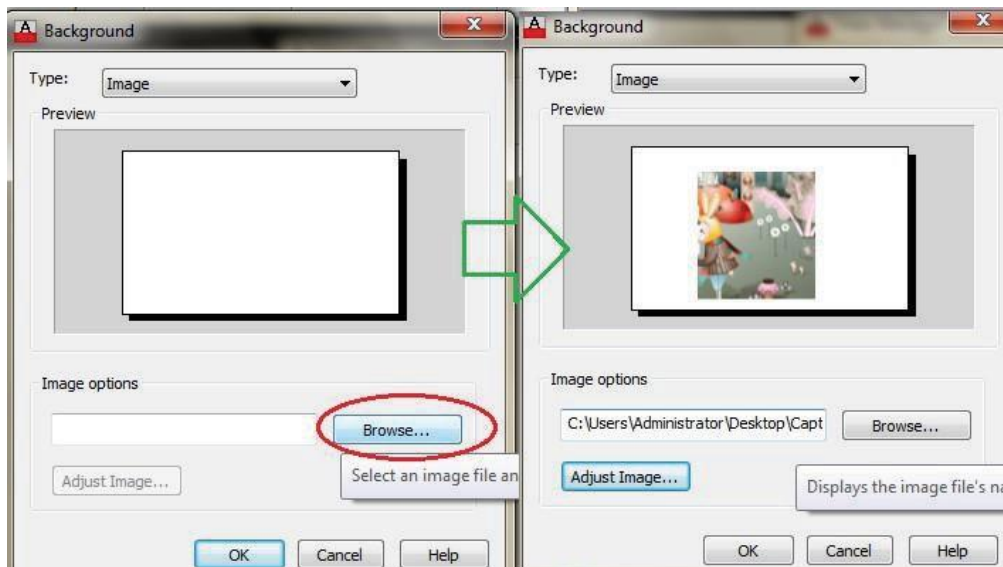
Step-4: After defining the boundary press Enter, you will get back to View Manager Window.

Step-5: Now select background option to apply one of the three option of background as show in figure below.

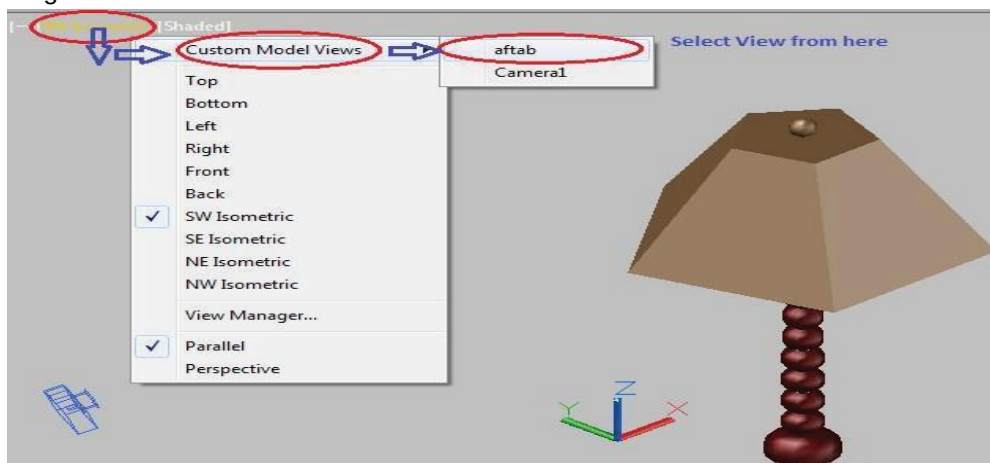




Step-6: Here we are going to select the image option to select image from file and click **Ok** as shown in figure.



Step-7: Select view from view control as follow
You should get the follow Out Put





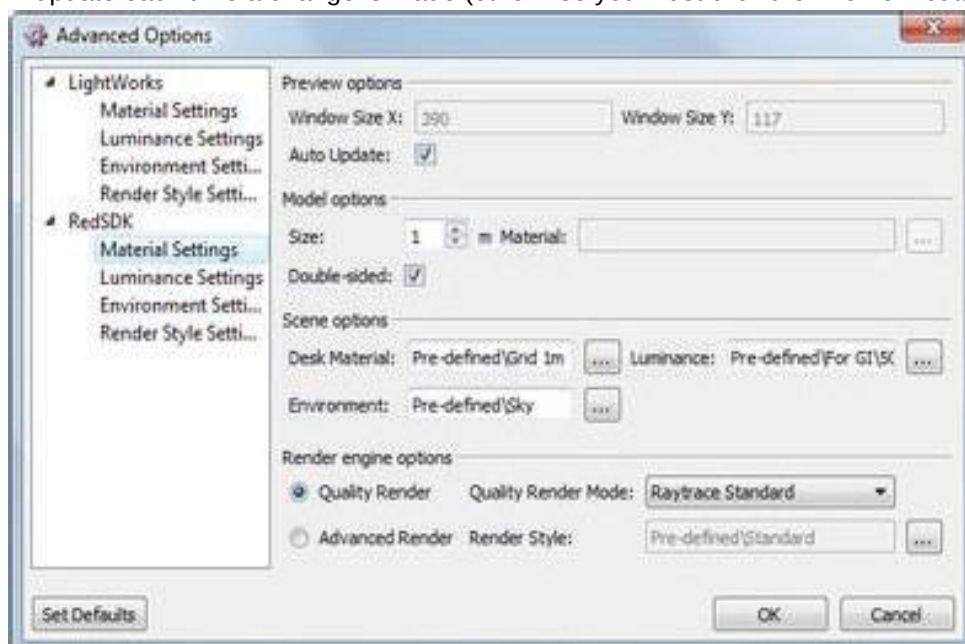
3.4.10 Opacity Control

Opacity is the opposite word for transparency. Each material has five categories of parameters you can set: Pattern, Reflectance, Transparency, Texture and Wrapping. Not all categories are used for each material, only those that are relevant.

- Select a material in the Materials Palette
- Right click and select Edit Materials.
- When the Render Manager appears click the small green help button. This will open the Lightworks help, which is replete with details on functions and settings.



In the **Preview** section, you can change the shape and orientation of the preview object. Under **Options**, you can toggle the display of the preview object or desk. If **Auto Update** is checked, the preview will update each time a change is made (otherwise you must click the **Preview** button).



The toolbar on the right side of the editor allows you to specify the elements of the preview. You can navigate within the preview window using the center mouse button. You can also see approximately how the material will appear on an object by entering a value into the **Model Size** field. Simply specify a size that is close to the size of the object to which you will be applying the material. Alternately, you can use the selection arrow under the preview.

This will show you exactly how the material will appear on the selected object.

Warning: If the selection arrow is the specified option for the preview object, and no object is selected, you will get a warning that a preview cannot be generated. This will also happen if the selection arrow is the default and you open the Render Manager with no object selected.



3.4.11 Apply Lights

You will also be able to differentiate between the functionality of different types of light and its implementation in the drawing and get understanding of geographical location setting by specifying the latitude and longitude of a location for the sunlight.

Light

As we know that without a light, the scene cannot be looked attractive and realistic. Rendering has four conceptual steps to develop drawing more realistic.

- Create the model
- Attach materials to objects
- Render the image
- Place lights

We already discussed the first three steps of rendering “Creating the model, attach material and then Render the image or drawing”, the last conceptual step Place lights will we covered in this unit

Creating a Light Source

AutoCAD has four kinds of lighting, each with a distinct method for distributing light rays into the scene. They are as follows:

Point Light:

All light rays are emitted from a single location and diverge as they get farther away. An incandescent light bulb is a real-world example of a point light, even though the light does not travel in the direction of the light’s fixture.

Spotlight:

With this type of light, rays are emitted from a single point, but they are restricted to a conical portion of the amount of light that a similar point light would emit. Flashlights and headlights are examples.

Distant Light:

With this type of light, all light rays are parallel. Although the sun is technically a point light, at the enormous distance the light rays travel to Earth, they are nearly parallel

Weblight:

These are photometric lights with real-world distributions. These lights can be used in conjunction with light distributions derived by manufacturers of real-world lights. Using manufacturer data to establish lighting distributions helps ensure more accurate representation of rendered lights than possible when using point or spotlights.

Default Lighting

When there are no lights in a scene, the scene is shaded with default lighting. Default lighting is derived from two distant sources that follow the viewpoint as you move around the model. All faces in the model are illuminated so that they are visually discernible. You can control brightness and contrast, but you do not need to create or place lights yourself.

When you insert custom lights or add sunlight, you can disable the default lighting. You can apply default lighting to the viewport only; at the same time, you can apply custom lights to the rendering.

Turn On/Off the default Lighting

You can turn on/Off the default lighting by using “DEFAULTLIGHTING” command as shown below

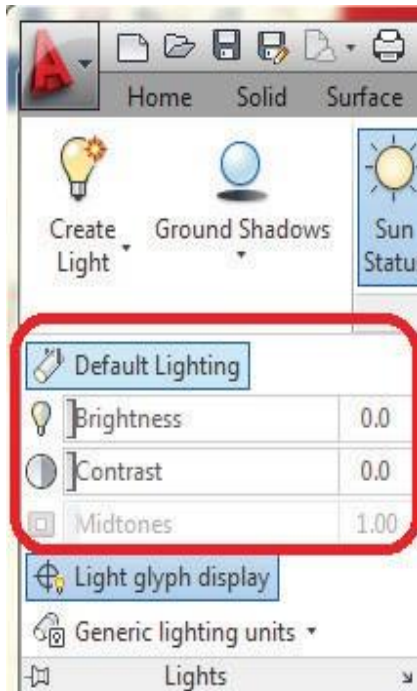
Method-1:

Step-1: Type DEFAULTLIGHTING command in command bar <Enter>

Step-2: Enter an option

- Enter new value for DEFAULTLIGHTING <0>: 1 <For On>
- Enter new value for DEFAULTLIGHTING <1>: 0 <For Off>

Method-2: Follow the figure below.



