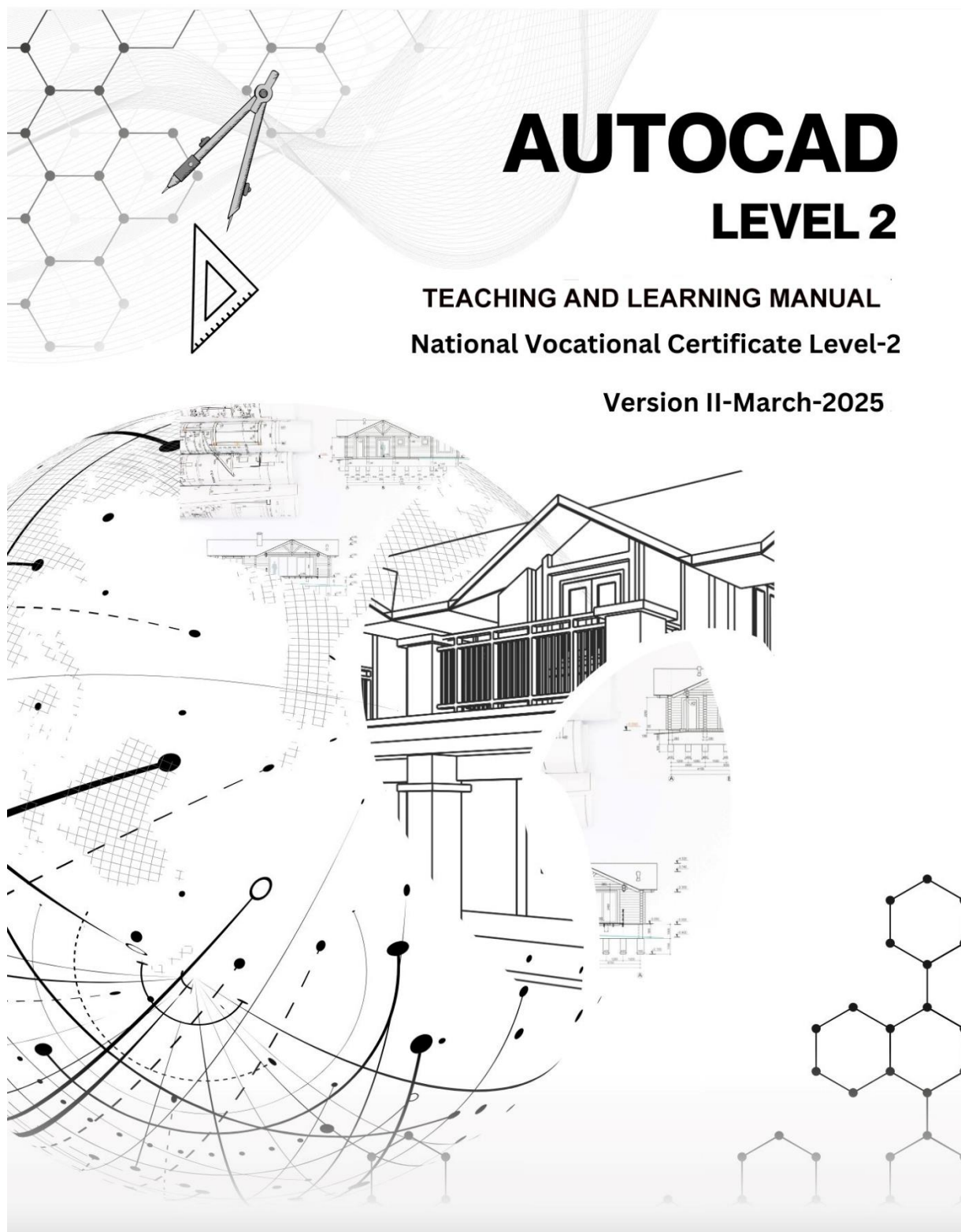




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Authors

Huma Ghafoor (Sr Instructor, GTTI(W) Gujar Pura Lahore)
Mohammad Tauseef (Instructor, Vocational Training Institute Green Town Lahore)
Amir Siddiq (Instructor, GTTI Okara)
Syeda Tehseen Fatima (Chief instructor. Govt Technical Training Institute W Township Lahore)
Muneef Younas (Instructor, GTVC (Boys) Gulbahar Peshawar)
Afira Nawaz (Instructor, GTTI Kohati Bazar Rawalpindi)
Saima Asghar (DACUM Facilitator, Lahore)

Responsible

Director General Skills Standard and Curricula, National Vocational and Technical Training
Commission National Deputy Head, TVET Sector Support Programme, Deutsche Gesellschaft
für Internationale Zusammenarbeit (GIZ) GmbH

Layout & design

Muhammad Muneeb (Computer Operator, TEVTA Secretariat Gulberg II, Lahore)
Ayesha (Freelancer)

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INTRODUCTION

AutoCAD software is used by draftsmen and other professionals for preparing the layouts and designs in architecture industry. It is also used in other industries for designing the layout of the products and their components in three dimensions.

The National Vocational & Technical Training Commission (NAVTTTC) has developed a national qualification entitled, “National Vocational Certificate Level-2 in Information Technology (CAD-AutoCAD)”. Relevant industry and employers were consulted in the design and validation processes in order to come up with a national qualification that fulfills the requirements of the sector in general and the occupation in particular.

This Teaching and Learning Material (TLM) is developed based on competency standards and curriculum of the AutoCAD national qualification. It includes three learning modules which are as under:

Module 1:	Follow Occupational Health and Safety practices
Module 2:	Demonstrate Basic Numeracy Skills
Module 3:	Perform Basic Computer Operations
Module 4:	Perform Basic Manual Drawing
Module 5:	Develop 2D Drawings in AutoCAD
Module 6:	Develop 3D Model in AutoCAD
Module 7:	Develop Entrepreneurial Skills
Module 8:	Plan Market and Site Visit
Module 9:	Adopt Soft Skills

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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Module 1	Follow Safety Rules at Workplace
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Learning Outcomes:

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

- Maintain Occupational Safety, Health and Green Environment at Workplace
- Use Personal Protective and Safety Equipment (PPEs)

Learning Unit 1.1	Maintain Occupational Safety, Health and Green Environment at Workplace
--------------------------	--

Learning Outcomes:

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

- Assess the situation.
- Select equipment as per task
- Verify the working condition.
- Apply PPEs as per task
- Adopt green practices
 - Use of energy efficient computers
 - Reduce paper usage/reuse paper
 - Use both sides of paper
 - Adjust /monitor settings for brightness
 - Use Energy efficient lighting.
 - Understand Basic maintenance of tool/equipment
 - Understand House Keeping

1.1.1 Types of Hazards

- **Physical Hazards:** These include factors like noise, radiation, extreme temperatures, or machinery that can cause injury.
- **Chemical Hazards:** Exposure to harmful chemicals such as gases, vapors, or toxic substances.
- **Biological Hazards:** Includes bacteria, viruses, fungi, or any other harmful biological agents.
- **Ergonomic Hazards:** These are related to poor workstation design, repetitive movements, or improper lifting techniques that can cause strain or injury.
- **Psychosocial Hazards:** Factors like stress, harassment, bullying, or high workloads that can negatively affect mental health.
- **Mechanical Hazards:** Equipment or machinery that could malfunction or cause injury.

Remember

About 30% of workplace injuries are muscle and bone problems (MSDs), which are caused by things like repeating the same movements or sitting/standing in uncomfortable positions.



Biological Hazards



Chemical Hazards



Physical Hazards



Safety Hazards



Ergonomic Hazards



Psychosocial Hazards

1.1.2 Unsafe Working Conditions

- **Poor Lighting:** Can lead to eye strain or accidents.
- **Cluttered Workspaces:** Makes it difficult to move around and increases the risk of tripping or falling.
- **Inadequate Ventilation:** Can lead to the build-up of harmful gases or dust.
- **Improper Use of Equipment:** Using machinery without proper training or safety measures.
- **Lack of Personal Protective Equipment (PPE):** Failing to use appropriate safety gear like helmets, gloves, or goggles.

1.1.3 Knowledge of Housekeeping

- **Cleanliness:** Keep work areas tidy to avoid accidents and improve efficiency.
- **Proper Waste Disposal:** Ensure that waste is disposed of in a safe and appropriate manner.
- **Organized Equipment:** Tools and equipment should be stored properly to avoid accidents.
- **Slips, Trips, and Falls Prevention:** Clean up spills immediately and keep walkways clear of obstructions.
- **Regular Inspections:** Regularly check for hazards, like frayed cords, loose flooring, or faulty equipment.



1.1.4 Methods of Dealing with Hazards

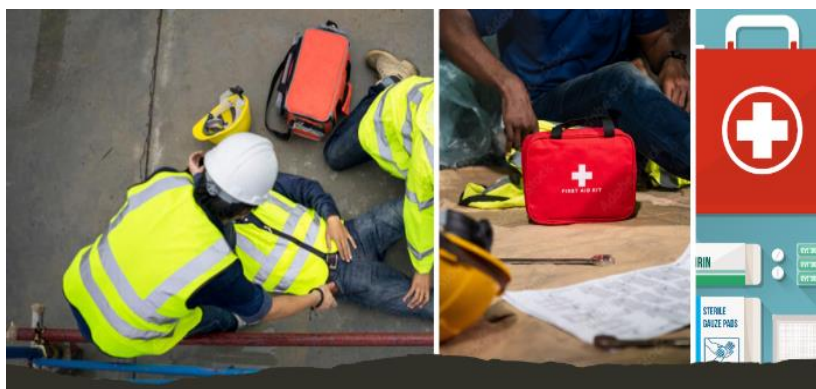
- **Risk Assessment:** Identify potential hazards and evaluate their risk to safety.
- **Implementing Safety Measures:** Use PPE, guard machinery, and implement emergency procedures.
- **Training and Awareness:** Provide safety training to employees to make them aware of potential risks and safe practices.
- **Safety Inspections:** Regularly check for new or emerging hazards.
- **Emergency Protocols:** Establish procedures for handling accidents or emergencies (e.g., fire drills, evacuation plans).

1.1.5 Factors Affecting Health & Safety in the Workplace

- **Workplace Culture:** A positive culture where safety is prioritized promotes a safer environment.
- **Management Commitment:** Support from leadership is crucial for effective health and safety programs.
- **Employee Engagement:** Involving employees in safety training and discussions can lead to better safety outcomes.
- **Workload:** Overwork can lead to fatigue, stress, and accidents.
- **Work Environment:** Adequate lighting, ventilation, temperature control, and clean workspaces all affect safety.

1.1.6 Introduction to First-Aid

- **Basic First-Aid Skills:** Learn how to provide basic first-aid in case of accidents, such as cleaning wounds, applying bandages, or performing CPR.
- **First-Aid Kit:** Make sure to have a well-stocked first-aid kit available at the workplace.



1.1.6.1 Emergency Medicines and Expiry

- **Expiry Dates:** Regularly check the expiry dates on all emergency medications and replace expired items to ensure they are effective when needed.
- **Common Emergency Medicines:** These may include pain relievers, antiseptics, bandages, gauze, burn ointments, and more.

1.1.6.2 Methods of Treatment Against Electric Shock

- **Stop the Current:** If safe, turn off the power supply. Do not touch the person with your bare hands if the electricity is still on.
- **Call for Help:** Call emergency services immediately.
- **CPR (Cardiopulmonary Resuscitation):** If the person is not breathing or has no pulse, administer CPR.
- **Monitor the Victim:** After the shock, keep the person lying down, keep them warm, and avoid any movement until medical help arrives.

1.1.6.3 Methods of Treatment against Minor Injuries

- **Cuts and Scrapes:** Clean the wound with water and apply a sterile bandage.
- **Burns:** Cool the burn under running cold water for 10-20 minutes, and cover it with a clean bandage.
- **Sprains and Strains:** Rest, ice, compression, and elevation (R.I.C.E) method.

- **Bruises:** Apply ice to reduce swelling and pain.

1.1.7 Importance of Adopting Green Skills

Green skills are the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society.

- **Sustainability:** Green skills help workers contribute to reducing environmental impact, promoting sustainability.
- **Energy Efficiency:** Using green skills can lead to energy savings, reducing utility costs, and minimizing environmental harm.
- **Waste Reduction:** Proper waste management practices can help recycle materials and reduce landfill waste.
- **Healthier Environment:** Reducing the use of toxic chemicals and creating cleaner workspaces leads to better health and well-being for everyone.
- **Innovation:** Green skills encourage new ways of thinking about production, design, and operations, leading to more sustainable and eco-friendly practices.

Remember

The green economy is creating millions of jobs worldwide. The International Labor Organization (ILO) estimates that moving towards greener economies can create up to 60 million jobs globally by 2030.



Activity:

Identify the physical hazards in mock situation and apply control measures

Step 1: Identifying Hazards

- Ergonomics:** Poor desk/chair setup, bad posture.
- Electrical:** Exposed cords, faulty equipment.
- Slips/Trips/Falls:** Cords in walkways, wet floors.
- Lighting:** Glare or insufficient light.
- Clutter:** Messy workspace, obstructed paths.
- Air Quality:** Poor ventilation or overheating.

Step 2: Control Measures

- i. **Ergonomics:** Adjust desk/chair, screen height.
- ii. **Electrical Safety:** Secure cords, avoid overloading outlets.
- iii. **Prevent Fall:** Clear walkways, clean spills.
- iv. **Lighting:** Adjust lighting, reduce glare.
- v. **Declutter:** Organize workspace.
- vi. **Air Quality:** Improve ventilation.

Learning Unit 1.2	Use Personal Protective and Safety Equipment (PPEs)
--------------------------	--

Learning Outcomes:

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

- Arrange the required personal protective equipment
- Check functional condition of PPE's
- Wear / use personal protective equipment
- Store PPE at appropriate place after use.
- Clean / care required personal protective equipment
- Operate PPEs
- Check expiry of PPEs

1.2.1 Types of PPE

- **Head:** Hard hats.
- **Eyes/Face:** Safety goggles.
- **Ears:** Earplugs, earmuffs.
- **Hands:** Gloves.
- **Feet:** Steel-toe boots.
- **Respiratory:** Masks.
- **Body:** High-visibility vests.

1.2.2 Importance of PPE

- **Prevents injuries** and complies with safety rules.
- **Promotes a safe environment** and reduces accidents.

1.2.3 Uses of PPE

- **Protects** from physical, chemical, and environmental hazards in construction or design work.

1.2.4 Safety Measures

- **Training** on proper use.
- **Inspect PPE** for damage before use.
- **Always wear PPE** in hazardous areas.

1.2.5 Types of Work Site Hazards

- **Physical:** Tools, machinery.
- **Chemical:** Paints, solvents.
- **Mechanical:** Equipment injuries.
- **Ergonomic:** Repetitive strain.

- **Environmental:** Dust, heat.

1.2.6 Risk Management

- Identify & assess hazards.
- Use PPE and safety measures.

Activity-1:

Regularly check safety practices.

Activity-2:

Demonstrate to Select PPEs for Specific Job

Step 1: Identify Hazards:

Look for risks such as flying debris, chemicals, sharp objects, loud noise, or dust.

Step 2: Choose the Right PPE:

- **Head Protection:** Wear a hard hat if there's a risk of falling objects.
- **Eye Protection:** Use safety glasses or goggles for flying particles.
- **Hand Protection:** Wear gloves to protect from cuts, chemicals, or heat.
- **Foot Protection:** Choose steel-toed shoes for protection from heavy objects.
- **Hearing Protection:** Use earplugs or earmuffs in loud environments.
- **Respiratory Protection:** Wear a mask for dust or fumes.

Step 3: Wear PPE Correctly:

Ensure PPE fits well and is worn properly for maximum safety.

Step 4: Maintain PPE:

Clean PPE regularly and replace any damaged items.

SUMMARY

Workplace safety involves recognizing hazards like physical, chemical, and ergonomic risks, and addressing unsafe conditions. It includes practices like proper housekeeping, using safety controls, and wearing protective gear. First-aid knowledge, such as treating electric shocks and minor injuries, is crucial in emergencies. Regularly checking emergency medicines for expiry is also important. Adopting green skills, like reducing waste and conserving energy, helps create a safer and more sustainable work environment.

FAQs:

1. What is a hazard?

Ans. A hazard is anything that can cause harm or injury in the workplace.

2. What are unsafe working conditions?

Ans. Unsafe working conditions are environments that increase the risk of accidents or injuries.

3. Why is housekeeping important at work?

Ans. Good housekeeping helps prevent accidents and maintains a clean, safe workspace.