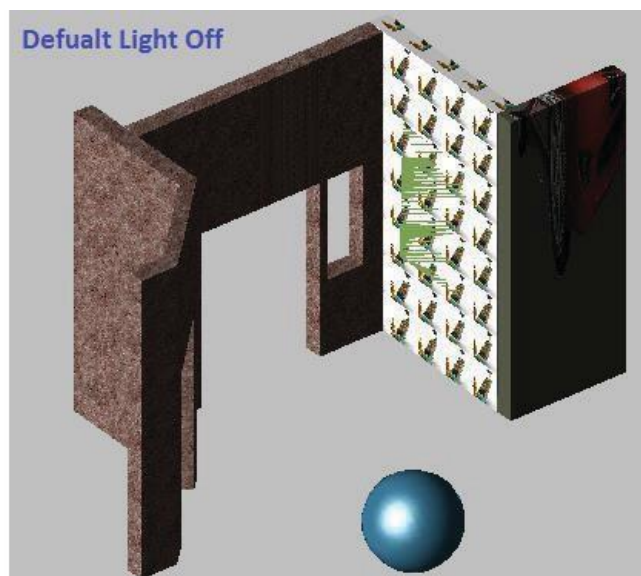
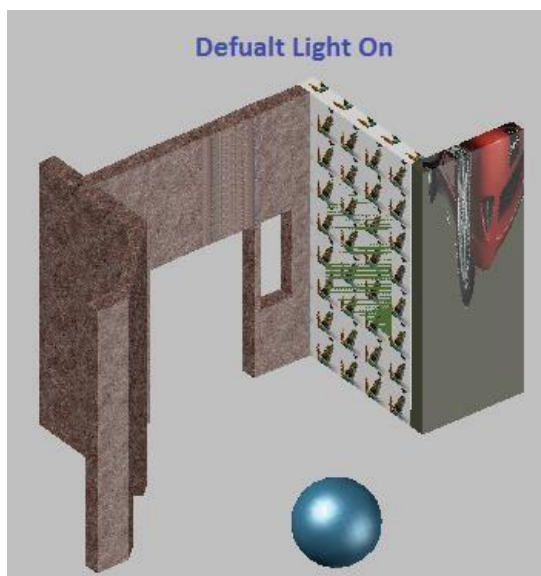
POINTLIGHT

Point light that radiates light in all directions from its location.

Step-1: type **pointlight** command in command bar <Enter> Or

Click go through 3D Modelling ▢ render tab ▢ Light ▢ PointLight

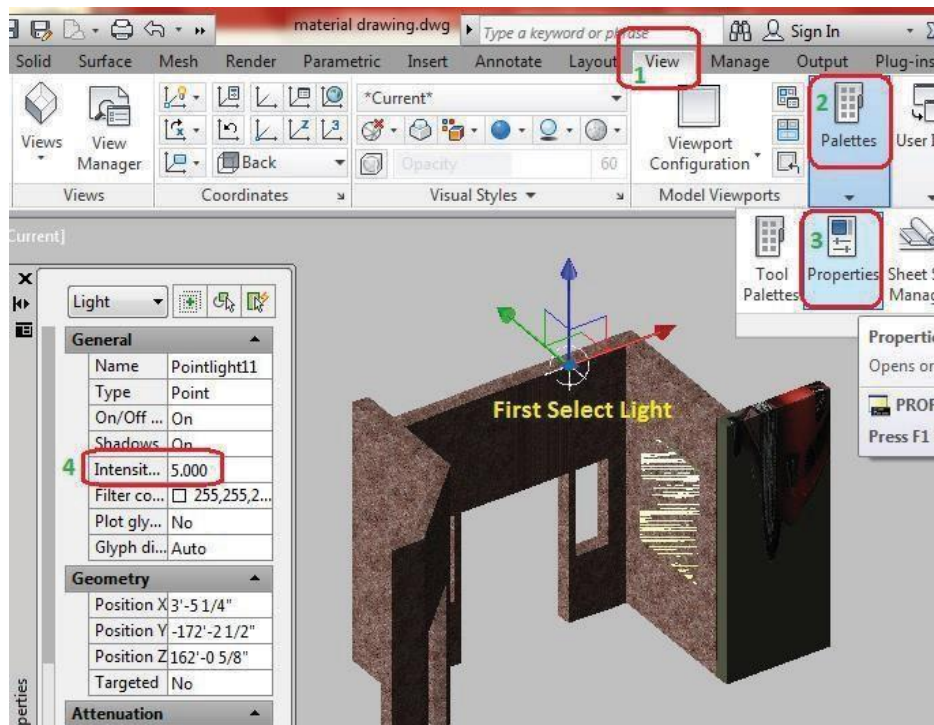
Step-2: Specify source location <0,0,0>: <Click or Define Source Location>



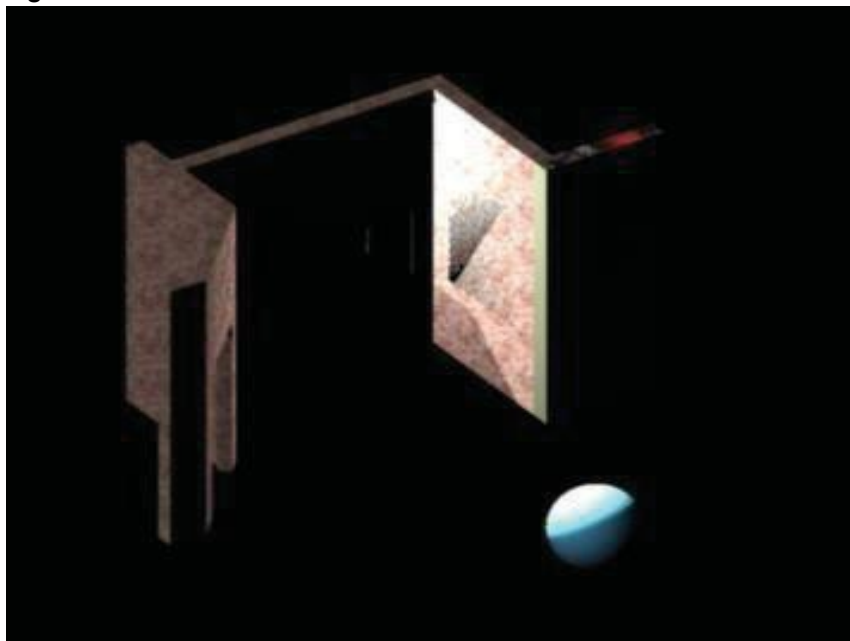
Step-3: Apply Rendering

Photometric Lights

You can control over lighting; you can use photometric lights to illuminate your model. To change the intensity of light, you should follow the following figure step by step.



Apply Rendering



SPOTLIGHT

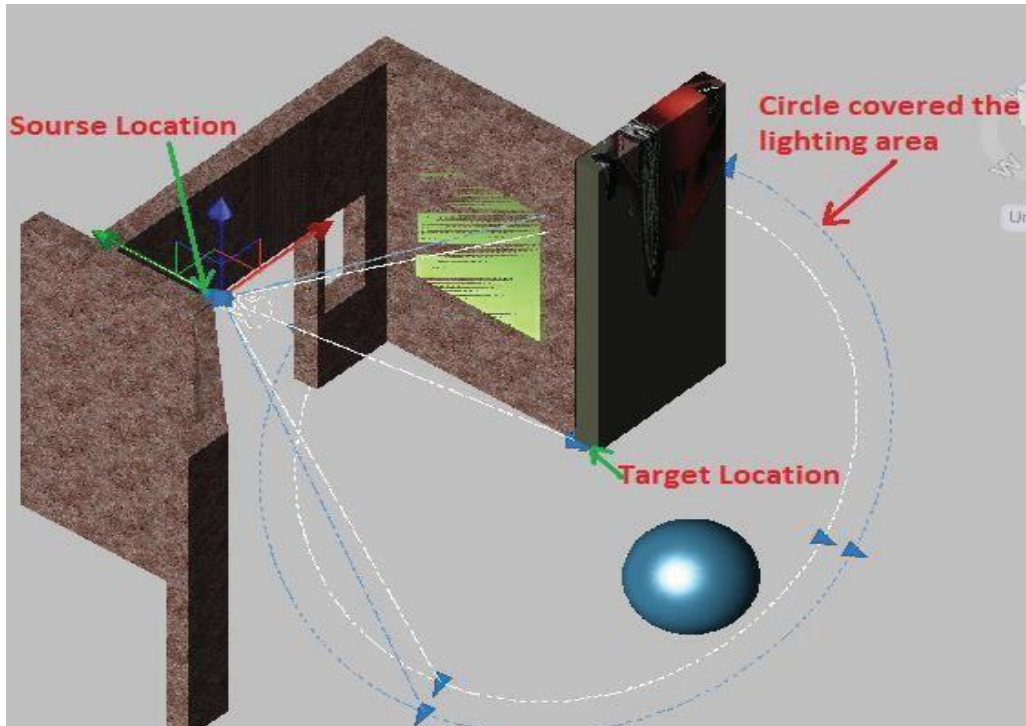
Spot Light emits a directional cone of light

Step-1: type spotlight command in command bar <Enter> Or

Click go through 3D Modelling → render tab → Light→ SpotLight

Step-2: Specify source location <0,0,0>: <Click or Define Source Location>

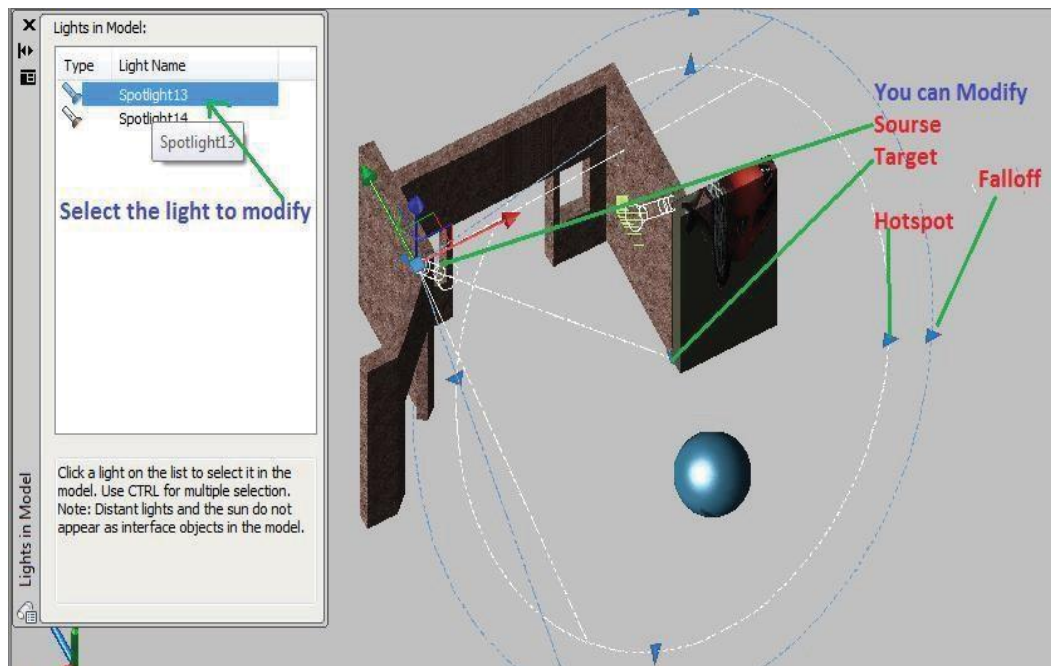
Step-3: Specify target location <0,0,0>: <Click or Define Source Location>



Modification of Lights

You can modify in light target location and area to cover by using LIGHTLIST command.

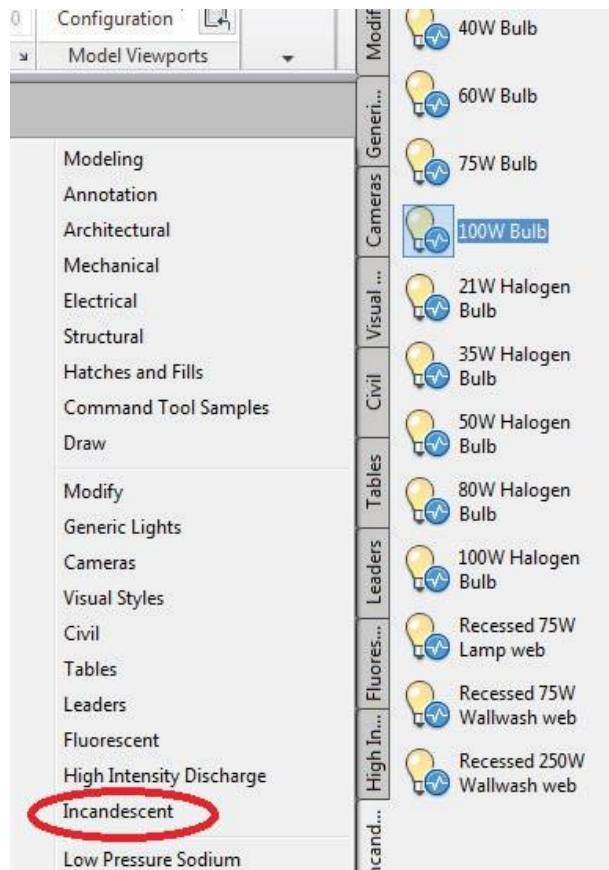
Type LIGHTLIST command in command bar <Enter> you will get the following as shown in the figure below:



3.4.12 Lights Tool Palette

Default lights can be added to your drawing from the Tool Palette menus

- Press Ctrl + 3 From Keyboard to display Light tool palette



DISTANTLIGHT

Distance light is used for uniform parallel light rays in one direction and mentioning from and to points.

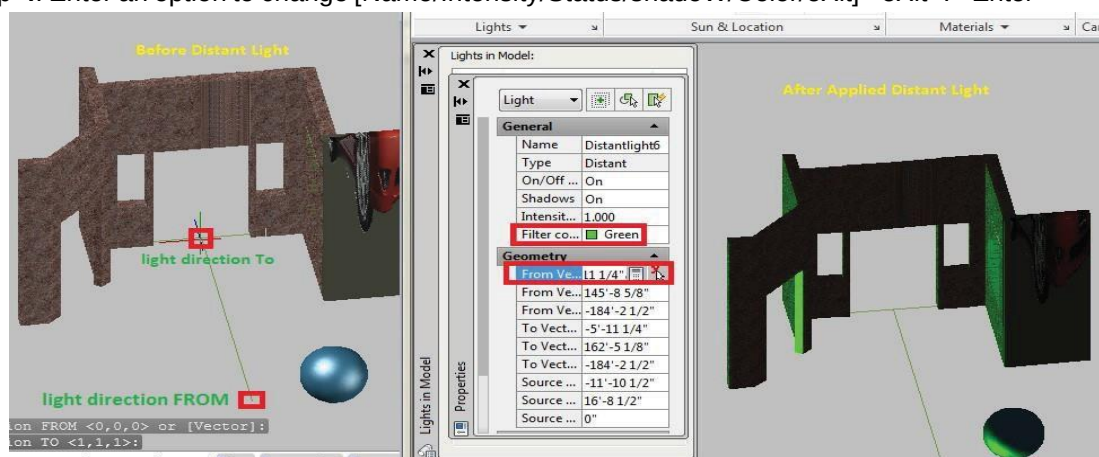
Step-1: type distantlight command in command bar <Enter> Or

Click go through 3D Modelling → render tab → Light → DistantLight

Step-2: Specify light direction FROM <0,0,0> or [Vector]: <Click or Define Source Location>

Step-3: Specify light direction TO <1,1,1>: <Click or Define Source Location>

Step-4: Enter an option to change [Name/Intensity/Status/shadow/Color/eXit] <eXit>: <Enter>



3.4.13 Assign Cameras to Execute Different Views of Required 3D Model

Camera is used to define a 3D view; you can place camera anywhere in the drawing to define a specific 3D view. You can Set a camera and target location to create and save 3D perspective views of objects. Further you can define its name, height, lens length, and clipping planes. This can be achieved by the following. 3D Navigate control (camera settings, scene creation, Walk, Constrained Orbit, etc.)

Creating Camera

To Access Camera

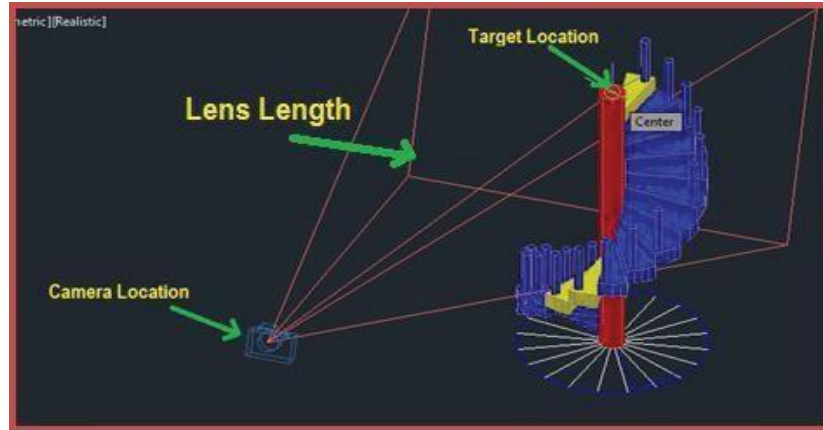
Render Tab	Button	Command Entry
Camera panel ☐ Create Camera		Cam/camera

Step-1: Type **cam/camera** command in command bar <Enter>

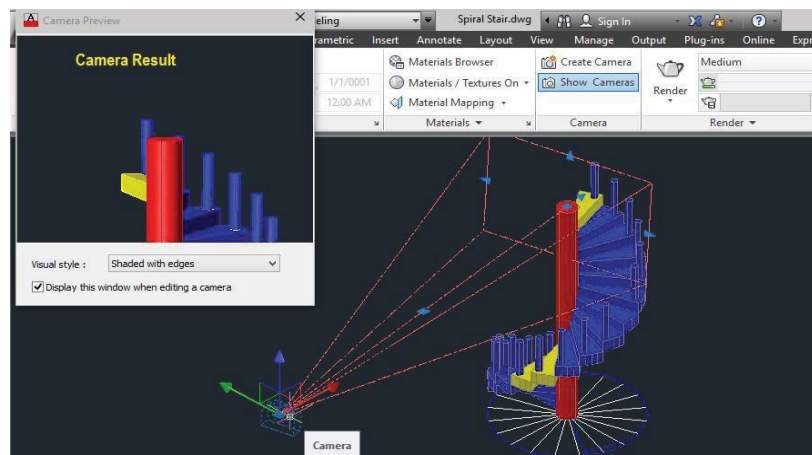
Step-2: Click in the drawing to specify the camera's location.