4. How can hazards be controlled in the workplace?

Ans. Hazards can be controlled by eliminating, substituting, engineering controls, administrative controls, or using PPE.

5. What is first aid?

Ans. First aid is the immediate help given to an injured or ill person before professional medical help arrives.

6. What should you do in case of an electric shock?

Ans. Turn off the power, and then call for help and perform CPR if needed.

7. What is PPE?

Ans. PPE (Personal Protective Equipment) includes safety gear like gloves, goggles, and helmets to protect against workplace hazards.

8. Why is PPE important?

Ans. PPE helps reduce the risk of injury and protects workers from harm.

9. What are work site hazards?

Ans. Work site hazards are dangers that can cause injury or illness, such as chemicals, machinery, or poor conditions.

10. What is risk management?

Ans. Risk management involves identifying, assessing, and controlling hazards to reduce accidents and injuries.

MCQS

Question	Option -A	Option -B	Option -C	Option -D
1. What is the purpose of using PPE in the workplace?	To enhance comfort	To prevent injuries and accidents	To comply with dress codes	To look professional
2. Which of the following is a physical hazard?	Exposure to noise	Exposure to toxic fumes	Poor workstation setup	Workplace bullying
3. What should be the first step in dealing with a workplace hazard?	Ignore it	Conduct a risk assessment	Implement safety measures	Report it to management
4. What is the effect of poor lighting in the workplace?	It increases productivity	It causes eye strain and accidents	It promotes better focus	It helps workers relax
5. What should be done if there is a cluttered workspace?	Leave it as is	Organize and declutter	Move it to another area	Ignore it
6. What is the goal of green practices in the workplace?	To reduce environmental impact	To increase energy consumption	To promote luxury	To reduce employee productivity

7. How should a minor burn be treated?	Apply ice directly to the burn	Cool under running water for 10-20 minutes	Cover it with ointment immediately	Apply heat to the burn
8. Which PPE protects the eyes?	Gloves	Safety Goggles	Ear plugs	Hard hats
9. How can electrical hazards be avoided in the workplace?	Ignore exposed wires	Secure cords and avoid overloading outlets	Use wet hands to handle wires	Leave electrical equipment unattended
10. What should be done after using PPE?	Leave it where you last used it	Clean and store it properly	Hand it to a colleague	Discard it immediately

Answer Key

1	2	3	4	5	6	7	8	9	10
B	A	B	B	B	A	B	B	B	B

Module 2	Demonstrate Basic Numeracy Skills
-----------------	--

Learning Outcomes:

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

- Apply Basic Numeracy Skills
- Perform Measurement

Learning Unit 2.1	Apply Basic Numeracy Skills
--------------------------	------------------------------------

Learning Outcomes:

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

- Perform addition
- Perform subtraction
- Perform multiplication
- Perform division
- Calculate percentage
- Perform and apply scaling factors and proportion to objects

2.1.1 Basic Principles of Numeracy

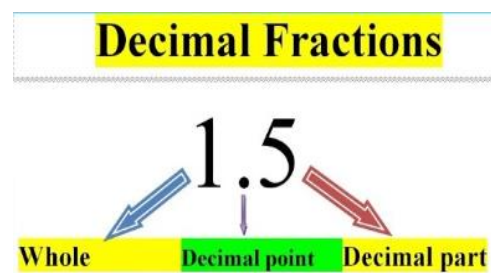
Numeracy is essential in AutoCAD because it helps in accurate measurements, scaling, and drawing. It involves the ability to:

- **Understand numbers:** Knowing how to read, write, and compare numbers.
- **Use basic arithmetic:** Addition, subtraction, multiplication, division, percentages, and fractions are frequently used in AutoCAD for calculating dimensions, areas, and scaling.
- **Understand units of measurement:** AutoCAD uses different units (e.g., inches, millimeters, feet) for precise drawings.

2.1.2 Concept of Fractions & Decimals

In AutoCAD, you'll often need to switch between fractions and decimals, especially when setting dimensions or scaling.

- **Fractions:** A fraction is a part of a whole, represented as a numerator (top number) and a denominator (bottom number).
 - **Example:** 1/2, 3/4, 5/8.
- **Decimals:** A decimal is another way to represent fractions, often used in AutoCAD for more precise measurements.
 - **Example:** 0.5 (equivalent to 1/2), 0.75 (equivalent to 3/4), 0.625 (equivalent to 5/8).

**2.1.3 Time-Saving Practices**

Efficiency is key when working with AutoCAD. Some time-saving tips include:

- **Use templates:** Start projects with pre-configured templates to save setup time.
- **Master keyboard shortcuts:** Learning common AutoCAD shortcuts speeds up drawing and command execution.

- **Layer management:** Proper layer naming and usage can reduce the time spent managing complex designs.
- **Blocks:** Use blocks for repeated elements, like doors, windows, and fixtures, to save time on drafting.
- **Drawing scale:** Understanding and applying correct scales will save time during revisions and printing.

Activity 1: Basic Arithmetic Practice

Practice basic arithmetic and the conversion between fractions and decimals. This helps with accuracy in drawing, scaling, and dimensioning.

Addition

Example: Add $5.75 + 2.25$.

- Solution: $5.75 + 2.25 = 8.00$

Subtraction

Example: Subtract 4.6 from 10.

- Solution: $10 - 4.6 = 5.4$

Multiplication

Example: Multiply 3.5 by 4.

- Solution: $3.5 \times 4 = 14$

Division

Example: Divide 14 by 3.

- Solution: $14 \div 3 = 4.6667$ (or $4 \frac{2}{3}$)

Percentage

Example: What is 15% of 200?

- Solution: $0.15 \times 200 = 30$

Converting Fractions to Decimals and Vice Versa

- $1/2 = 0.5$
- $3/4 = 0.75$
- $5/8 = 0.625$

To convert a fraction to a decimal, divide the numerator by the denominator.

Activity 2: Practice Setting Up Scaling Factors

Understand how to set up scaling factors in AutoCAD for accurate design work.

What is a Scaling Factor?

- A scaling factor is the ratio that converts measurements from one unit to another. For example, if you're working in a drawing where 1 unit represents 1 foot, but your actual object is measured in inches, the scaling factor will be necessary for accurate representation.

Setting Up Scaling Factors

- Example: If the drawing scale is 1:100, the scaling factor would be **100**.
- If the drawing scale is $1/4" = 1'$ (1:48), the scaling factor will be **48**.

Steps:

- **Step 1:** Determine the scale used for your drawing.
- **Step 2:** Calculate the scaling factor based on the ratio.
- **Step 3:** Use the scale factor when plotting or working with dimensions in your drawing to ensure the model fits the intended real-world size.

Practical Example:

- A room is 15 feet by 20 feet in real life, but in AutoCAD, we use a scale of 1:100. To find out how to draw it, multiply each dimension by the scaling factor (100).

Drawing dimensions:

15 feet $\rightarrow 15 \times 100 = 1500$ units

20 feet $\rightarrow 20 \times 100 = 2000$ units

Learning Unit 2.2	Perform Measurement
-------------------	---------------------

After completion of this Learning unit trainee will be able to:

- Select measuring tools as per requirement
- Identify imperial and metric system
- Perform inter conversion of Measuring units.
- Identify points, line and angles

2.2.1 Measuring Tools

These tools are commonly used for measuring dimensions in various fields such as engineering, construction, woodworking, and manufacturing. Here's an explanation of each:

2.2.1.1 Measuring Tape

A flexible ruler made of cloth, plastic, fiberglass, or metal strip with linear measurement markings. It is typically housed in a compact case and can be extended for measuring longer distances.

Use: Ideal for measuring lengths, widths, and heights, especially in construction, tailoring, and DIY projects.

Key Features: Retractable, marked in inches and centimeters, and available in various lengths (e.g., 10 ft, 25 ft, 100 ft).



2.2.1.2 Steel Ruler/Scale

A rigid, straight-edged ruler made of steel, marked with precise measurement units (millimeters, centimeters, inches).

Use: Used for measuring shorter lengths and drawing straight lines. It is commonly used in drafting, machining, and woodworking.

Key Features: Durable, corrosion-resistant, and provides high accuracy for small measurements.

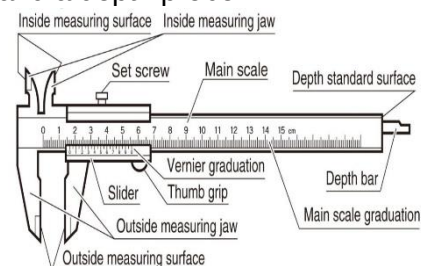


2.2.1.3 Vernier Caliper

A precision measuring tool with a sliding scale (vernier scale) that allows for highly accurate measurements. It consists of two jaws (internal and external) and a depth probe.

Use: Measures internal and external dimensions (e.g., diameter, thickness) and depths with high precision. Commonly used in engineering, machining, and scientific applications.

Key Features: Can measure to within 0.02 mm or 0.001 inches, available in digital, dial, and traditional Vernier scales.

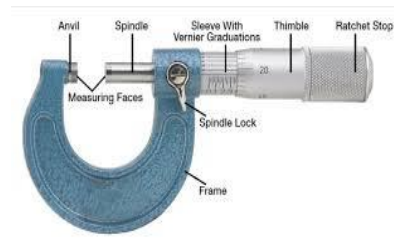


2.2.1.4 Micrometer

A precision instrument used to measure very small dimensions with extremely high accuracy. It consists of a calibrated screw and a thimble scale.

Use: Measures thickness, diameter, or depth of small objects, such as wires, sheets, or machined parts. Widely used in mechanical engineering and manufacturing.

Key Features: Can measure to within 0.01 mm or 0.0001 inches, available in digital and analog versions



2.2.2 Imperial and Metric Systems of Measurements

In AutoCAD, measurements are typically taken in either the **Imperial System** (inches and feet) or the **Metric System** (millimeters, centimeters and meters). Understanding both systems is essential for cross-disciplinary work.

2.2.2.1 Imperial System:

- **Inches (")**: A small unit of length. There are 12 inches in 1 foot.
- **Feet (')**: A unit of length equal to 12 inches. Often used in construction and architectural drawings.

2.2.2.2 Metric System:

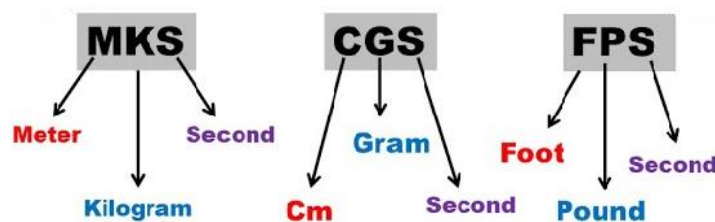
- **Millimeters (mm)**: The smallest unit of length in the metric system, commonly used for precision in design.
- **Centimeters (cm)**: 1 cm = 10 mm. Often used for smaller designs and interior layouts.
- **Meters (m)**: The standard unit of length in the metric system, used for larger-scale designs.

Key Conversion:

- 1 inch = 25.4 mm
- 1 foot = 0.3048 meters
- 1 meter = 1000 mm
- 1 foot = 12 inches

2.2.3 Basic Measuring Units (MKS, FPS, CGS, SI)

The system of measurements used in AutoCAD can be based on various unit systems. Here's a breakdown of the most common systems:



2.2.3.1 MKS (Meter-Kilogram-Second):

This is the International System (SI) of units used globally.

- **Unit of Length:** Meter (m)
- **Unit of Mass:** Kilogram (kg)
- **Unit of Time:** Second (s)

2.2.3.2 FPS (Foot-Pound-Second):

This system is commonly used in the United States, particularly in construction and engineering.

- **Unit of Length:** Foot (ft)
- **Unit of Mass:** Pound (lb)
- **Unit of Time:** Second (s)

2.2.3.3 CGS (Centimeter-Gram-Second):

A smaller unit system often used in scientific contexts.

- **Unit of Length:** Centimeter (cm)
- **Unit of Mass:** Gram (g)
- **Unit of Time:** Second (s)

2.2.3.4 SI (International System of Units):

The most widely used unit system for scientific and technical measurements.

- **Unit of Length:** Meter (m)
- **Unit of Mass:** Kilogram (kg)
- **Unit of Time:** Second (s)

Inter-Conversion of Units

In AutoCAD, you may need to convert between different units, especially when working with projects that require multiple measurement systems. Here are some essential conversions:

Inches to Millimeters:

1 inch = 25.4 mm

Centimeters to Meters:

1 cm = 0.01 meters

Feet to Meters:

1 foot = 0.3048 meters

Millimeters to Centimeters:

10 mm = 1 cm

To convert between other units (such as from meters to feet or kilograms to pounds), you can use the **Convert** function or manually calculate using the conversion factors above.

Activity 1: Measurement of Different Geometrical Figures with a Scale

Practice measuring basic geometrical shapes using a scale to reinforce the concept of precision in AutoCAD.

- Choose a Shape:** Select shapes like squares, rectangles, triangles, and circles.
- Use a Scale:** Measure the dimensions of each shape (length, width, height, radius, etc.).
- Record Measurements:** Ensure you use accurate measurement tools (ruler, scale, and caliper if needed).
- Interpret the Measurements:** Use AutoCAD's **DIST** and **DIM** commands to measure the geometry within the software.

Activity 2: Measure the Boundaries of Specific Land and Calculate its Area and Perimeter

- Land Boundaries:** Measure the perimeter of a land parcel (typically irregular in shape).
- Calculate Area:** Use AutoCAD's **AREA** command to calculate the area enclosed by the land boundary.
 - **Perimeter Calculation:** Add the lengths of each boundary side.

- iii. **Practical Application:** Apply scaling factors (if needed) for converting real-world dimensions into drawing dimensions.

Activity 3: Measurement of Different Solids

Practice taking measurements of 3D solids (e.g., cubes, cylinders, cones) to improve spatial awareness in AutoCAD.

- i. **Choose Solids:** Select 3D objects to measure (cylinder, cone, box, etc.).
- ii. **Use AutoCAD's 3D Measuring Tools:**
 - **DIST:** Measures distances between two points on solids.
 - **DIM:** Use dimensioning commands for 3D objects to measure height, diameter, radius, etc.
- iii. **Calculate Volume and Surface Area:** AutoCAD provides tools like **MASSPROP** to calculate the volume and surface area of 3D solids.

Activity 4: Practice Inter-Conversion of Units

Practice converting between units to ensure accurate scaling and dimensioning.

- **Convert Between Different Units:**
 - Convert inches to millimeters (e.g., 10 inches = 254 mm).
 - Convert feet to meters (e.g., 5 feet = 1.524 meters).
 - **Use Conversion Formulae:**
 - Practice converting both larger and smaller units using appropriate conversion factors.
- Example:** Convert 15 feet to inches, and 200 millimeters to centimeters.
- **Real-World Application:** Convert units for different measurement needs, ensuring your AutoCAD drawings match real-world dimensions.

SUMMARY

Mastering basic numeracy skills such as fractions, decimals, arithmetic, and scaling factors is essential for working efficiently in AutoCAD. By practicing these concepts, you'll be better prepared for accurate drafting and quick design work. Understanding measuring tools, both the **Imperial and Metric systems**, and the **basic units** (MKS, FPS, CGS, SI) is essential for accurate work in AutoCAD. Being comfortable with the conversion between these units will enhance your ability to work with designs that require cross-system compatibility. By practicing these skills through the activities above, you'll improve your proficiency and efficiency in AutoCAD.

FAQs:

1. What is numeracy?

Answer: Numeracy is the ability to understand and work with numbers, including basic arithmetic, measurements, and problem-solving.

2. How do fractions and decimals relate to measurements?

Answer: Fractions are often used in imperial measurements (e.g., ½ inch), while decimals are common in metric measurements (e.g., 12.5 mm). Converting between them ensures accuracy.

3. What are common measuring tools?

Answer: Common tools include rulers, tape measures, vernier calipers, and micrometers, used for precise measurements in different applications.

4. What is the main difference between imperial and metric systems?

Answer: The imperial system uses inches, feet, and yards, while the metric system uses millimeters, centimeters, and meters. The metric system is based on powers of ten.

5. What are MKS, FPS, CGS, and SI systems?

Answer: MKS: Meter, Kilogram, Second
CGS: Centimeter, Gram, Second

FPS: Foot, Pound, Second
SI: International System, based on

MCQs:

Question	Option -A	Option -B	Option -C	Option -D
1. Which of the following is NOT a basic principle of numeracy?	Understanding numbers	Recognizing patterns	Ignoring measurement units	Performing calculations
2. What is $\frac{3}{4}$ expressed as a decimal?	0.25	0.50	0.75	1.25
3. Which of the following time-saving practices is most effective in numerical problem-solving?	Estimation and approximation	Guessing answers	Avoiding calculations	Skipping steps in solutions
4. A Vernier caliper is primarily used to measure	Weight	Small linear dimensions	Angles	Electric current
5. How many millimeters are there in 1 inch?	10.16 mm	25.4 mm	50.8 mm	100 mm
6. The metric system is based on powers of:	2	5	10	12
7. Which of the following is NOT a basic measuring unit in the SI system?	Meter	Kilogram	Foot	Second
8. The FPS system of measurement stands for:	Foot-Pound-Second	Force-Pressure-Speed	Fractional-Physical-Scientific	Force-Power-Strength

9. Convert 5 feet into inches.	30 inches	48 inches	60 inches	72 inches
10. What is the equivalent of 1 meter in millimeters?	10mm	100mm	1,000mm	10,000mm

Answer Keys

1	2	3	4	5	6	7	8	9	10
C	C	A	B	B	C	C	A	C	C

Module 3	Perform Basic Computer Operations
-----------------	--

Learning Outcomes:

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

- Configure Computer System
- Create a Document using MS Word
- Prepare a Worksheet using MS Excel
- Prepare a presentation using MS PowerPoint

Learning Unit 3.1	Configure Computer Systems
--------------------------	-----------------------------------

Learning Outcomes:

After completion of this Learning unit trainee will be able to:

- Connect computer components and peripherals as per requirements.
- Install Drivers and applications according to the software specification.
- Troubleshoot Applications to trace and fix faults

3.1.1 Knowledge of Computer components and peripherals

A peripheral is a device that connects to a computer to input or output information, like a mouse, keyboard, scanner, or webcam. This unit covers common peripheral devices and communication ports.

3.1.1.1 Identify basic components and peripheral devices of computer system.

Any computer system includes following:

➤ **Computer Components (Internal)**

- **Motherboard:** The main circuit board that connects all the components.
- **CPU (Central Processing Unit):** The "brain" of the computer, responsible for executing instructions.
- **RAM (Random Access Memory):** Temporary storage for data and programs currently in use.
- **GPU (Graphics Processing Unit):** Handles the processing of graphics and video output.
- **Storage Devices (Hard Disk Drive/Solid State Drive):** Stores data permanently.
- **Power Supply:** Converts AC power from the wall to DC power for the computer.

➤ **Computer Peripheral (External)**

A computer peripheral device is an external device that provides input and output for the computer.

There are four types of peripherals (External) devices:

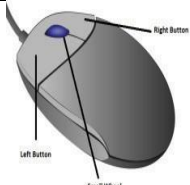
- **Input Devices:**

Teaching and Learning Guide: Information Technology (CAD) **AutoCAD**

Remember

Computer is an electronic machine that accepts the instruction in the form of Input and after process gives us information in the form of Output.

Everything that we give to computer is known as Input. Some common input devices include:

Mouse: Used for controlling the cursor and interacting with the screen.	
Keyboard: Used for entering text and commands. There are many types of keys on the keyboard like, Numeric Keys, Alphabet Keys and Function Keys.	
Scanner: Used for converting physical documents into digital images.	
Webcams: Used for capturing video and audio.	
Microphones: Used for inputting audio.	
Joysticks and Gamepads: Used for playing video games.	
Touchscreens: Allow for direct interaction with the display.	

Do You Know

Any images you make available to others via webcam could remain on the internet forever

- **Output Devices**

Everything that we receive after processing is known as output. Some common output devices include:

Monitor: It is an output device used to visual display information. There are four basic types of monitors: CRT (cathode ray tube) monitors, the LCD (liquid crystal display) monitors, TFT (thin film transistor) monitors, and LED (light emitting diodes) monitors.	CRT Monitor  LCD Monitor 
Printer: It produces physical copies of digital documents/images/photos	
Projectors: Project images onto a screen	
Speakers: Output Audio	
Plotter: Plotter is an output device similar to printer but print the large-scale printing	

- **Storage Devices:**

- **Hard Disk Drives (HDDs):** Store data persistently.
- **Solid State Drives (SSDs):** Similar to HDDs, but use flash memory for faster performance.
- **USB Flash Drives:** Portable storage devices.
- **External Hard Drives:** Larger capacity storage devices for backing up data.
- **Optical Drives (CD/DVD/Blu-ray):** Read and write data on optical media.

- **Networking Devices:**

- **Modems:** Connect to the internet.
- **Network Interface Cards (NICs):** Allow computers to connect to a network.
- **Routers:** Manage network traffic.
- **Wireless Adapters:** Allow computers to connect to wireless networks.

- **Different Types of Communication Ports:**

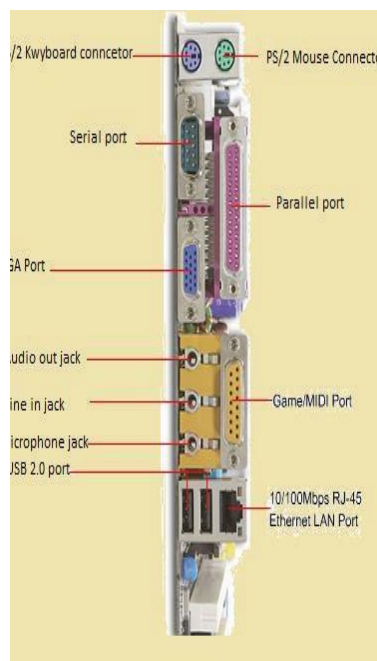
In computer hardware, a **port** serves as an interface between the computer and other computers or peripheral devices. A port generally refers to the female part of connection. Computer ports have many uses, to connect a monitor, webcam, speakers, or other peripheral devices. These **ports** are connection points or interfaces with other peripheral devices.

Physical ports/ Communication ports are used for connecting a computer through a cable and a socket to a peripheral device. Physical **computer ports** list includes:

- Serial ports (DB9 socket),
- USB ports (USB 2.0 or 3.0 socket / connector),
- Parallel ports (DB25 socket / connector),
- Ethernet /internet ports (RJ45 socket / connector).
- VGA port (Display port)
- Fire wire (IEEE 1394 interface)
- E-SATA port
- PS/2 port

Remember

Communication ports are the gateway for data between devices and computers



i. Serial Ports:

A serial port is a communication gateway that transfers data one bit at a time. It was widely used for connecting computers to peripheral devices but has now been replaced by USB ports. The serial port, also known as the COM port, appears in the device manager as COM1 or COM2 when a device is connected

**ii. USB Port:**

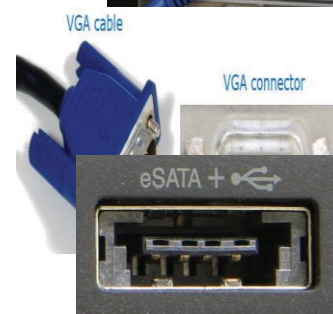
USB port (Universal Serial Bus) is the most usable connection point for data transfer in the world.

**iii. Ethernet Port:**

Ethernet port is a network hardware interface used for data transfer and control between two devices that can support the IP protocol. The Ethernet port speed can vary 10Mbps up to 10Gbps.

**iv. VGA Port:**

The **VGA** port is used for connecting a computer to a monitor. It was the replacement of MDA, CGA and EGA standards. VGA monitors compatible with 640×480 resolution.

**v. E-SATA Port:**

E-SATA is a connection for external storage devices, combining the functions of e-SATA and USB ports in one connector. It connects devices like hard drives and optical drives to a computer, supplying power at 5V and 12V.

3.1.2 Install System Software and Application Software

Computer consists of two main parts Hardware and Software.

3.1.2.1 Hardware and Software:

Following are the two major elements of the computer.

i. Hardware:

Hardware refers to the physical components of a computer that can be seen or touched, including the casing, monitor, keyboard, and mouse. It also includes internal parts like the hard drive, motherboard, video card, and LAN card.

ii. Software:

Software refers to the instructions given to a computer to perform tasks. It directs the computer's processor to carry out specific operations. The two main types of software are system software and application software.

- **System software:** System software is computer software designed to operate and control the computer hardware and to provide a platform for

Teaching and Learning Guide: Information Technology (CAD) **AutoCAD**

Do you Know

Hardware is tangible elements and software is intangible elements of computer. Hardware and Software are dependents on each other

running application software. It includes software like operating system language software, device drivers

- **Application Software** performs specific task which includes word processing software, spreadsheet software, database software, education software, entertainment software and many more.

MS- Office

Microsoft Office, includes programs like Word, Excel, Access, and Outlook, commonly used in offices. You can either buy a copy of MS Office for your computer or subscribe to its cloud-based version.

Google Docs

Google Docs is a free web-based application for creating, editing, and storing documents and spreadsheets online. Files can be accessed from any computer with an internet connection and a web browser. It is part of a larger suite of online tools offered by Google.

- **Sheet**

A sheet is another name for a single piece of paper or a hard copy. In software, a sheet is a single page in a word processor or single worksheet in a spreadsheet.

Precautions to Be Taken Before Installing Windows:

Before installing any operating system, following precautions must be followed for safety and security of important data / software's.

- Regularly take backup of your computer system data.
- Check the prefix for Installation of new Operating system.
- Check the compatibility issue before installing windows.
- Create check points/restore points

System requirements for Windows 10/11:

For installing windows 10/11 we need

- 1 gigahertz (GHz) or faster for 32-bit (x86) or 64-bit (x64) processor.
-
- 1 gigabyte (GB) RAM (32-bit) or 2 GB RAM (64-bit).
- 16 GB available hard disk space for (32-bit) or 20 GB for (64-bit).
- DirectX 9 graphics device with WDDM 1.0 or higher driver.

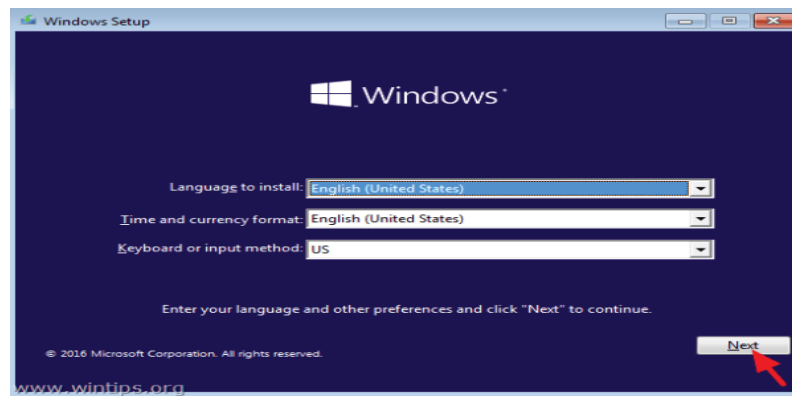
Remember

F2 key is used for entering setup of the computer system.

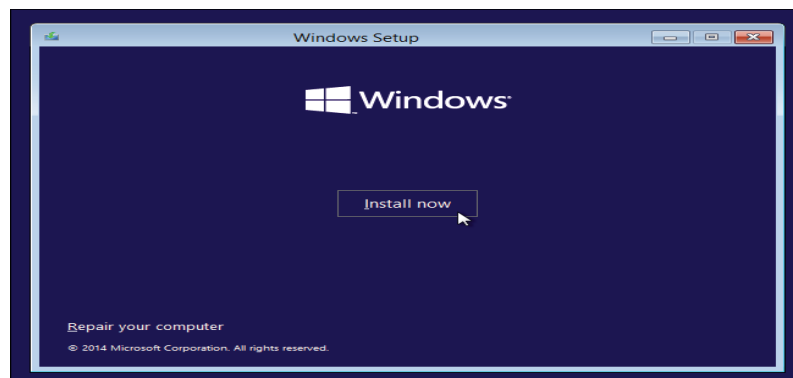
Installation of Operating System

Step by Step Windows Installation

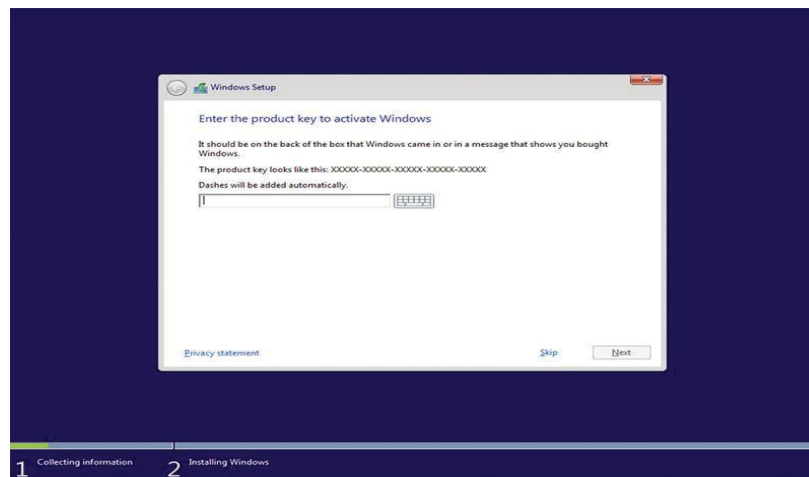
- Boot/Start Computer from Window 10/11, bootable DVD or Bootable USB Flash
- Press **Esc, F10, F2 or Delete** key from Keyboard depending upon your manufacturer.
- If prompted, **press any key to Boot from CD/DVD.....** then press any key
- The obvious place to start in Win 10/11 is with the installation process



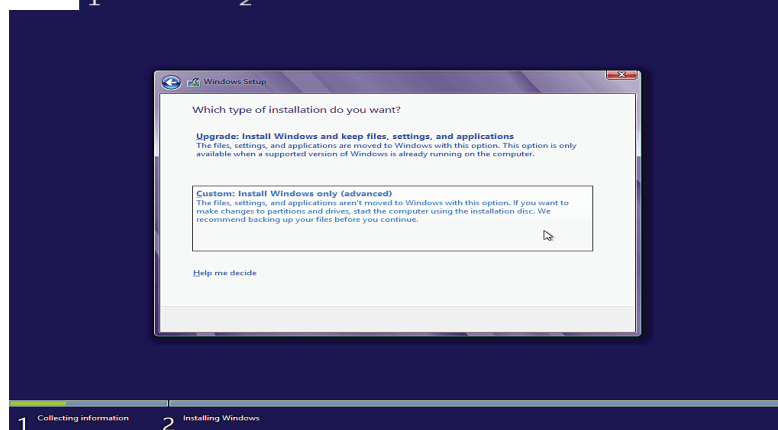
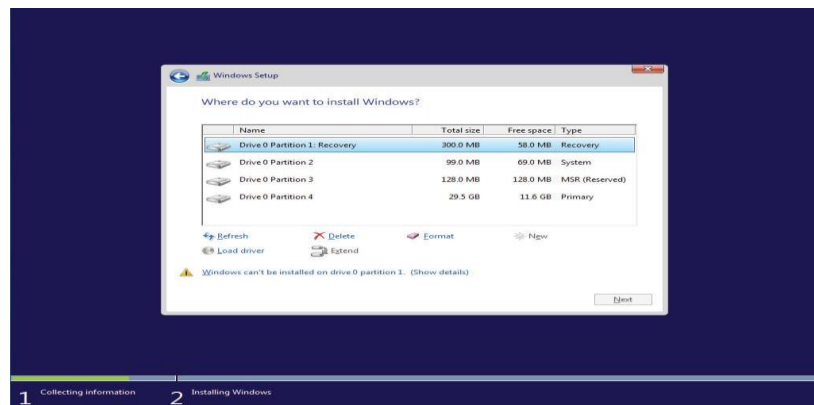
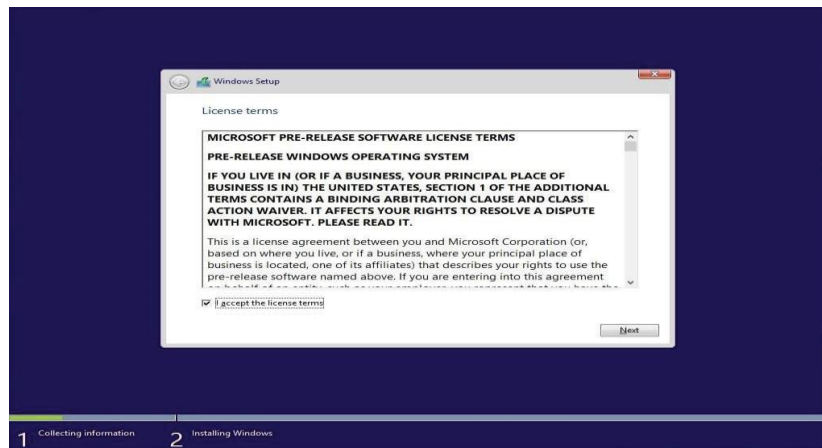
- v. Click on Install Now