Step-3: Click again in the drawing to specify a target location.

Step-4: Press Enter to Finish, you will get the following as shown in figure below

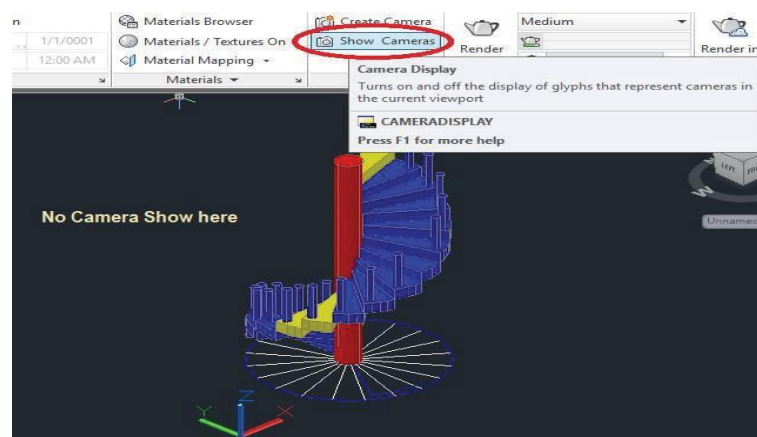


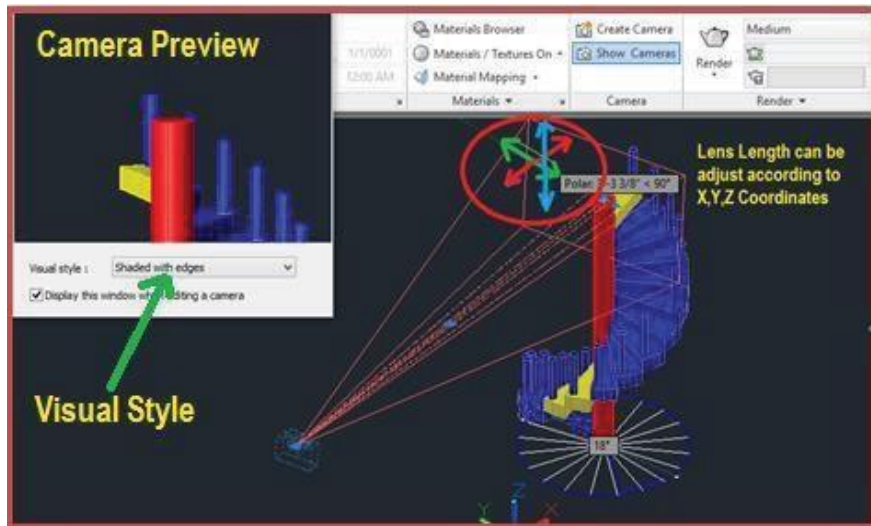
Step-5: To View the Camera, just click the camera location, you will get the following as shown in the figure below



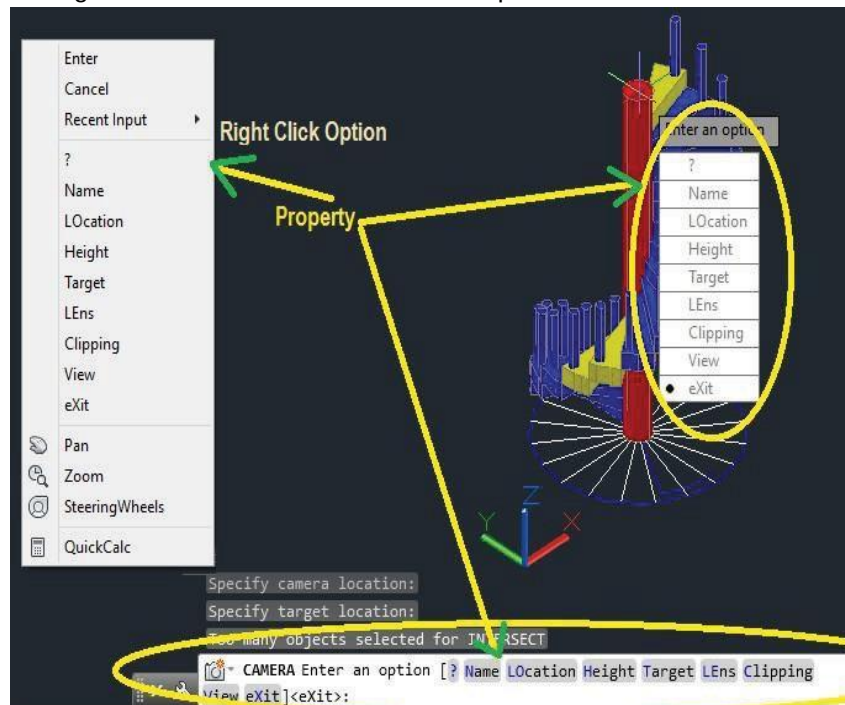
Step-6: You can show/hide the camera by clicking show camera button as shown in figure below

Step-7: Lens length setting can be adjusted according to X, Y and Z coordinates as shown in the figure below.





To further define camera properties, you will get properties on the screen while you setting up camera or you can right-click and select from the list of options.



Camera Properties

Display a list of the currently defined Cameras if any. Just enter the name of the Camera or press Enter to list all cameras if created.

Name You can Enter Name of the New Camera, if you never enter name of the Camera, by default it will named camera1, camera2... so on.

Location Specifies the location of the camera as we discussed previously.

Height You can define or changes the camera height.

Target Specifies the target of the camera as we discussed previously.

Lens Changes the lens length of the camera as we discussed previously.

Clipping Defines front and back clipping planes and sets their values.

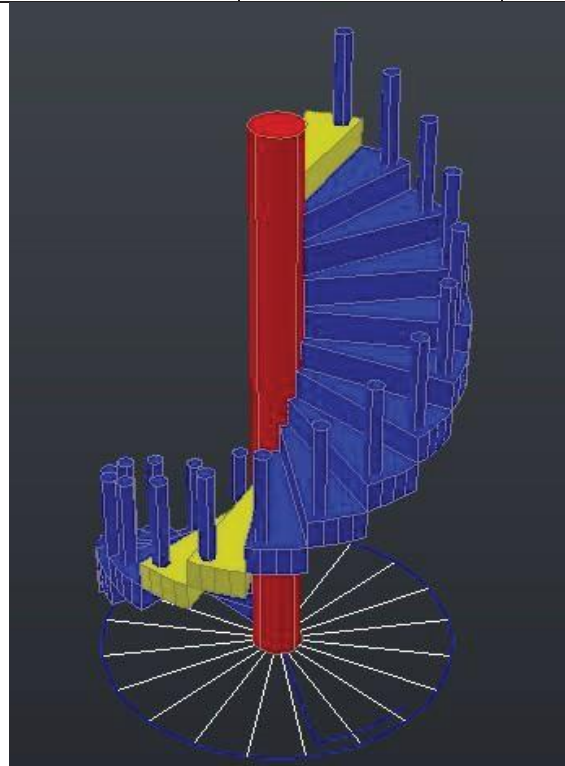
Make Animation file in Auto CAD

Animation Path is 3D Camera view through which you can view the object/s in as animated motion via a specified path.

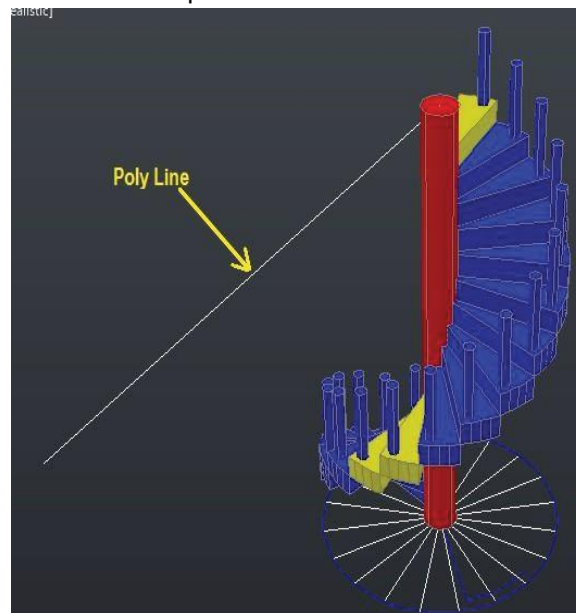
In the drawing, you can create a path object for either the camera or the target

A path can be a line, polyline, 3D polyline, arc, elliptical arc, circle, or spline. To Access Camera, we are going to apply animation path on drawing as shown in the figure below.

Render Tab	Button	Command Entry
Main Menu □ View □ Animation.	 Animation Motion Path	ANIPATH



Step-1: Draw a line/polyline to consider a path for animation.