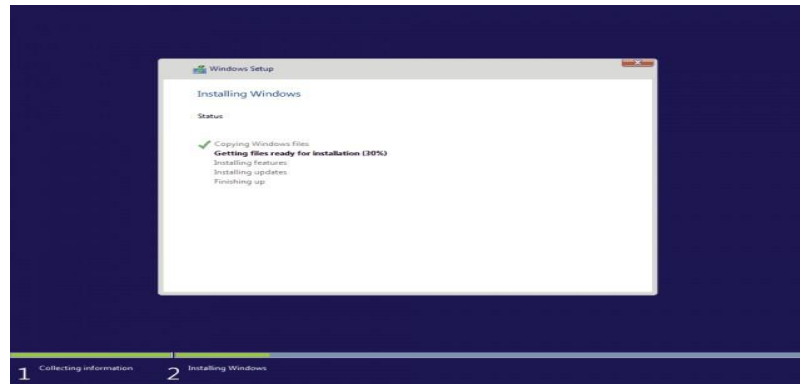
- vi. Enter product key or skip



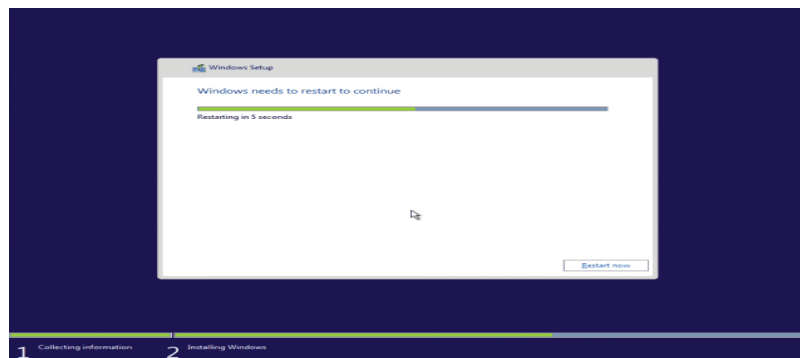
- vii. Click "I accept the license terms" and Select Custom



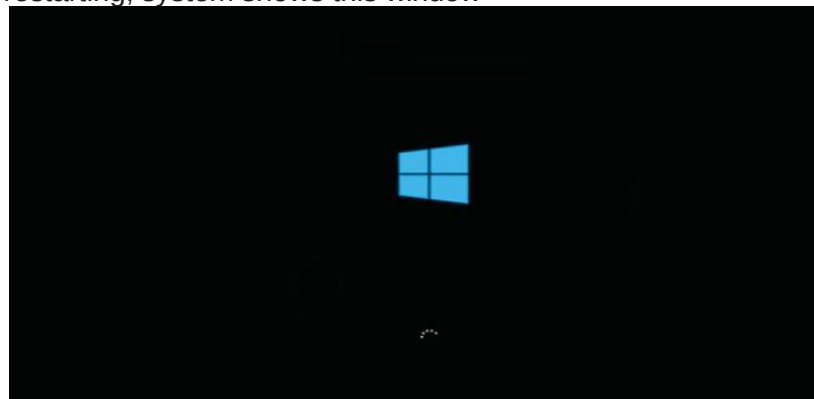
viii. Select the drive where you want to install windows.



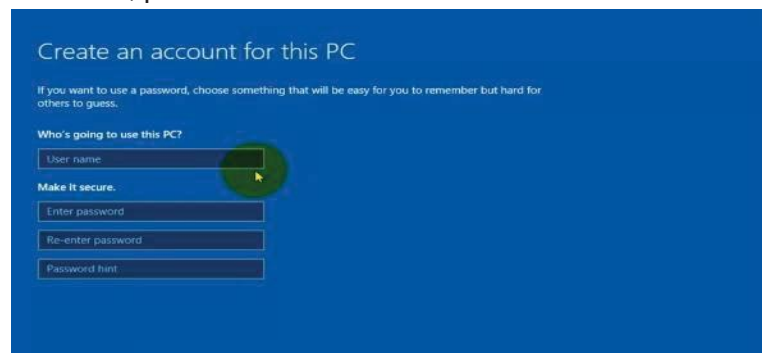
- ix. Now system has been restarted.



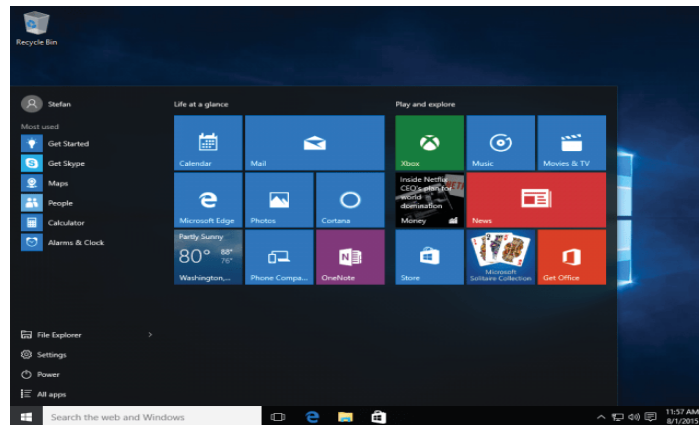
- x. After restarting, system shows this window



- xi. Enter user name, password and hint.



- xii. After completion of all the steps the windows will prepare your desktop



Install Software Applications

Application software is a type of software that is used to do specific tasks. This learning unit covers different types of application software and procedure of installing this software. After completion of this learning unit, you will be able to describe various types of application software and how to install this software.

Remember

An application is a program, or group of programs, that is designed for the end user.

Different Software Applications

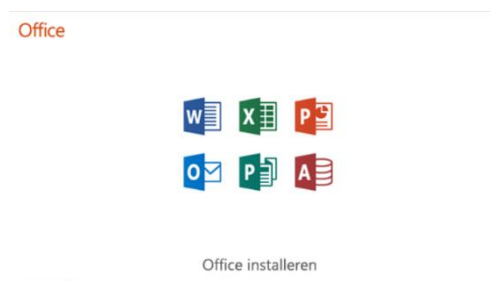
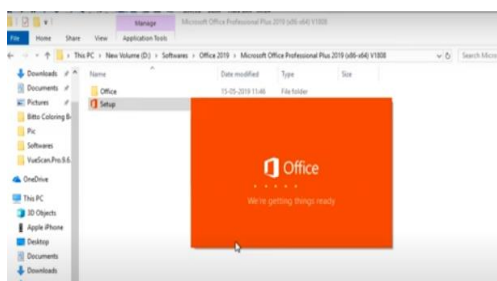
Application software is the software that is used at offices, home and school. Application software consists of programs like Word processing, Spreadsheets, Database, Graphics software, designed to perform specific tasks for users.

Installing Microsoft Office

Step by Step Installation of Microsoft Office

Installation of Microsoft office is very easy.

- i. Insert the office DVD or double click on the downloaded setup.exe file, you will see the option.



Extracting files

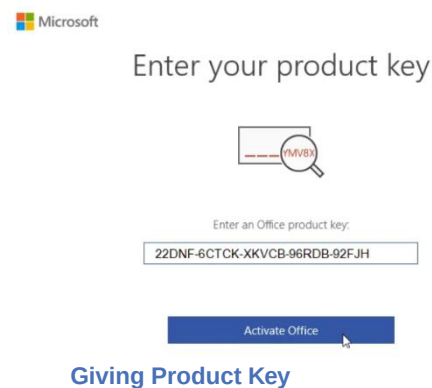
- ii. Then a window will appear simply pop a tick in the accept license conditions and click continue.



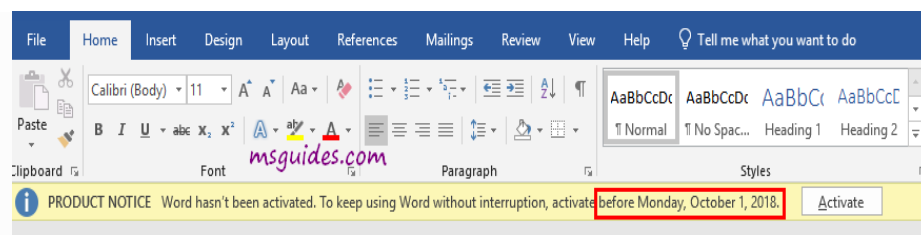
- iii. Then it will ask about the product key.



- iv. Copy the product key from the text file given in the CD and paste it in the given box. Or if it is a downloaded setup the product key text file will be available with it.



And as you can see, I am using Office Professional and the trial license will expire in 7 days.



7-day trial license of Office



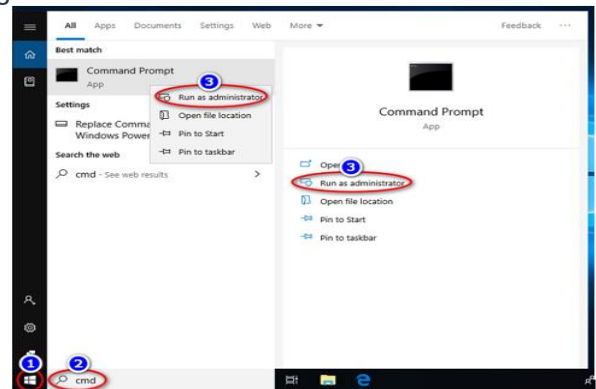
Important features are disabled

Activating Office using KMS license key

Method 1: Running commands one by one manually

Step 1: Open command prompt in administrator mode.

First, you need to [open command prompt with admin rights](#), then follow the instruction below step by step. Just copy/paste the commands and do not forget to hit Enter in order to execute them.



Open cmd as admin

Step 2: Open location of the Office installed on your PC.

If you install your Office in the Program Files folder, the path will be “%Program Files%\ Microsoft Office\Office16” or “%Program Files(x86) %\Microsoft Office\Office16”. It depends on the architecture of the Windows OS you are using. If you are not sure of this issue, don't worry, just run both of the commands above. One of them will be not executed and an error message will be printed on the screen.


```
Administrator: Command Prompt
Microsoft Windows [Version 10.0.17763.107]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Windows\system32>cd /d %ProgramFiles%\Microsoft Office\Office16

C:\Program Files\Microsoft Office\Office16>cd /d %ProgramFiles(x86)%\Microsoft Office\Office16
The system cannot find the path specified.

C:\Program Files\Microsoft Office\Office16>
```

Open Office folder

Step 3: Convert your retail license to volume one.

If your Office is got from Microsoft, this step is required. On the contrary, if you install Office from a Volume ISO file, this is optional so just skip it if you want.

```
Administrator: Command Prompt
Microsoft Windows [Version 10.0.17763.107]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Windows\system32>cd /d %ProgramFiles%\Microsoft Office\Office16

C:\Program Files\Microsoft Office\Office16>cd /d %ProgramFiles(x86)%\Microsoft Office\Office16
The system cannot find the path specified.

C:\Program Files\Microsoft Office\Office16>for /f %x in ('dir /b ..\root\Licenses16\ProPlus2019VL*.xrm-ms') do cscript ospp.vbs /inslic:"..\root\Licenses16\ProPlus2019VL_KMS_Client_AE-ppd.xrm-ms"

C:\Program Files\Microsoft Office\Office16>cscript ospp.vbs /inslic:"..\root\Licenses16\ProPlus2019VL_KMS_Client_AE-ppd.xrm-ms"
Microsoft (R) Windows Script Host Version 5.812
Copyright (C) Microsoft Corporation. All rights reserved.

---Processing-----
Installing Office license: ..\root\licenses16\proplus2019vl_kms_client_ae-ppd.xrm-ms
Office license installed successfully.
---Exiting---
```

Convert Office license

Step 4: Activate your Office using KMS client key.

Make sure your PC is connected to the internet, then run the following command.

If you see the error 0xC004F074, it means that your internet connection is unstable or the server is busy. Please make sure your device is online and try the command “act” again until you succeed.

Here is all the text you will get in the command prompt window.

```
Administrator: Command Prompt

C:\Program Files\Microsoft Office\Office16>cscript ospp.vbs /sethst:kms8.msguides.com
Microsoft (R) Windows Script Host Version 5.812
Copyright (C) Microsoft Corporation. All rights reserved.

---Processing-----
Successfully applied setting.
---Exiting-----

C:\Program Files\Microsoft Office\Office16>cscript ospp.vbs /act
Microsoft (R) Windows Script Host Version 5.812
Copyright (C) Microsoft Corporation. All rights reserved.

---Processing-----
Installed product key detected - attempting to activate the following product:
SKU ID: 85dd8b5f-aaa4-4af3-a628-cce9e77c9a03
LICENSE NAME: Office 19, Office19ProPlus2019VL_KMS_Client_AE edition
LICENSE DESCRIPTION: Office 19, VOLUME_KMSCLIENT channel
Last 5 characters of installed product key: 6MWKP
Product activation successful
---Exiting-----

C:\Program Files\Microsoft Office\Office16>
```

Activate Office manually using KMS license

Right now, the Office is activated successfully. Now the installation is completed and your software is ready to use.

Configuration of Printer

A printer does not work without driver. If driver is not available then it can be downloaded from internet.

Connecting the printer to the computer

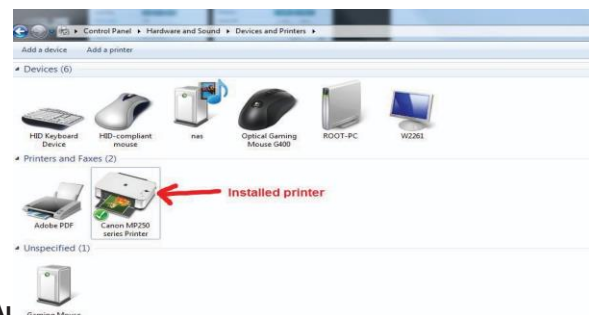
Connect the printer to the computer either using a USB cable, parallel port cable, or SCSI cable and then connect the power plug to a power outlet.

Setup printer and install software:

- After everything has been plugged in turn the computer on.
- Insert the CD that came with the printer. If the CD does not automatically start, open **My Computer**, double-click on the **CD drive**, and then click the **Setup** or **Install** file.
- If you have downloaded the drivers, run the downloaded **setup file**.
- Follow the installation wizard and once completed, the

Do you Know

If you do not see your printer in the printer's list, your printer is not installed



software is installed.

Installing a Scanner

To scan documents, first install the scanner driver so it can communicate with your computer. Connect the scanner to the USB port, and Windows will automatically detect and install it if it's Plug and Play-enabled. New peripherals often come with an installation CD for the driver.

- i. Turn on the scanner.
- ii. Click the found new hardware message, click Yes, this time only, and then click Next again.
- iii. Insert the driver's CD in CD drive and click next.
- iv. Windows 7,8,10 searches for your scanner driver software automatically and installs it.
- v. Click on start button in search bar type Add Device.
- vi. Click the Add Device button and then click Next.
- vii. The Scanner and Camera Installation Wizard window appears. When you click Next, the next screen of the wizard appears.



Installing Scanner

- viii. Click a Manufacturer in the list on the left and then click a model in the list on the right.
- ix. Now it's just a matter of following the wizard directions based on the model of scanner you choose and whether you have a manufacturer's disc (a CD- or DVD-ROM). If you don't have a disc, Windows can help you download software from the Internet.
- x. Click Finish when the wizard ends
- xi. Now the installation is complete and scanner is ready to use.
- xii.

Uninstalling a computer Software

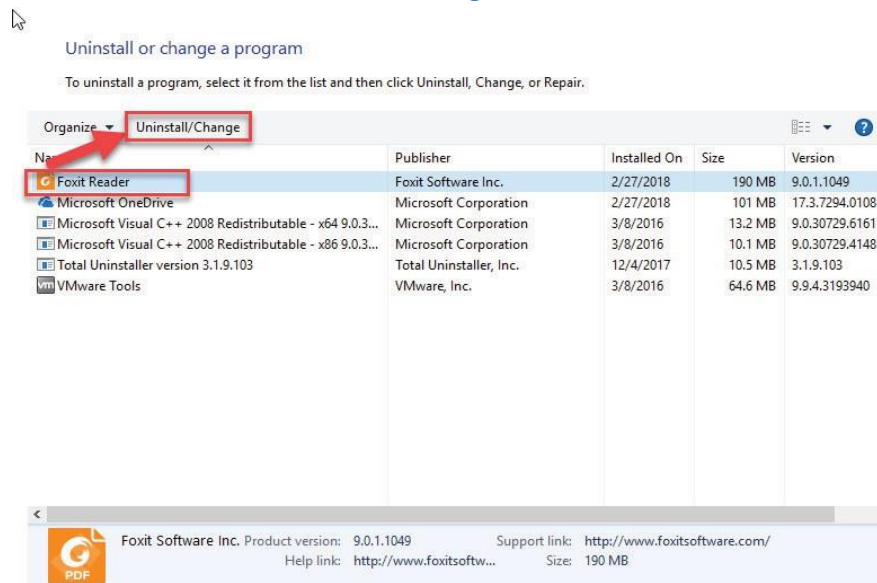
To properly uninstall a program, use its provided uninstall option to remove all files and registry data. Simply deleting its icon or folder can cause conflicts and issues later.

Procedure for Un-Installing A Software

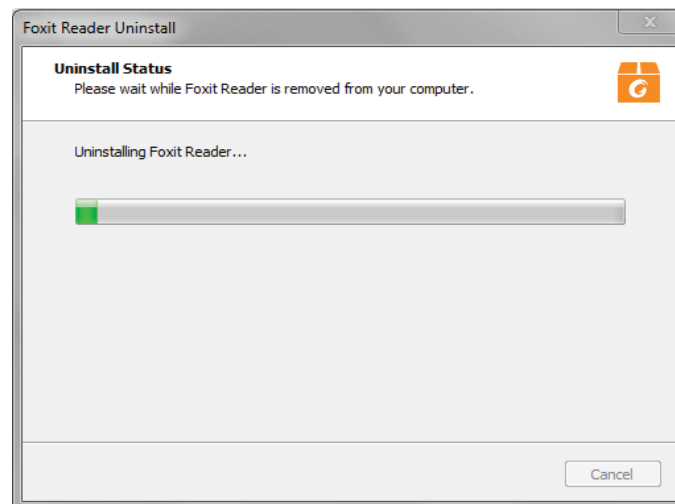
- i. Click on **start** button.
- ii. Click on control panel.
- iii. Click on programs and features.

- iv. **Select** a program, and then click **Uninstall**. Some programs include the option to change or repair the program in addition to uninstalling it, but many simply offer the option to uninstall. To change a program, click Change or Repair.

Uninstalling a software



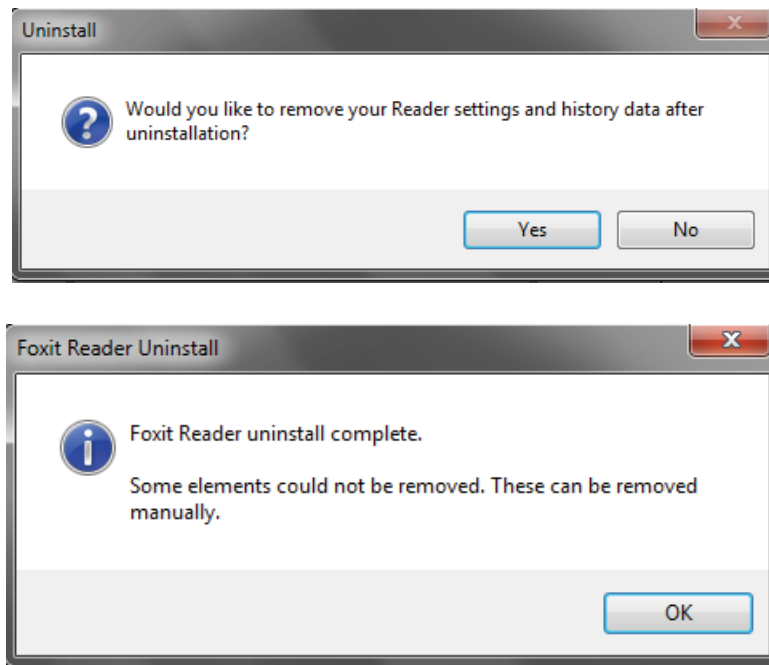
- v. A dialogue box will appear for uninstallation.



Completing uninstalling a software

Then another dialogue box will appear for asking do you want to remove History.

- Click on Yes.
- Then click on OK.



3.1.3 Process of troubleshooting of application software.

Software troubleshooting involves identifying, diagnosing, and fixing errors or bugs in software. This unit covers common software issues like bugs and path corruption, along with precautions for troubleshooting.

Troubleshooting common Errors in windows:

The Control Panel has troubleshooting tools that can fix common computer problems, saving time and effort.

Open troubleshooting by clicking the **Start** button then clicking **Control Panel**, and then, under **System and Security**, click **Find and fix problems**

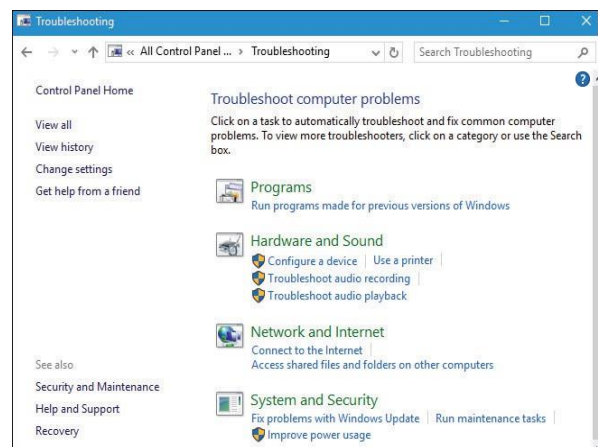
Simple solutions to common Computer Errors:

Problem: An application is running slowly:

Solution 1: Close and reopen the application.

Solution 2: Update the application. To do this, click the **Help** menu and look for an option to check for **Updates**. If don't find this option, another idea is to run an online search for application updates.

Problem: An application is hanged:



Sometimes an application may become **frozen**. When this happens, you won't be able to close the window or click any buttons within the application.

Solution 1: Force quit the application. On a computer, press (and hold) Ctrl+Alt+Delete on keyboard to open the Task Manager. Select the unresponsive application and click **End task**

Activity: 1

- Practice of connectivity of different cables and identify different ports.

Activity: 2

- Perform installation of OS and drivers and their trouble shooting.



Learning Unit 3.2

Prepare Document Using MS WORD

Learning Outcomes:

After completion of this Learning unit trainee will be able to:

- Compose a document as per requirement.
- Format Word Document according to given requirements.
- Print Word Documents both sides of paper according to requirements.

3.2.1 Introduction

MS Word / Microsoft Word is part of the Microsoft Office. Its main function is for producing documents that includes text, graphics, table, clip art, etc.

Features of Standard Word Processor

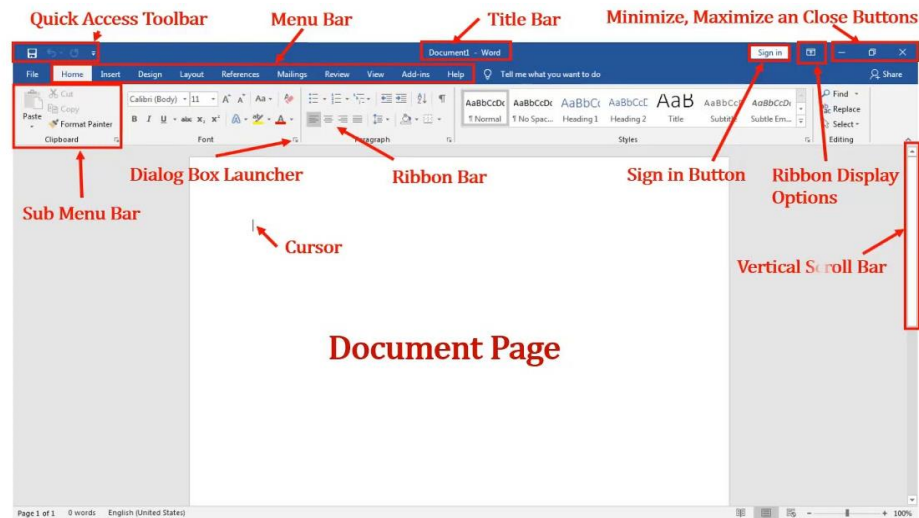
- File Management:**
File management allow to create, delete, move, and search for files.
- Font specifications:**
It allows to change fonts within a document. For example, you can specify bold, italics, and underlining.

Do you Know

MS Word has a "Read Aloud" feature that can read your document out loud.

Do you Know

In MS Word default paper size is US Letter (8.5"x11") or A4 (8.27"x11.69")



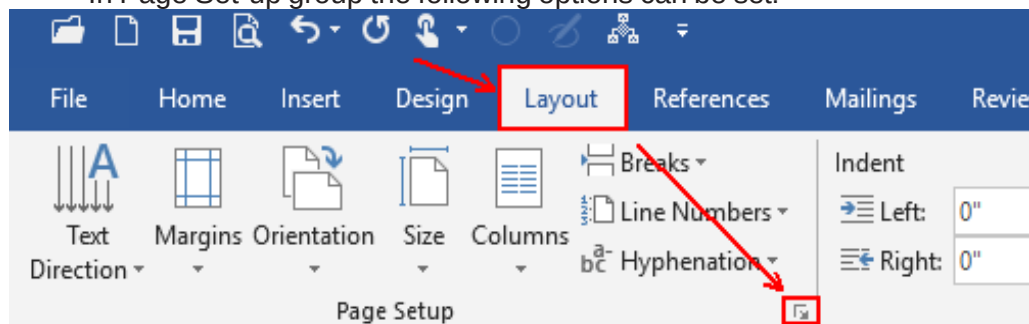
3.2.2 Compose Documents as per the requirements.

Formatting and modify documents.

- **Layout**

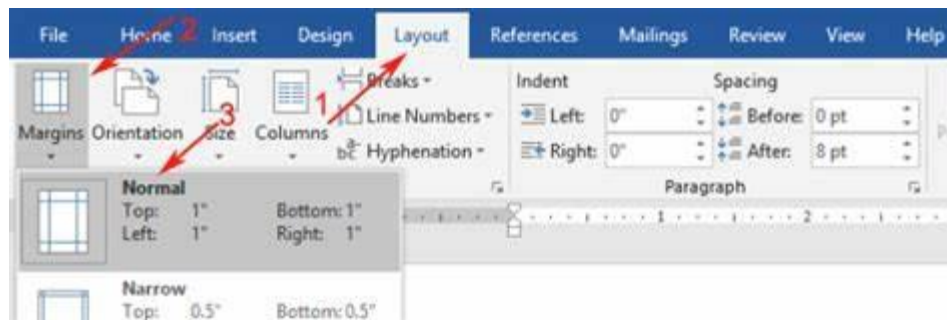
To setup a page in MS Word a **layout** tab is available in the Tabs. In Layout tab a group is available for the page setup as shown in picture below:

In Page Set-up group the following options can be set:



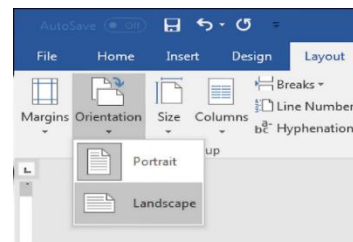
- **Margin:**

A Margin is the space between the text and the edge of your document.



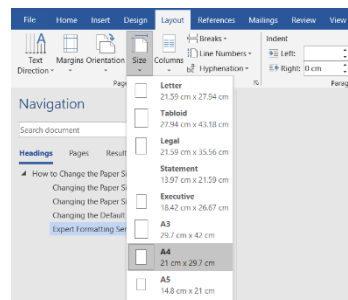
- **Orientation:**

Paper on which text is printed could have two orientations – portrait and landscape. In portrait orientation, height of the paper is larger than its width whereas in landscape orientation, the width is larger than the height.



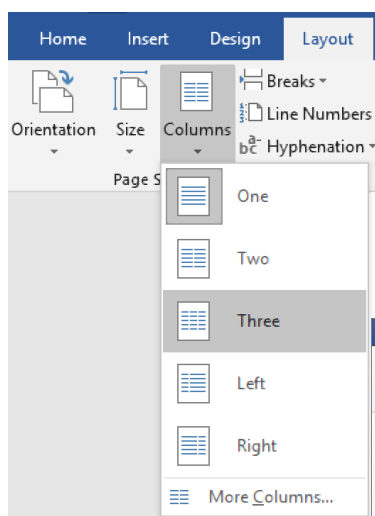
- **Size:**

Books and magazines are printed in a variety of sizes. Different paper sizes are required to meet printing needs. Microsoft Word allows you to choose a variety of paper sizes for your documents.



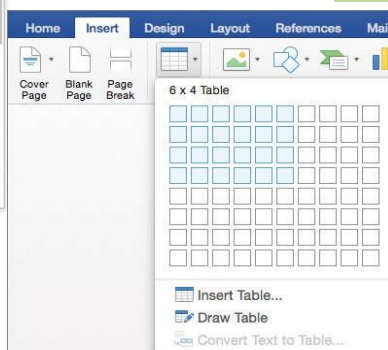
- **Columns**

Columns are used in many types of documents, but most commonly used in newspapers, magazines, academic journals, and newsletters.



Remember

Columns serves to organize or present data in a clear and understandable way.



- **Tables:**

A **table** is a grid of cells arranged in **rows** and **columns**. Tables can be customized and are useful for various tasks such as presenting text information and numerical data.

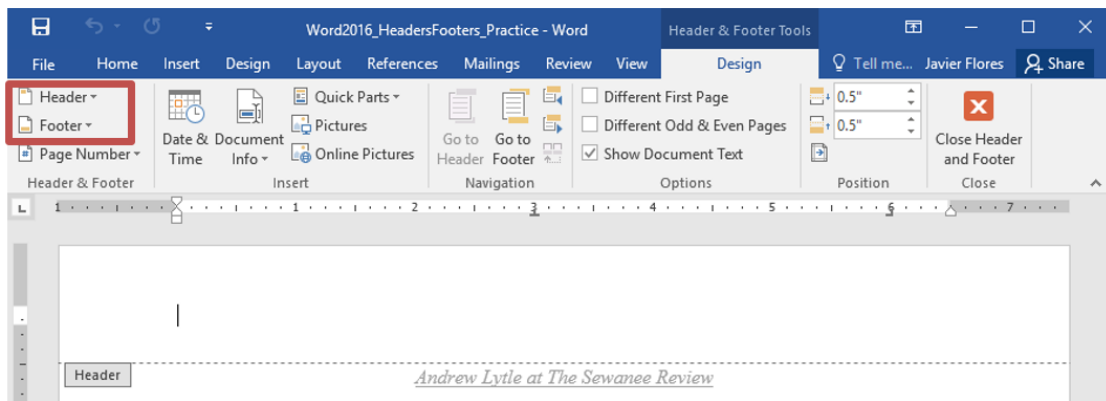
Inserting a blank table:

The procedure to insert a blank table in MS Word has following steps:

- Place your insertion point in the document where you want the table to appear.
- Select the insert tab.
- Click the table command.

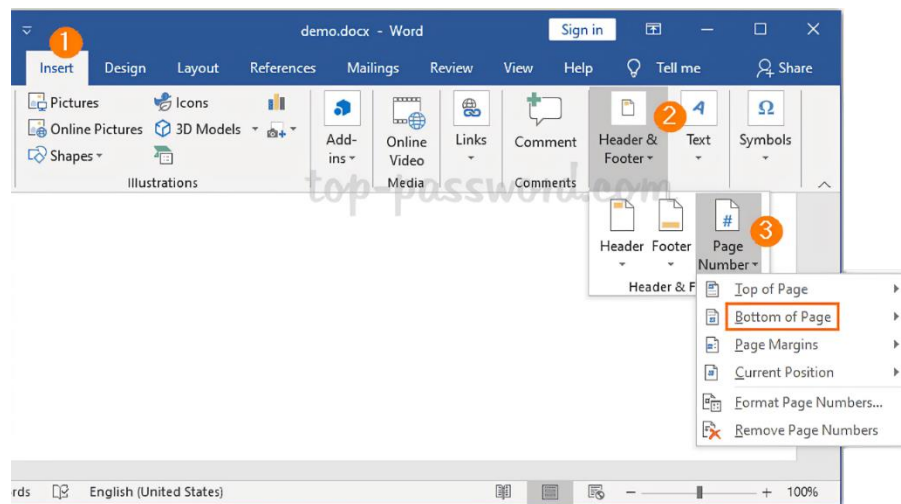
- **Procedure of Inserting Header and footer:**

To set up a header and footer for your document, click on the insert tab at the top of Word. Now locate the Header & Footer panel:

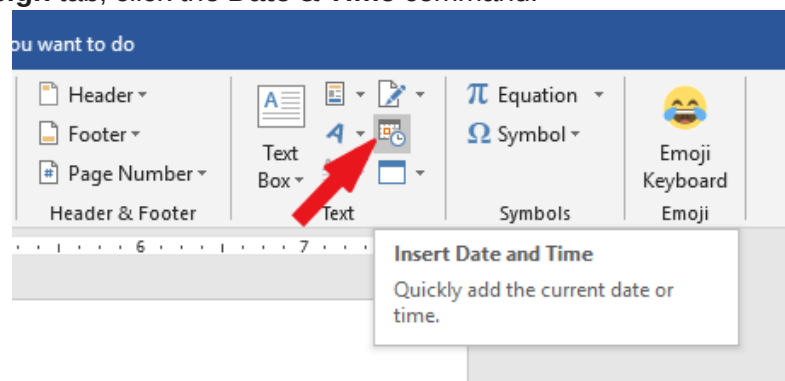


- **Page Numbering**

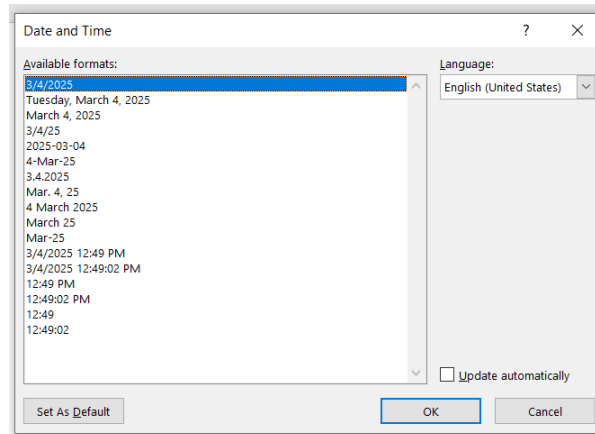
We can attach page number in every page or in footer.