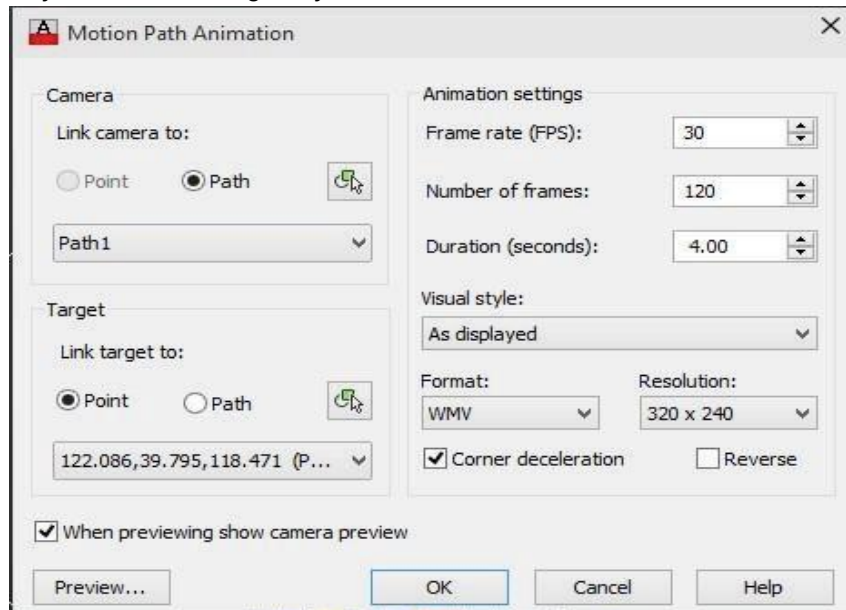


Step-2: Type **ANIPATH** command in command bar or Click Render Tab □ Animations panel Animation Motion Path.

Step-3: In the Motion Path Animations dialog box, do the following:

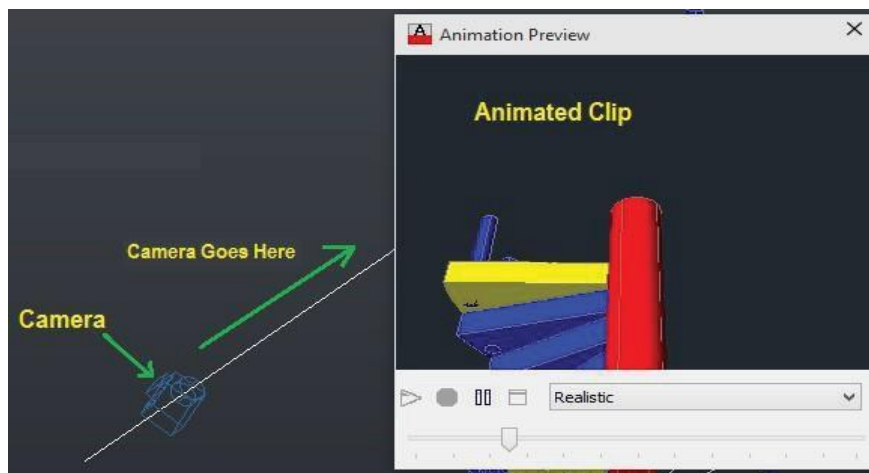
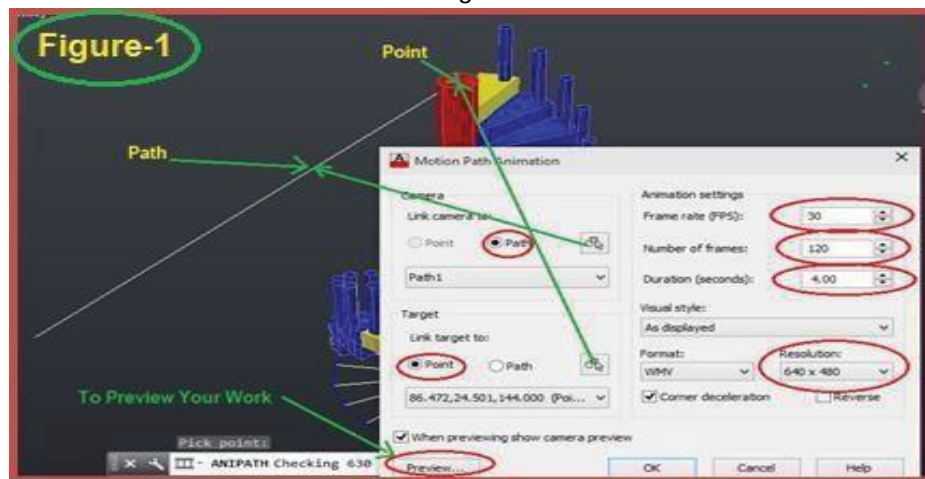
- Specify a point or path for the camera.
- Specify a point or path for the target.

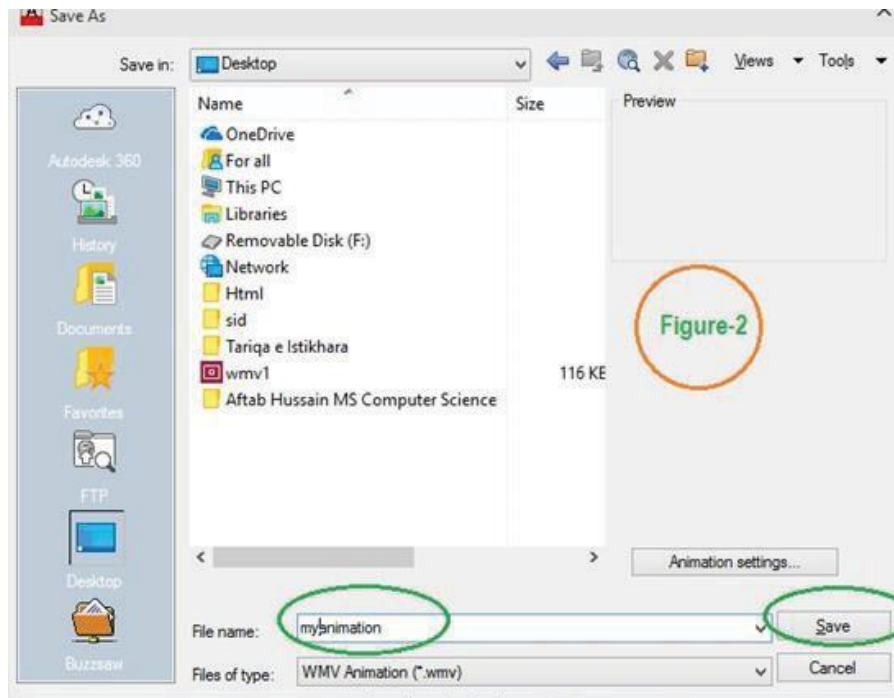
- iii. Modify any animation settings as you want.



For practice, select

- i. Path for the camera.
- ii. Point for the Target.
- iii. Click Preview to View your work.
- iv. Click OK to save the file as shown in the figure-2.





Output Look like

Walk and Fly

You can simulate walking and flying through a 3D drawing.

When you walk through a model, you travel along the XY plane. When you fly through a model, you are not constrained by the XY plane, so you appear to “fly” over an area in a model. The following shortcuts are available for walking:

Up arrow / W key

Move forward Down arrow / S key **Move backward** Left arrow / A key **Move left** Right arrow / D key

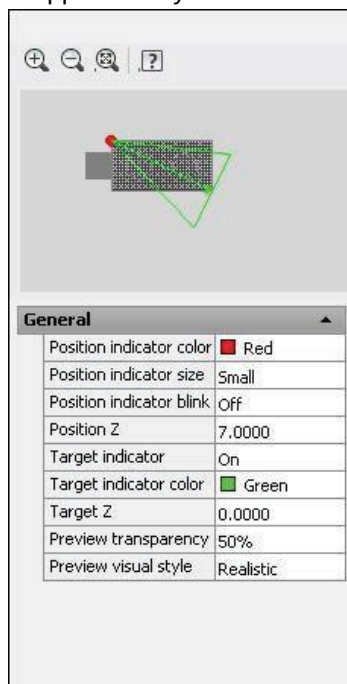
Move right Drag mouse around & turn

Step-1: Open a drawing with 3D objects and display in a 3D view

Step-2: Create a camera anywhere in the drawing and set the view to that camera

Step-3: 3DWalk or 3DFly at the command prompt. Command: **3DWALK**

The following Position Locator dialog box will appear that you can use to navigate your drawing.

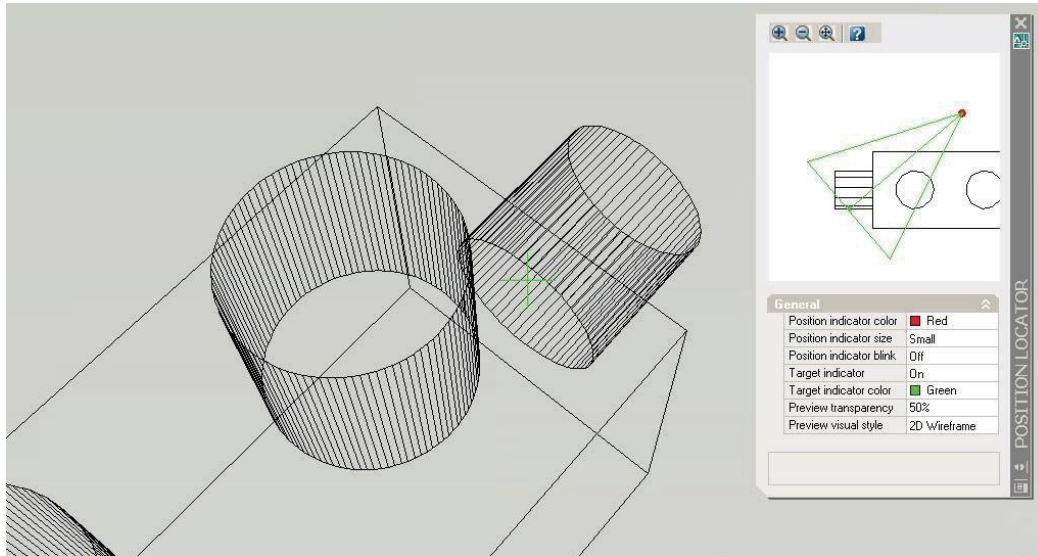


Step-4: Press the **Up**, **Down**, **Left**, and **Right** keys on the keyboard to see how the camera location moves in the drawing and Position Locator dialog box.