- From the **Design** tab, click the **Date & Time** command.



- Select a **date format** in the dialog box that appears.

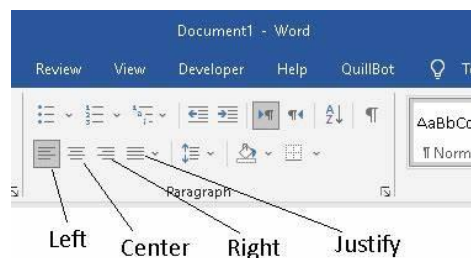


- **Alignment**

In Word, there are several options for adjusting the font of text, including size, color, and inserting special symbols. You can also adjust the alignment of the text to change how it is displayed on the page. The text formatting toolbar is given below with the options related to text formatting.

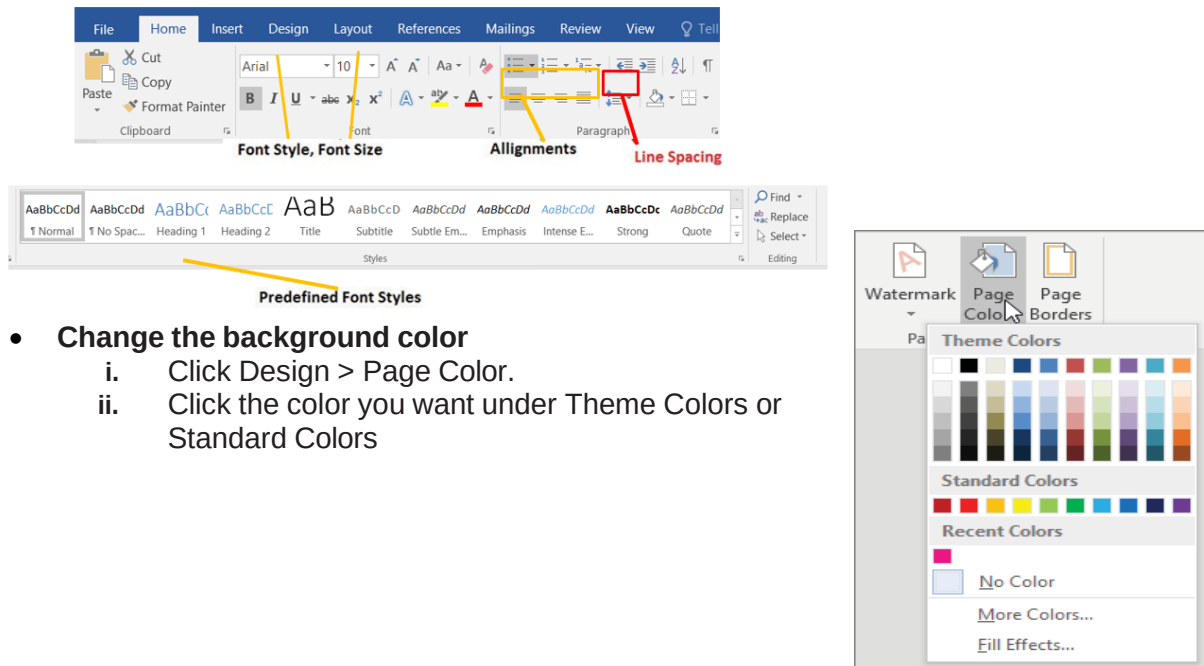
Basic Alignments

- Left:** Aligns all selected text to the left margin
- Center:** Aligns text an equal distance from the left and right margins
- Right:** Aligns all selected text to the right margin
- Justify:** Aligns text equally on both sides and lines up equally to the right and left



Do You Know

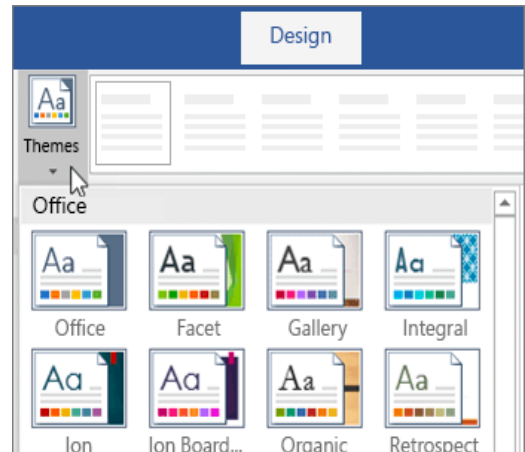
The selected Table is converted into Text. Each row gets converted into a paragraph. The text in each cell of the row gets separated by tabs.



- **Change the background color**
 - i. Click Design > Page Color.
 - ii. Click the color you want under Theme Colors or Standard Colors

- **Themes/Style**

A **style** is a predefined combination of font style, color, and size of text that can be **applied to selected text**. A **theme** is a set of formatting choices that can be applied to an **entire document** and includes theme colors, fonts, and effects.



- **Page / Paragraph borders**

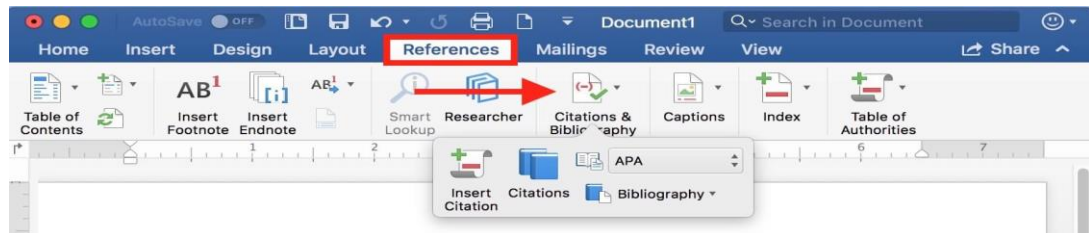
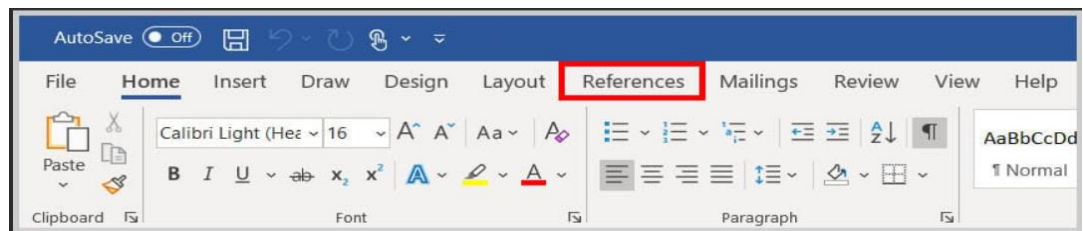
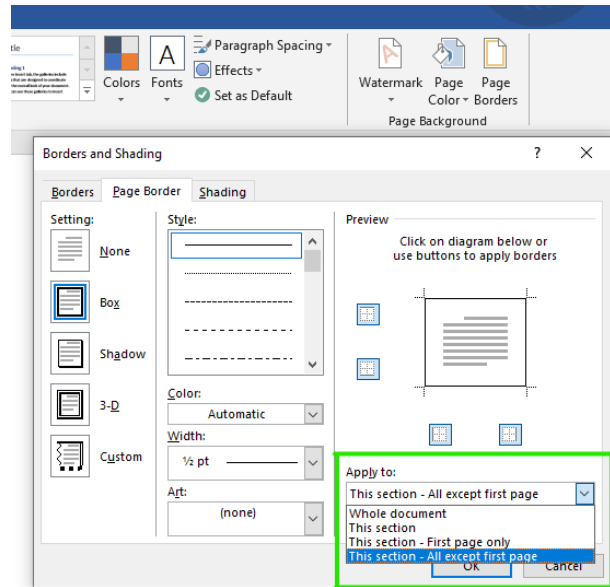
Microsoft Word gives you hundreds of page border options that allows you to surround a page with a clean or fancy border. Follow the steps below to insert a border in your Microsoft Word document

- i. Open Microsoft Word.
- ii. Click on the Page Layout tab. In Word 2016 and 2019 click on the Design tab instead.
- iii. In the Page Background group, click the Page border option.
- iv. In the Borders and Shading window (shown below), click the Page Border tab.
- v. Select Box if you want a square border around your page.
- vi. Select the Style of border you want on the page, which can be solid, dotted, or dashed. Select the Color and Width of the border. If you want to select artwork to use as the border, click the down arrow for the Art drop-down list. In the example below, we're using the hearts art as a border

- To insert a bibliography using the Bibliography tool, you must first enter references and sources, which can be done simultaneously.

Step 1:

Open your document in Microsoft Word 2019 and click on the **References** tab.

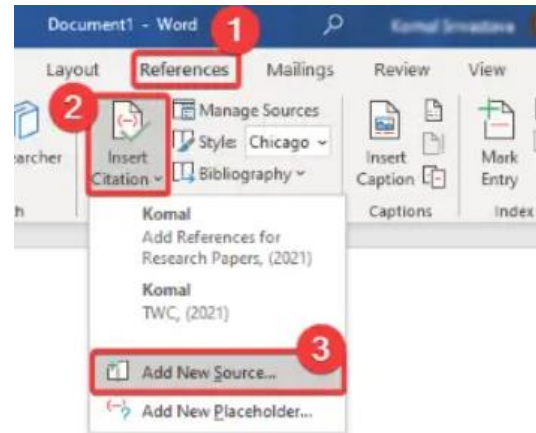


Step 2:

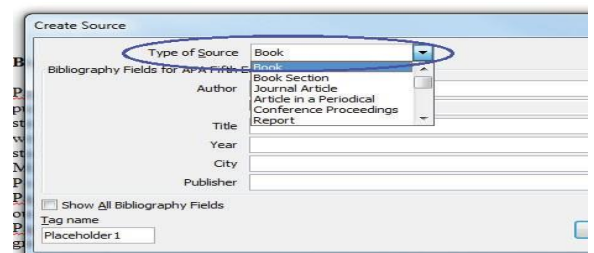
Place your cursor where you would like the citation inserted. Select your style of references in the **Style** menu, shown in the screenshot below

Step 3:

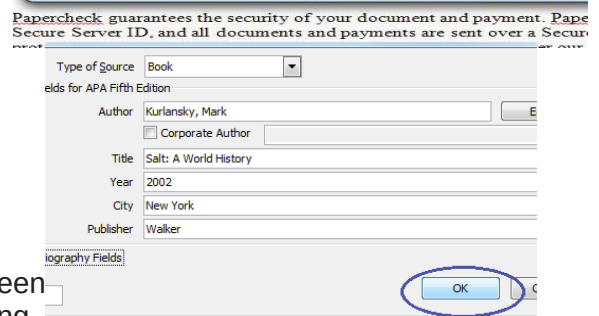
In the screenshot below, APA Fifth Edition is shown in the Style menu. Click on the Insert Citation button to produce the drop-down menu shown below, and select Add New Source.

**Step 4:**

A Create Source window will appear. Choose the source type from the drop-down menu.

**Step 5:**

Enter the source information in the fields provided and click **OK**.

**Step 6:**

In the screenshot below, note that a reference has been entered. Follow Steps 2–5 to insert your remaining references.

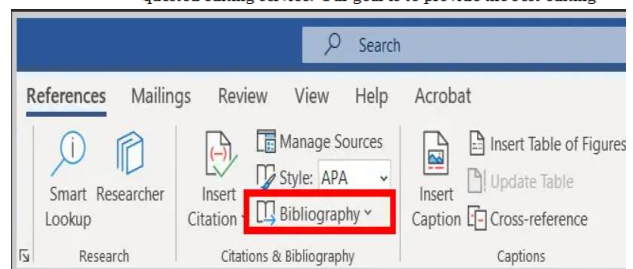
and sentence structure. The document body and thesis is effective communication of the written concept from the writing academic editing can request editors to follow any of the Chicago, CSE, or MLA. Papercheck proofreading services accept docx), Microsoft Excel Files (*.xls or .xlsx), Microsoft Portable Document Files (*.PDF), or Rich Text Files (*.rtf) easily employed by many businesses worldwide. Businesses use s on a daily basis for emails and other outgoing correspondence. rvice are available for web sites, emails, memos, proposals, i, and other formal business documents. (Kurlansky, 2002)

ity of your document and payment. Papercheck has a VeriSign ents and payments are sent over a Secured Socket Layer, y disclosure. Documents travel over our encrypted network, and our queue to ensure your privacy and security. Paper the TRUSTe Privacy Program. TRUSTe is an independent enable individuals and organizations to establish trusting a personal identity and information by promoting the use of fair use or share personally identifiable information in ways requested editing service. Our goal is to provide the best editing

Step 7:

Once you have entered all references and sources, place your cursor at the end of your document. The bibliography will be inserted wherever you place the cursor.

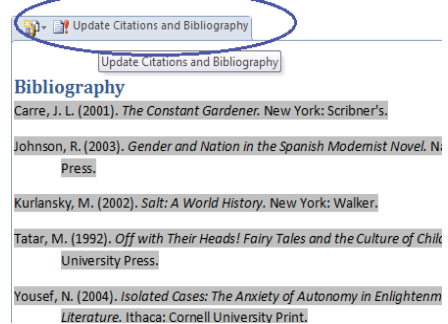
Click on the **Bibliography** button, shown below, and select either **Bibliography** or **Works Cited**.



Step 8:

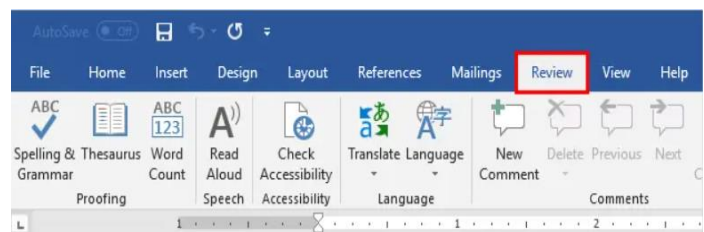
To update the bibliography after entering new sources, click anywhere on the bibliography table. Click on **Update Citations and Bibliography**.

info@papercheck.com. If you do not receive acknowledgment or if you satisfactorily addressed, you should then contact **TRUSTe** through the [Dispute Resolution Process](#). **TRUSTe** will serve as a liaison with the concerns.



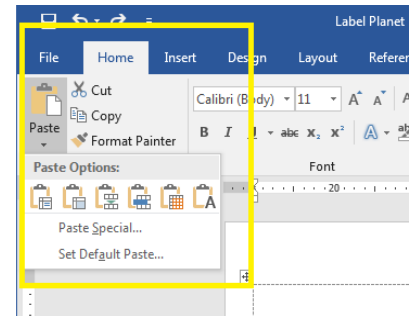
- **Review option**

There are different group in Review group, proofing (in proofing check spelling & grammar checking), Comments (add comments), Changing (changing the words), and protect documents.



- **Editing tools (Cut/copy/paste, Undo/redo, Delete/insert)**

The **Select** function stays in the **Editing** group of **Home** tab; the **Paste** function stays in the **Clipboard** group of **Home** tab



Cut: Removes the selection from the active document and places it on the clipboard. Short Key of Cut command is CTRL+X.

Copy: Copies the selected text to the clip board

Paste: Paste the contents of the clipboard at the insertion point (cursor) or whatever is selected.

Clear: Deletes the selected object or text, but does not place it on the clipboard.

Select All: Selects all text and graphics in the active window.

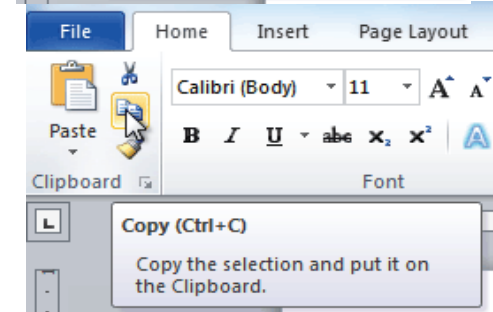
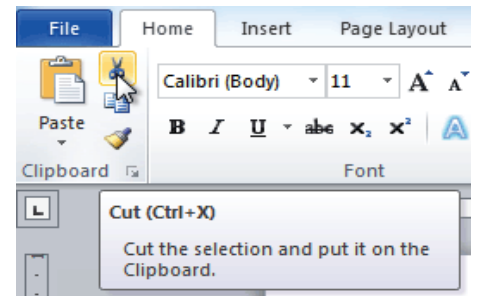
Find: Searches for specified text in the active document.

Replace: Searches for and replaces specified text and formatting.

- **Copying and Pasting Text**

The procedure to Copy and paste the text has following steps:

- i. **Select** the text you want to copy.
 - ii. **Click the Copy command on the Home tab. You can also right-click your document and select Copy**
 - iii. Place your insertion point where you want the text to appear.
- **Cutting and Pasting Text**
 - i. Select the text you want to copy.
 - ii. Click the **Cut** command on the **Home** tab. You can also right-click the document and select **Cut**.



- **Undo**

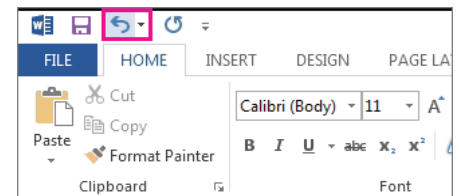
Repeat the last action it can found quick access toolbar. The Undo command is activated by pressing the Ctrl+Z

- **Redo**

To do last one step Ctrl+Y

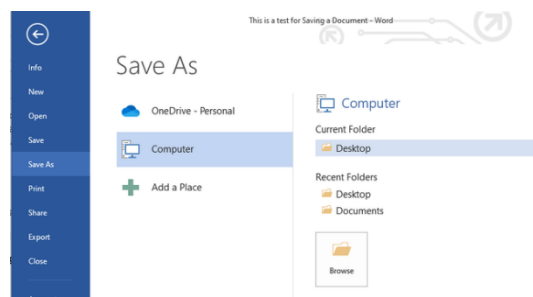
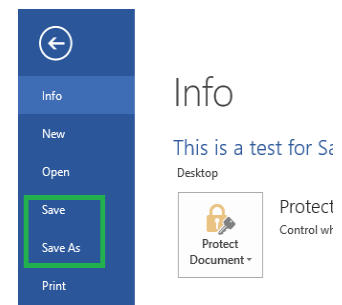
- **One drive location**

Save As function allows you to choose a name and location for your document. It's useful if you've first created a document or if you want to save with different name while keeping the original document.



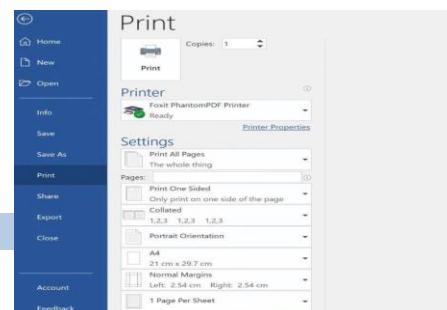
The procedure to save a word file through Save As function has the following steps:

- i. Open the word File
- ii. Click the **File** tab.
- iii. Select **Save As**.
- iv. The Save As dialog box will appear. Select the location where you want to save the document



3.2.3 Print Document:

- i. Select document for print (**Type Ctrl+P**)
- ii. Select/Chose Printer
- iii. Select Page Orientation
- iv. Select Page size

**Activity-1**

Install MS Office Application correctly

Activity-2

Practice of short keys, document opening/closing, saving, coping and pasting.

Activity-3

Practice of creating and editing a document/letter in MS word and print it.

Create a letter in Microsoft Word, format it with proper text and paragraph settings, and make any necessary edits. After finalizing your document, you'll save it and prepare it for printing. This will help you practice basic document creation and editing skills.

Learning Unit 3.3	Prepare a Worksheet Using MS Excel
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Learning Outcomes:

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

- Develop a worksheet as per given data.
- Format the worksheet according to given Criteria.
- Apply formula according to given Requirement.
- Generate Charts/Graphs according to the given data.

3.3.1 Introduction

Microsoft Excel is an excellent program for organizing, formatting, and calculating numeric data. Excel displays data in a row-and-column format, with gridlines between the rows and columns, similar to accounting ledger books or graph paper.

Remember

Every workbook in MS Excel contains 3 worksheets by default.

Develop Worksheet

Worksheets Microsoft Excel consists of worksheets. Each worksheet contains columns and rows. The columns are lettered A to Z and then continuing with AA, AB, AC and so on to XFD (16384); the rows are numbered 1 to 1,048,576

- **THE INTERFACE:**

Cell: The intersection of a column and a row. Information is stored in cells.

Cell Reference: Address, consisting of a column and a row IDs of a specific cell.

Column: A vertical group of cells. Total number of columns is 16,384.

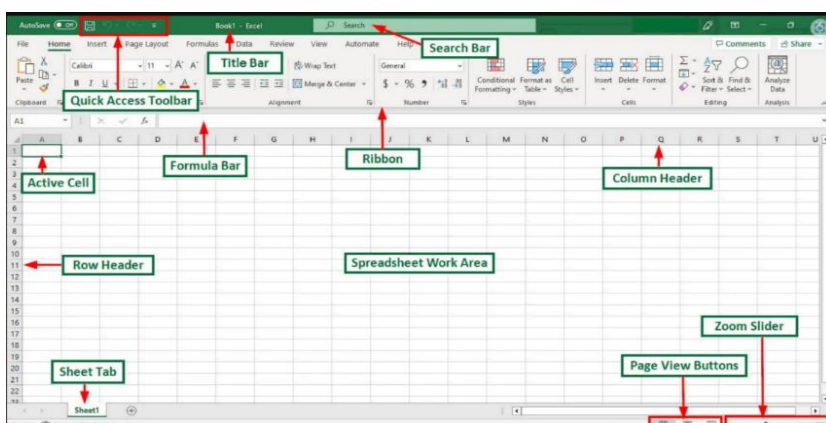
Formula: A self-made method of calculation is called formula. **Function:** A pre-defined method of calculation is called function. **Range:** A group of cells.

Row: A horizontal group of cells

Value: A number that can be used in an Excel calculation.

Workbook: A collection of worksheets contained within a single file

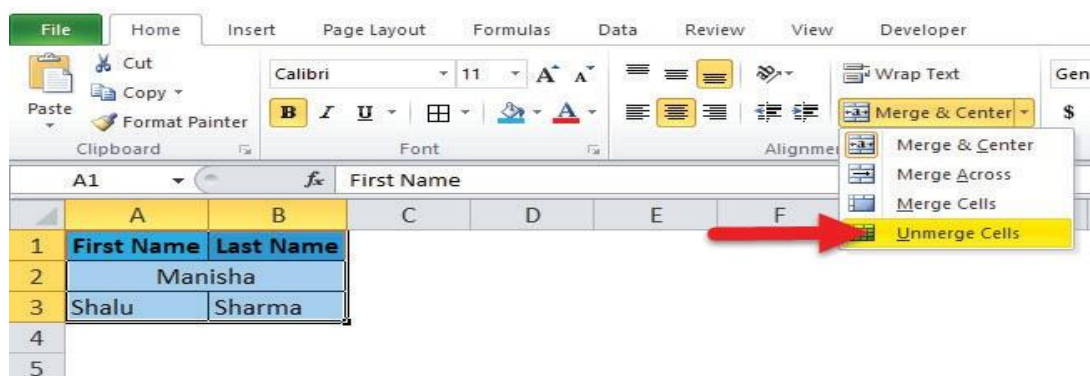
Main parts of Spreadsheet Work Area



3.3.1.1 Format Cells to Prepare the Worksheet.

- **Merge and Unmerge**

Merging cells is often used when a title is to be centered over a particular section of a spreadsheet. When a group of cells is merged, only the text in the upper-leftmost box is preserved.

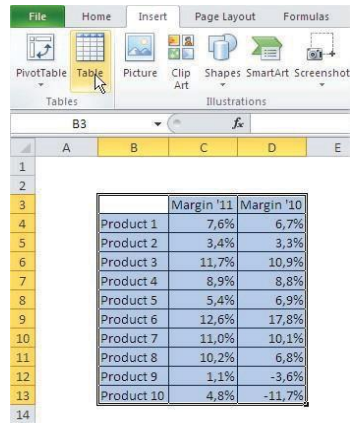


- **Numbering and Bullets**

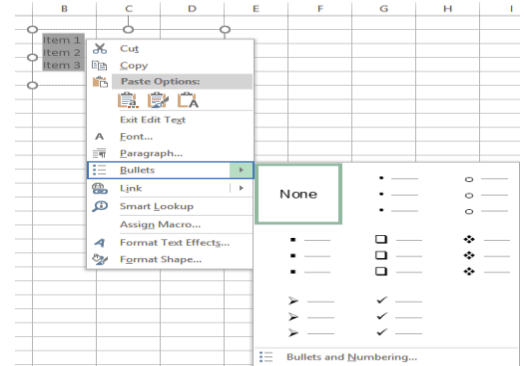
Numbering and bullets are used to highlight any point in a manner. There are many types of bullets and numbering.

- **Tables:**

A table in Excel is a block of cells containing related data that have been formatted as a table. Table can be inserted from insert tab.



	Margin '11	Margin '10
Product 1	7,6%	6,7%
Product 2	3,4%	3,3%
Product 3	11,7%	10,9%
Product 4	8,9%	8,8%
Product 5	5,4%	6,9%
Product 6	12,6%	17,8%
Product 7	11,0%	10,1%
Product 8	10,2%	6,8%
Product 9	1,1%	-3,6%
Product 10	4,8%	-11,7%



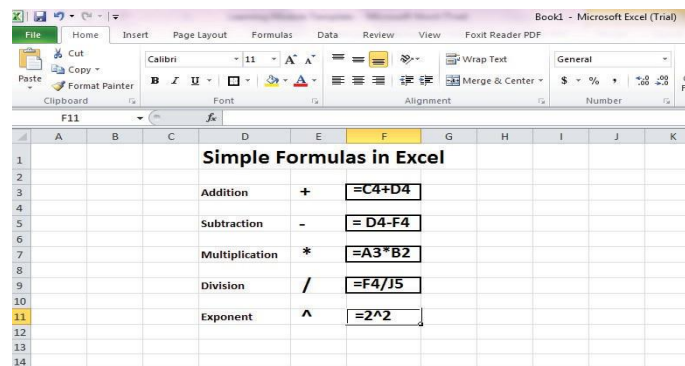
3.3.2 Applying formulas to create functional worksheet.

Creating Formulas

There are different methods used for creating or inserting formulas in Excel. It can insert through predefined formulas, using cell references or it can create through using point and click method.

Excel uses different standard operators for equations, such as

- A **plus sign** for addition (+)
- Minus sign** for subtraction (-)
- Asterisk** for multiplication (*)
- Forward slash** for division (/)
- Caret** for exponents (^)



Simple Formulas in Excel			
Addition	+	=C4+D4	
Subtraction	-	=D4-F4	
Multiplication	*	=A3*B2	
Division	/	=F4/J5	
Exponent	^	=2^2	

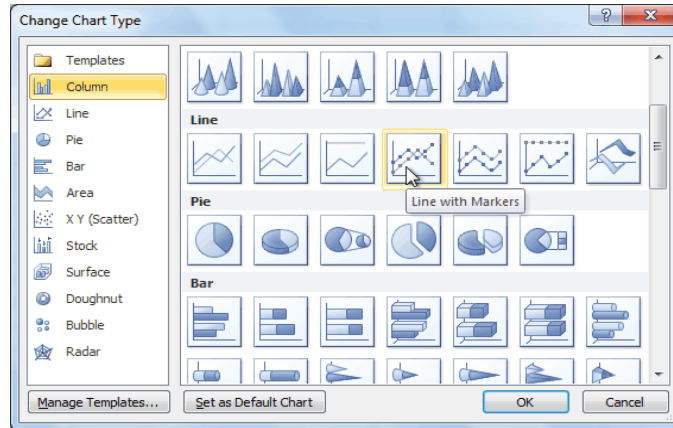
3.3.3 Create Charts / Graphs

Defining charts/Graphs.

A chart, also called a graph, is a graphical representation of data, in which the data is represented by symbols, such as bars in a bar chart, lines in a line chart, or slices in a pie chart. A chart can represent numeric data, functions or some kinds of qualitative structure and provides different information. There are many types of chart / graphs used in Excel.

Excel Chart Type

MS Excel has different types of charts as shown in the picture below.



Creating a Chart in Excel

Select the **cells** that are wanted to chart, including the **column titles** and

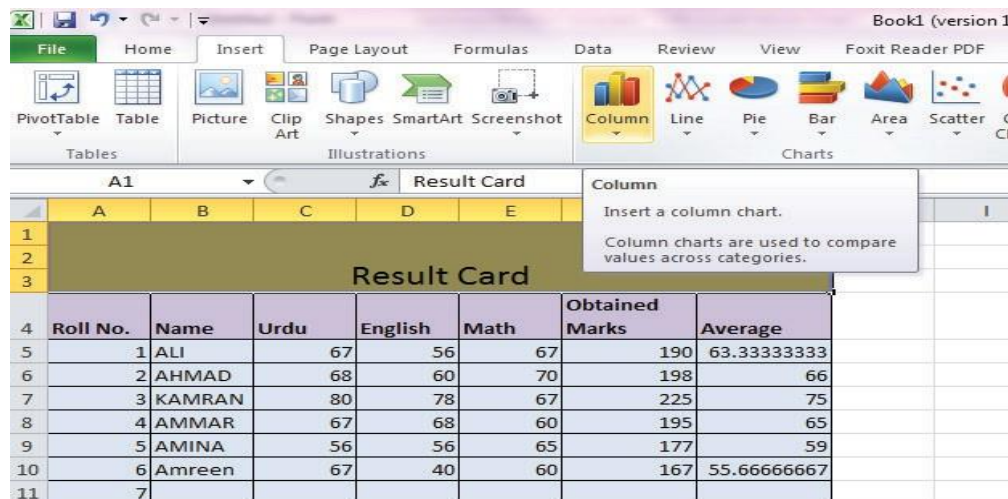
	A1						
	A	B	C	D	E	F	G
1							
2							
3							
4	Roll No.	Name	Urdu	English	Math	Obtained Marks	Average
5	1	ALI	67	56	67	190	63.33333333
6	2	AHMAD	68	60	70	198	66
7	3	KAMRAN	80	78	67	225	75
8	4	AMMAR	67	68	60	195	65
9	5	AMINA	56	56	65	177	59
10	6	Amreen	67	40	60	167	55.66666667
11	7						
12							
13							
14							

Do You Know

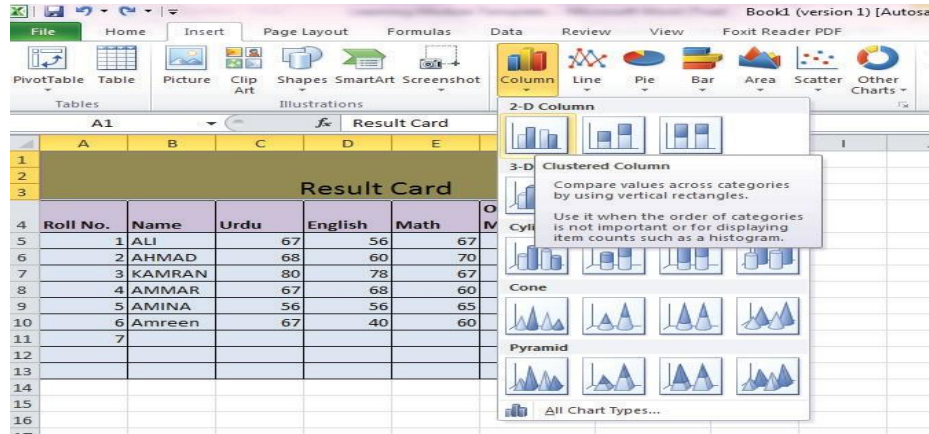
Charts are (called graphs in math class) visual representations of worksheet data.

row labels. These cells will be the **source data** for the chart.