Step-5: Move the camera and target in the Position Locator dialog box

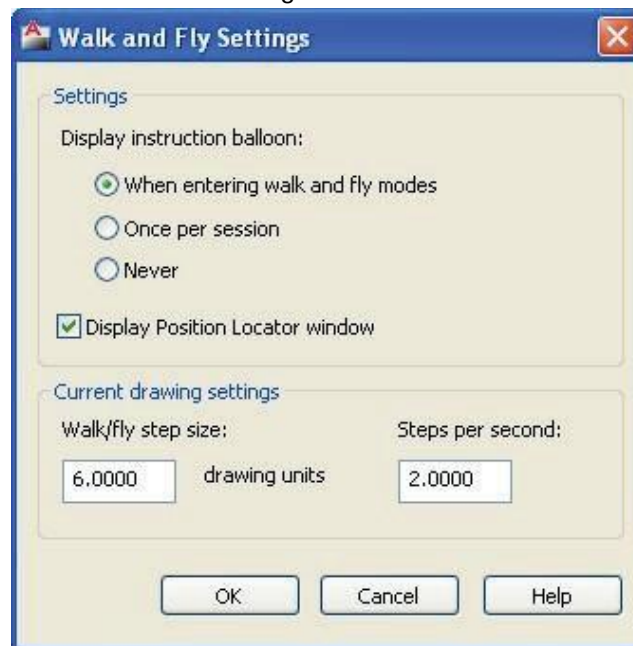
Step-6: Click and drag your mouse to “fly” through the drawing

Step-7: Close the Position Locator dialog box and try walking and flying using only the keys on the keyboard and mouse



Walk and Fly Settings

If you are working in a drawing with a large architectural scale, be sure to set your drawing units to a large number, similar to the scale of the drawing.



A-Settings

Specifies settings related to the Walk and Fly Navigation Mappings balloon and the Position Locator window.

When Entering Walk and Fly Modes

Specifies that the Walk and Fly Navigation Mappings balloon is displayed each time you enter walk or fly mode.

Once Per Session

Specifies that the Walk and Fly Navigation Mappings balloon is displayed the first time in each AutoCAD session that you enter walk or fly mode.

Never

Specifies that the Walk and Fly Navigation Mappings balloon is never displayed.

Display Position Locator Window

Specifies whether the Position Locator window opens when you enter walk mode.

B- Current Drawing Settings

Specifies walk and fly mode settings specific to the current drawing.

Walk/Fly Step Size

Sets the size of each step-in drawing units (the STEPSIZE system variable).

Steps Per Second

Specifies how many steps occur per second (the STEPSERSEC system variable).

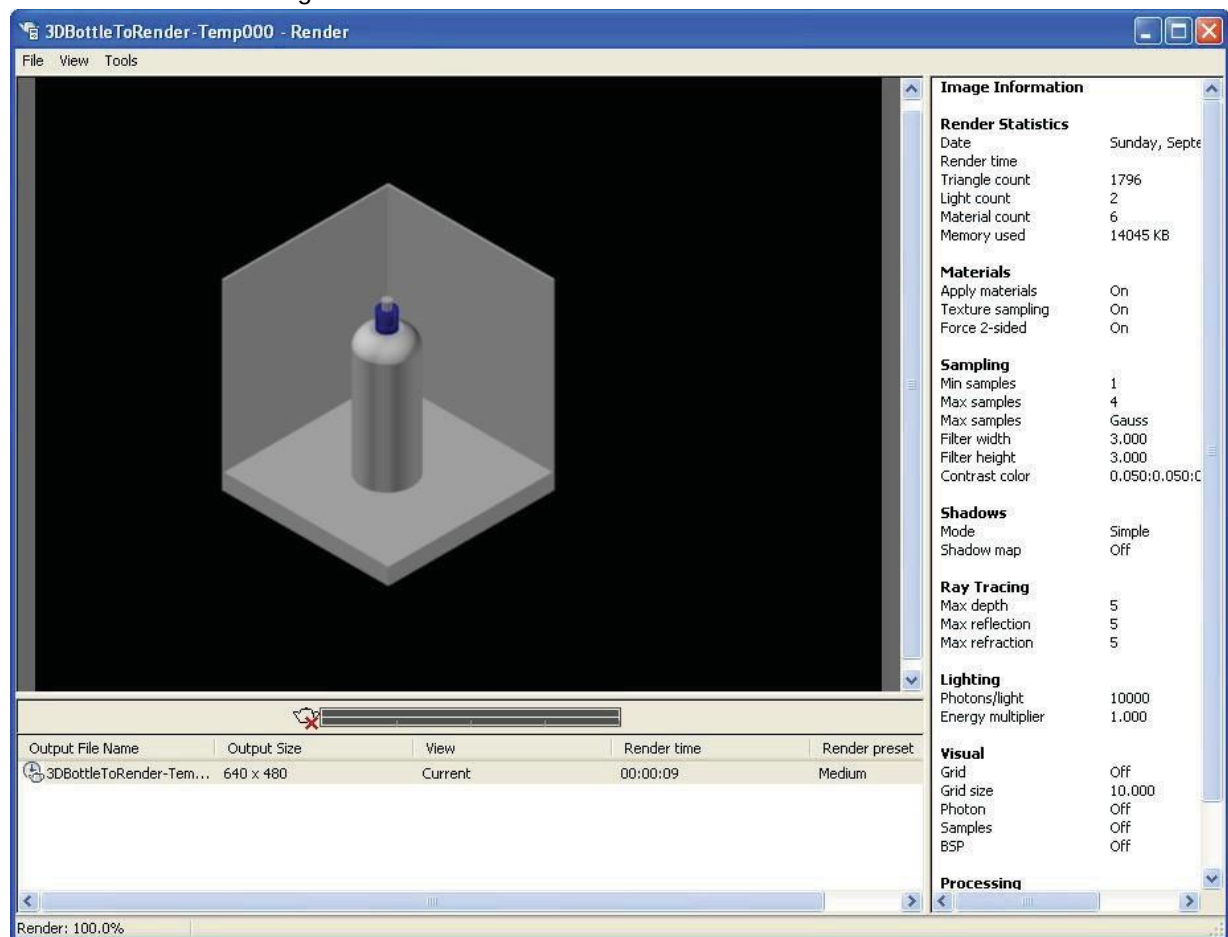
3.4.14 Render and Print the 3D Model Accordint to Required Size & Orientation

By Render Command

Creates a photorealistic or realistically shaded image of a three- dimensional wireframe or solid model

Step-1: Open an AutoCAD drawing with 3D objects to render

Step-2: RENDER at the command prompt. Command: **RENDER** The following render window is the result of default rendering



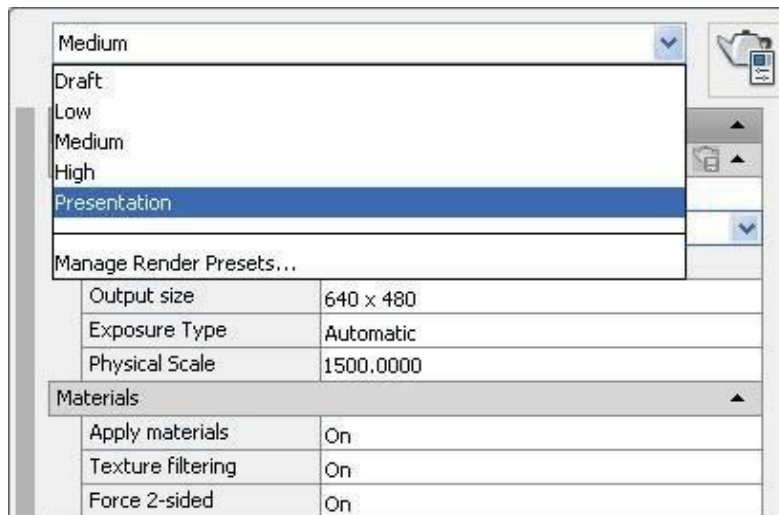
Render Quality

Step 1: Type RPREF at the command prompt

Step 2: Click the dropdown option for the render quality and choose **Presentation**

Render Selection

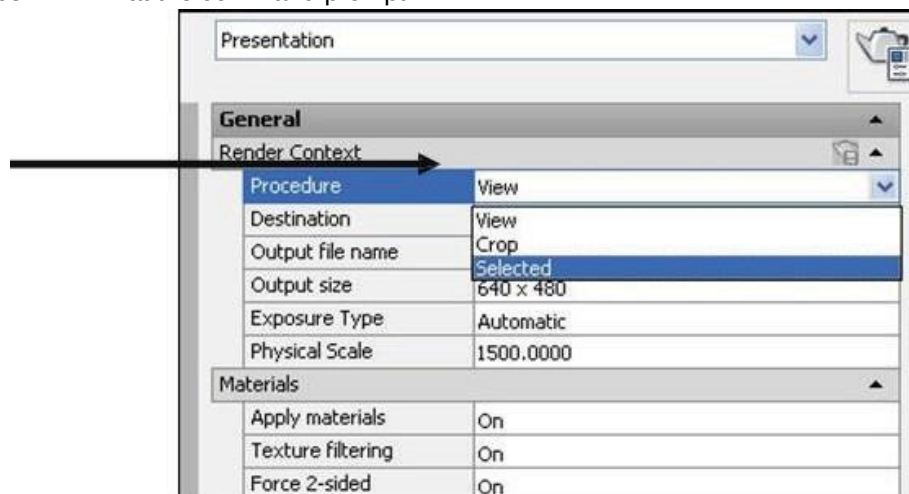
Controls the parts of the model that gets processed during rendering. The render procedure has three settings: View, Crop, and Selected



Do you know

Rendering in presentation mode might take a long time, depending on the objects, lights, materials, etc.

Step 1: Type RPREF at the command prompt



Step 2: The dropdown option for Procedure and choose **Selected**.

The render preferences and render selected objects

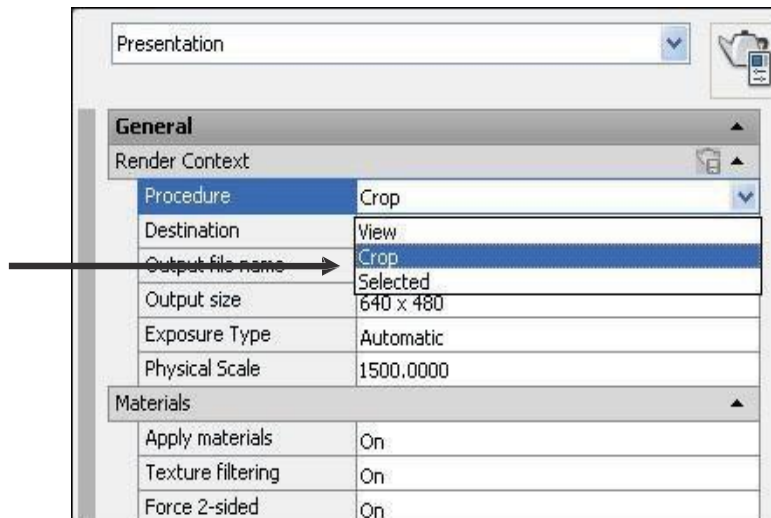
This result is a selected object in the drawing that is rendered.



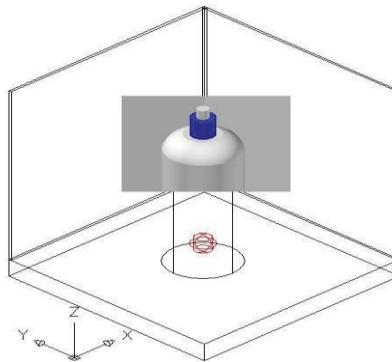
Render Cropped Window

Step 1: Type RPREF at the command prompt

Step 2: The dropdown option for Procedure and choose **Cr**

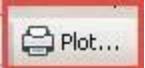


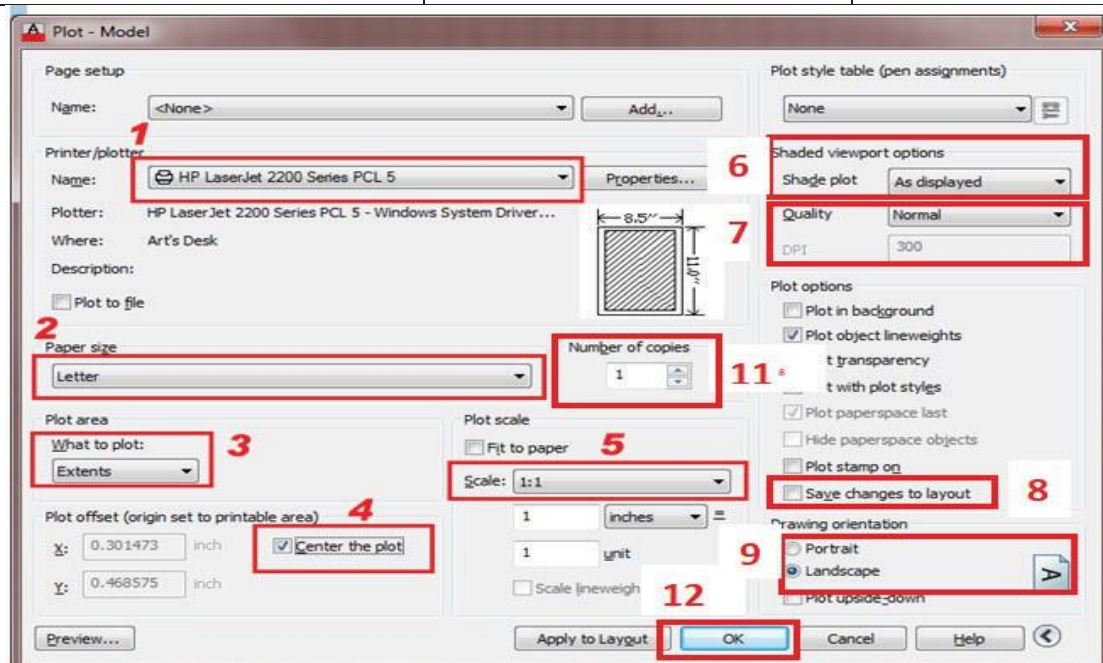
The render preferences and render a cropped window.
The result is a cropped portion of the drawing that is rendered.



Print The 3D MODEL

Step 1: Type PLOT at the command prompt (Ctrl +P)

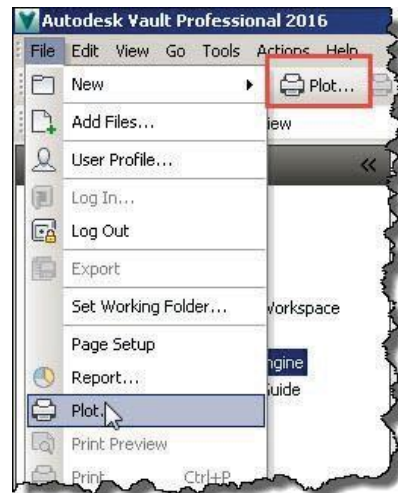
Render Tab	Button	Command Entry
Main Menu □ File □ Plot.		Ctrl + P



Open the Plot Window

Step 2: Open the Plot window

- i. Select Plotter/Printer
- ii. Select Page Size
- iii. Select Plot area
- iv. Center the plot
- v. Set the plot Scale
- vi. Select shade plot
- vii. Select Print Quality
- viii. Save the layout
- ix. Select drawing Orientation
- x. Preview
- xi. Set number of copies
- xii. Ok



Constrained 3D Orbit

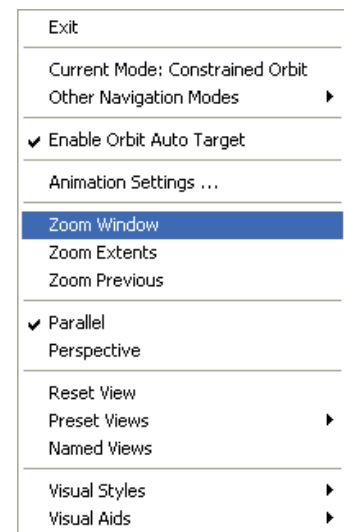
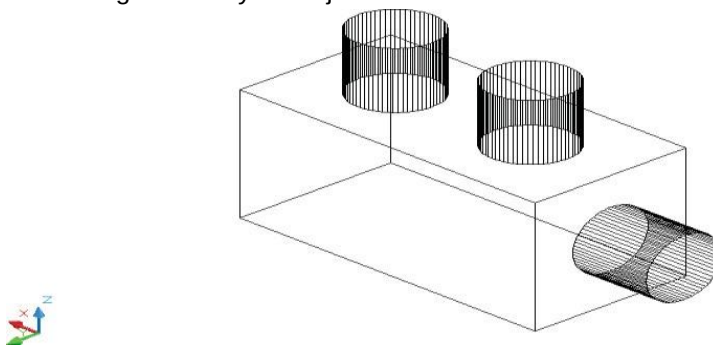
3DORBIT activates a 3D Orbit view in the current viewport. You can view your entire drawing or select one or more objects before starting the command.

When 3DORBIT is active, the target of the view stays stationary and the camera location, or point of view, moves around the target. However, from the user's point of view, it appears as if the 3D model is turning as the mouse cursor is dragged. In this way, you can specify any view of the model.

Open a drawing with 3D objects. Choose View, Orbit, Constrained Orbit. or

Type 3D Orbit at the command prompt. Command: **3DOrbit**

Click and drag to move your object in 3D.



Zoom and Pan in 3D Orbit

Click the **right mouse** button while in the 3D Orbit command.

Choose **Zoom Window** from the pop-up menu. Zoom to a new area of the 3D drawing.

Click the **right mouse** button while in the 3D Orbit command.

Choose **Zoom Previous** or **Zoom Extents**

Pan

Click the **right mouse** button while in the 3D Orbit command.

Choose **Other Navigation Modes** from the pop-up menu. Choose **Pan**.

Pan to a new area of the drawing.

Click the **right mouse** button while in the 3D Orbit command.

Choose **Other Navigation Modes** from the pop-up menu. Choose **Constrained Orbit** to set the mode back to orbit

Activity 1:

Create and Apply wood material with following material settings to previously created object in AutoCAD

- Opacity 70%
- Adjust Bitmap setting
- Fit to object
- Un check tiles

- Visual style: realistic

Step 1: Create a Wood Material

- Open your AutoCAD project and go to the **Render** tab.
- Click on **Materials** to open the Materials Editor.
- In the Materials Editor, click **Create a new material** (usually represented by a plus icon).
- Name the material, e.g., “Wood”.

Step 2: Set Opacity to 70%

- In the Material Editor, under the **Basic** tab, find the **Opacity** setting.
- Set the opacity to 70%. This will make the material slightly transparent, showing 70% of the object’s surface color and texture.

Step 3: Adjust Bitmap Settings

- Under the **Maps** tab in the Material Editor, click on **Diffuse** (the color or texture map).
- Select **Bitmap** from the dropdown to apply a wood texture image. Choose a suitable wood texture file (JPEG, PNG, etc.) for the material.
- Now adjust the bitmap settings:
 - **Fit to Object:** Click the checkbox for **Fit to Object** to ensure that the texture fits the dimensions of the object.
 - **Uncheck Tiles:** Uncheck the **Tile** option to prevent the texture from repeating on the surface.

Step 4: Set Visual Style to Realistic

- Switch to the **Visual Styles** toolbar or use the **View** tab.
- Set the visual style to **Realistic** to get a more accurate representation of how the material will look in the final rendering.

Step 5: Apply Material to Object

- In the Material Editor, click **Apply** after configuring all the settings.
- Select the object in your drawing that you want to apply the wood material to.
- The material will now be applied to the object, and you can preview it in **Realistic** view.

Activity 2:

Practice to apply spot and point light to previously created drawing and then render the drawing to show applied materials and lights

Step 1: Apply Spot Light

- **Open your drawing** in AutoCAD.
- Go to the **Lights** panel under the **Visualize** tab.
- Click on **Spot Light**. This will place a spotlight in your drawing.

Position the Spot Light:

- Click in the drawing area to specify the center of the light.
- Then, drag to specify the direction and distance of the spotlight beam.
- You can adjust the intensity and cone angle in the **Spotlight Settings**.

Adjust the Spot Light Properties:

- After placing the light, select it and go to the **Properties** panel.
- Adjust the **Intensity**, **Cone Angle**, and **Falloff** settings to control how the light affects the scene.
- Set the **Target** (where the spotlight will focus) and the **Position** (where the light is placed).

Step 2: Apply Point Light

- Go to the **Lights** panel under the **Visualize** tab.
- Click on **Point Light** to place a point light source in the scene.

Position the Point Light:

- Click in the drawing area to place the point light. It will emit light uniformly in all directions.

Adjust the Point Light Properties:

- Select the point light and open the **Properties** panel.
- Adjust the **Intensity** of the point light and set the **Radius** and **Decay** to control the light’s spread.

- You can also adjust the **Color** to match the scene's mood or environment.

Step 3: Apply Materials (If Not Already Done)

- Ensure you've already created and applied materials (like the wood material in your previous request). If not, refer to the material application steps mentioned earlier.
- If you need to apply or adjust materials to specific parts of your object, use the **Material Editor** as described in the previous instructions.

Step 4: Render the Drawing

- Once the spot and point lights are in place and materials are applied, go to the **Render** tab.
- Click on the **Render** button to generate the rendering. You can adjust the quality of the render by selecting the **Render Preset** option:
 - **Low** (for faster previews)
 - **Medium** (for better quality)
 - **High** (for the final detailed render)
- **Preview the Render:** Before committing to the final render, you can preview how the materials and lights will look by using the **Render Preview** option.

Step 5: Adjust Rendering Settings (Optional)

For a more realistic render, you can adjust settings such as:

- **Lighting:** Set the **Global Illumination** or **Ambient Occlusion** to enhance how light interacts with materials.
- **Shadow:** Adjust **Shadow Quality** for a sharper or softer shadow effect.
- **Anti-Aliasing:** Increase the anti-aliasing setting to smooth jagged edges in your render.

Step 6: Final Render and Review

- After adjusting the settings and previewing, click **Render** for the final image.
- Review how the materials, lights, and overall scene look in the rendered image.
- Make any final tweaks to the lights or materials as necessary and re-render to get the perfect result.

Activity 3:

Practice to print rendered model as per required scale

Activity 4:

Create portfolio in PDF format

SUMMARY

This module provided us with essential skills to confidently work with 3D models in AutoCAD. We learned how to navigate the 3D workspace, visualize objects from different angles, and efficiently create and modify 3D geometry. The module also covered advanced tools for editing 3D objects, setting up dynamic and realistic views, and creating basic animations. These skills are valuable for solving complex design problems and are applicable across various professional fields, such as architecture, engineering, and product design. By mastering these tools, we are better prepared to handle real-world 3D modeling tasks with precision and creativity.

FAQs:

1. What is AutoCAD 3D used for?

Ans: AutoCAD 3D is used for creating three-dimensional models, designs, and visualizations for architecture, engineering, and construction projects.

2. How do I switch to 3D mode in AutoCAD?

Ans: Go to the Workspace Switching menu and select 3D Modeling or 3D Basics.

3. What are the basic 3D modeling tools in AutoCAD?

Ans: Common tools include Extrude, Revolve, Sweep, Loft, and Press/Pull.

4. How do I view my 3D model from different angles?

Ans: Use the View Cube or the Orbit tool to rotate and view your model from different perspectives.

5. How do I create a 3D object in AutoCAD?

Ans: Use commands like Box, Cylinder, Sphere, or Extrude to create basic 3D shapes.

6. What is the Extrude command used for?

Ans: It converts 2D shapes into 3D objects by adding height or depth.

7. How do I create a 3D solid from a 2D shape?

Ans: Use the Extrude, Revolve, or Press/Pull command on a 2D closed shape.

8. What is the Press/Pull tool used for?

Ans: It allows you to quickly extrude or cut 3D shapes by clicking on a face or region.

9. How do I create a hole in a 3D object?

Ans: Use the Subtract command to remove a 3D shape (e.g., cylinder) from another 3D object.

10. What is the Union command used for?

Ans: It combines two or more 3D objects into a single object.

11. How do I slice a 3D object?

Ans: Use the Slice command to cut a 3D object along a plane.

12. How do I render a 3D model in AutoCAD?

Ans: Go to the Render tab and click Render to generate a photorealistic image.

13. How do I add materials to a 3D object?

Ans: Use the Materials Browser to apply textures and finishes to your model.

14. What is the purpose of lighting in 3D rendering?

Ans: Lighting enhances the realism of the model by adding shadows and highlights.

15. How do I change the background in a 3D view?

Ans: Use the View Manager to set a background color or image.

16. How do I create a walkthrough or animation in AutoCAD?

Ans: Use the Motion Path Animation tool to create a camera path and generate a video

MCQs:

1. What is AutoCAD 3D primarily used for?

- a. Creating 2D drawings
- b. Creating three-dimensional models
- c. Editing images
- d. Writing scripts

2. How do you switch to 3D mode in AutoCAD?

- a. Use the Line command
- b. Go to Workspace Switching and select 3D Modeling
- c. Press Ctrl + 2
- d. Use the Hatch command

3. Which of the following is NOT a basic 3D modeling tool in AutoCAD?

- a. Extrude
- b. Revolve
- c. Hatch
- d. Loft

4. What tool is used to view a 3D model from different angles?

- a. View Cube
- b. Line
- c. Trim
- d. Hatch

5. What is the main difference between 2D and 3D in AutoCAD?

- a. 2D has depth, while 3D is flat
- b. 2D is flat, while 3D has depth and volume
- c. 2D is used for rendering, while 3D is for drafting
- d. There is no difference

6. Which command is used to create a 3D box in AutoCAD?

- a. Circle
- b. Box
- c. Line
- d. Arc

7. What does the Extrude command do?

- a. Converts 2D shapes into 3D objects
- b. Deletes 3D objects
- c. Rotates 3D objects
- d. Scales 3D objects

8. Which command is used to create a 3D solid from a 2D shape?

- a. Extrude
- b. Trim
- c. Hatch
- d. Line

9. What is the Press/Pull tool used for?

- a. Deleting objects
- b. Extruding or cutting 3D shapes quickly
- c. Rotating objects
- d. Scaling objects

10. How do you create a hole in a 3D object?

- a. Use the Union command b. Use the Subtract command
c. Use the Hatch command d. Use the Line command
- 11. Which command is used to move a 3D object?**
a. Rotate Move c. Scale d. Trim
- 12. How do you rotate a 3D object?**
a. Use the Move command b. Use the Rotate command
c. Use the Scale command d. Use the Hatch command
- 13. What does the Union command do?**
a. Combines two or more 3D objects into one b. Deletes 3D objects
c. Rotates 3D objects d. Scales 3D objects
- 14. Which command is used to scale a 3D object?**
a. Move b. Rotate c. Scale d. Trim
- 15. What does the Slice command do?**
a. Combines 3D objects b. Cuts a 3D object along a plane
c. Deletes 3D objects d. Rotates 3D objects
- 16. How do you render a 3D model in AutoCAD?**
a. Use the Line command b. Go to the Render tab and click Render
c. Use the Hatch command d. Use the Trim command
- 17. Which tool is used to add materials to a 3D object?**
a. Materials Browser b. Line
c. Trim d. Hatch
- 18. What is the purpose of lighting in 3D rendering?**
a. To delete objects b. To add shadows and highlights for realism
c. To rotate objects d. To scale objects
- 19. How do you change the background in a 3D view?**
a. Use the View Manager b. Use the Line command
c. Use the Hatch command d. Use the Trim command
- 20. Which tool is used to create a walkthrough or animation in AutoCAD?**
a. Motion Path Animation b. Line
c. Trim d. Hatch

True Answer

1.	b	2.	b	3.	c	4.	a
5.	b	6.	b	7.	a	8.	a
9.	b	10.	b	11.	b	12.	b
13.	a	14.	c	15.	b	16.	b
17.	a	18.	b	19.	a	20.	a