- 1) Click the **Insert** tab
- 2) In the **Charts** group, select the desired **chart**.

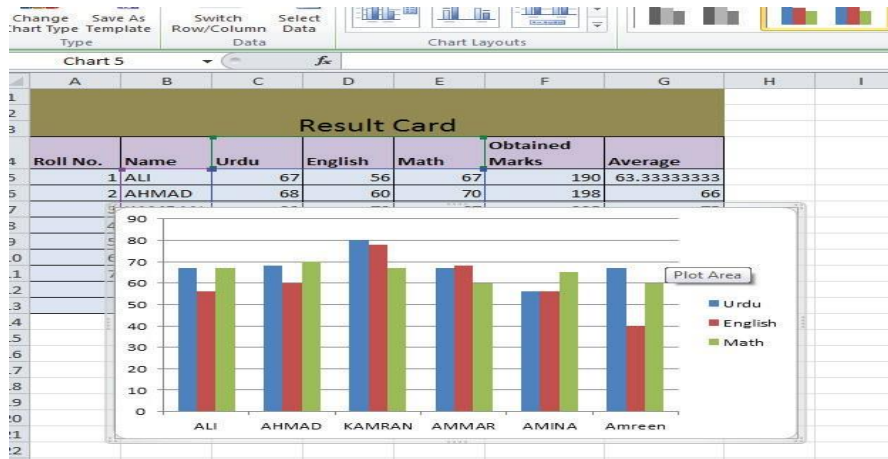


- 3) Select the desired **chart type** from the drop-down menu (**Clustered Column**, for



example)

- 4) The chart will appear in the worksheet.



Using different charts in Excel.

The steps for creating a basic **column chart** in Excel are:

- Select the data which wanted to be in the chart. Insert row and column headings but not the title for the data table.
- Click on the Insert tab of the Ribbon.
- In the Charts box of the ribbon, click on the Insert Column Chart icon to open the drop-down list of available chart types.
- Hover mouse pointer over a chart type to read a description of the chart.
- Click on the desired chart.

Activity 1:

Practice to enter data into columns and rows as per given instructions.

Solution

B9									
	A	B	C	D	E	F	G	H	I
1									
2									
3	Sr. No.	Names	Math	Computer	Engalish	Obtain Marks	% Age	Grade	Remarks
4	1	Nabeel Masood	89	80	78	247	82	A	PASS
5	2	Attig-ur-Reham	80	50	86	216	72	B+	PASS
6	3	Shehzad Ali	45	50	60	155	52	C	PASS
7	4	Ai Hamza	23	15	35	73	24	F	FAIL
8	5	Ayaz Ahmad	30	45	40	115	38	F	FAIL
9									

Activity 2:

Format and apply formulas to a work sheet according to the requirement.

INSTRUCTIONS

- 1- Calculate the worksheet given below.
2. Calculate Maximum Score as Row Wise.
3. Calculate Minimum Score as Column Wise.
4. Calculate Minimum Score as Row Wise.
5. Calculate Maximum Score as Column Wise.
6. Calculate Minimum Score as Overall the Table.
7. Calculate Maximum Score as Overall the Table.
8. Draw a Pie and line Graph from column Batsman Name to Year 2000.

INTERNATIOLNAL CRICKET PERFORMANCE

St. #	Batsman Name	Year 1995	Year 1996	Year 1997	Year 1998	Year 1999	Year 2000	Minimu m Score	Maximu m Score
1	Inzimam	456	986	875	795	1285	968	456	1285
2	Saeed Anwar	789	867	856	756	784	755	755	867
3	Ijaz Ahmad	568	598	489	845	457	845	457	845
4	Muh. Yousif	865	485	785	745	654	684	485	865
5	Ganguly	789	864	785	458	698	792	458	864
6	Rahul Dravid	598	854	489	456	675	985	456	985
7	Jay Soria	756	565	785	746	458	965	458	965
8	Mark Waugh	795	856	765	699	587	459	459	856
9	Ricky Ponting	784	489	764	678	685	456	456	784
10	Alec Stewart	756	597	486	684	675	255	255	756
Minimum Score		456	485	486	456	457	255	BEST	SCORE
Maximum Score		865	986	875	845	1285	985		
Overall Minimum Score							255		
Overall Maximum Score							1285		

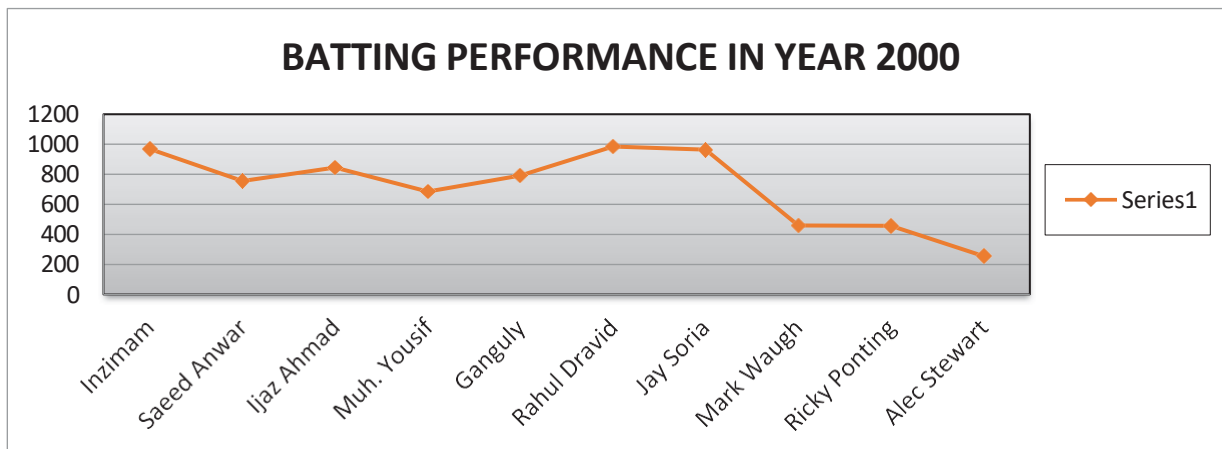
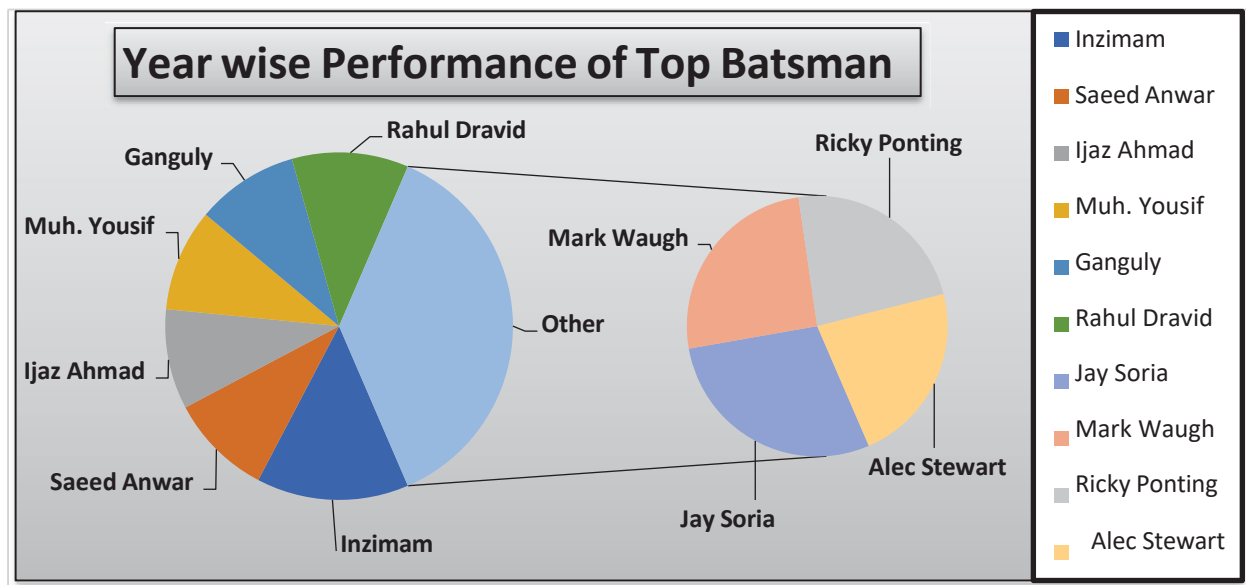
Activity3:

Set page layouts and margins.

You will adjust the page layout and set margins in your document. Start by selecting the page orientation (portrait or landscape), then choose the appropriate paper size. Afterward, set the margins to standard or custom measurements. These settings help ensure your document looks clean and professional.

Activity4:

Practice to generate chart/graph according to given data.



Learning Unit 3.4	Prepare Presentation Using MS PowerPoint
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Learning Outcome

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

- Insert slides with different layouts according to the requirements of presentation
- Insert text, tables, images, etc. according to the requirements.
- Apply a set of effects to animate the slide according to the requirements.
- Apply slide transitions on slides according to the requirement.
- Apply sound effects on objects/text/images according to job requirements.
- Present a presentation according to 7Cs of communication

3.4.1 Introduction

A PowerPoint presentation is a collection of electronic slides that can have text, pictures, graphics, tables, sound and video. This collection can run automatically or can be controlled by a presenter. The file extension of a saved PowerPoint presentation is “. ppt”. A PowerPoint presentation comprising slides and other features is also known as PPT.

3.4.2 Layout and interface of PowerPoint

Mini Toolbar

This is a floating toolbar that is displayed when you select text or right-click text. It displays common formatting tools, such as Bold, Italics, Fonts, Font Size and Font Color.

Layout of Power point



3.4.3 Slide and different layout of Power Point

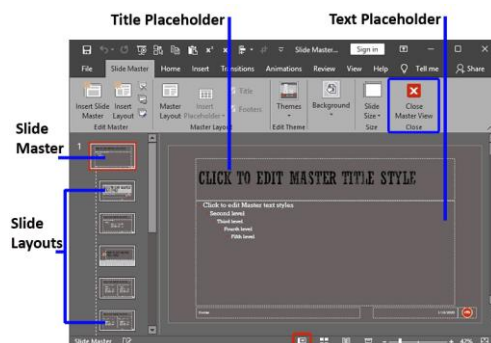
Slide Views Presentations can be viewed in a variety of manners. On the View tab, the Presentation Views group allows you to view the slides as normal, slide sector, notes page, slide show, slide master, handout master and notes master.

Slide Master

A slide master is the top slide that stores information about the theme and slide layouts of a presentation. It includes the **background, color, fonts, effects, and positioning**. By using Slide Master, affects can be added in every slide. Individual slide layouts can also be modified using this feature.

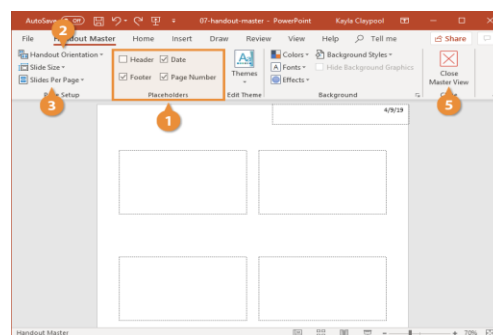
Remember

Every presentation contains at least one slide master



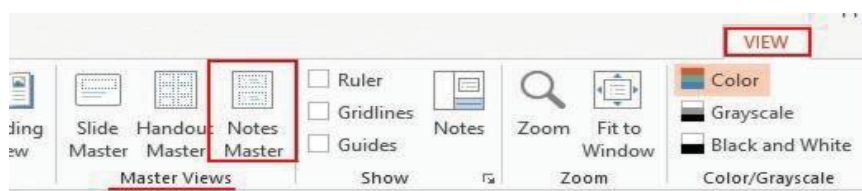
Handout Master

Handout master customizes your presentation and will look as a printing handout. You can choose the design and layout of the handout, such as background formatting and where header/footer will appear.



Notes Master

A presentation may have a notes master part (zero or one). The notes master determines the background elements and default layout of a **notes** page

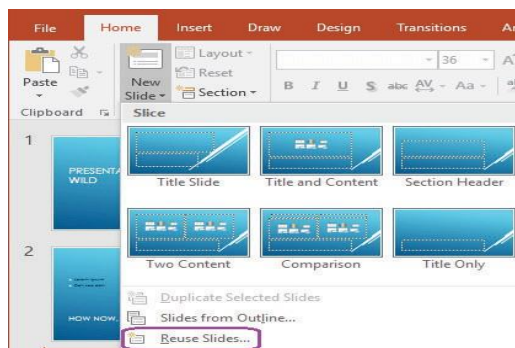


3.4.4 Insert Slides with different layout.

One or more slides can be added in a presentation easily

Following are the steps.

- Open MS Power point.
- Under the Home tab.
- Click on New Slides
- Select the desired layout of a slides.
- The slide will be inserted.



Remember

Duplicate slide can be added by copy and paste the existing slide again.

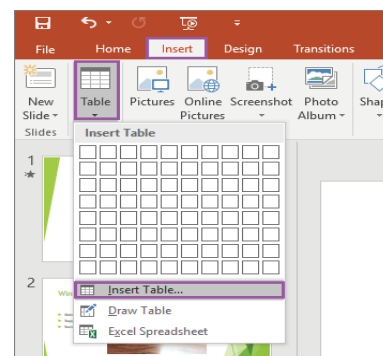
3.4.5 Insert Table picture, Picture, Text Box, Shape and Action Button.

Insert Table:

Add table in your slide

Following are the steps.

- Open MS Power point.
- Under the Insert tab.
- Click on tables
- Select the desired rows and columns
- The table will be inserted.

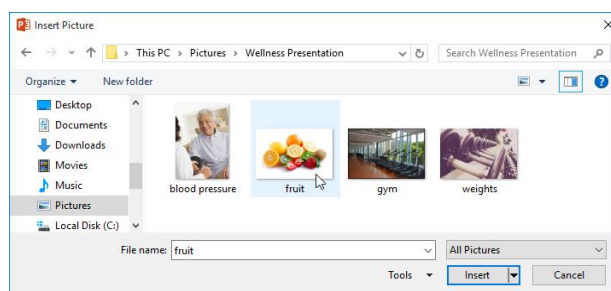
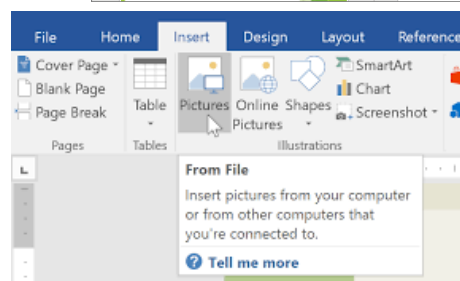


Insert Picture

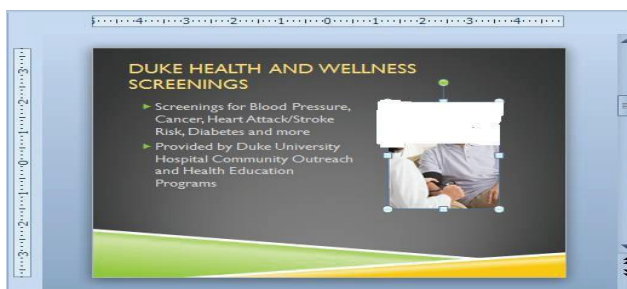
Add picture in you slide

Following are the steps.

- Open MS Power point.
- Under the Home tab.
- Click on picture
- Select the desired image file, then click inset.

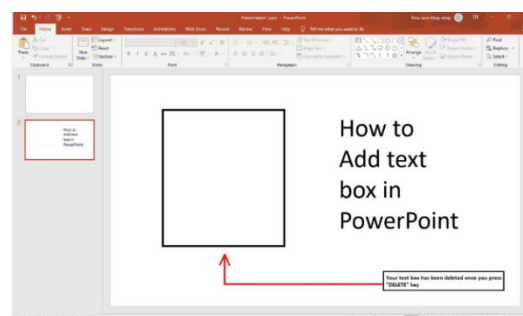


- v. The picture will appear in your slide



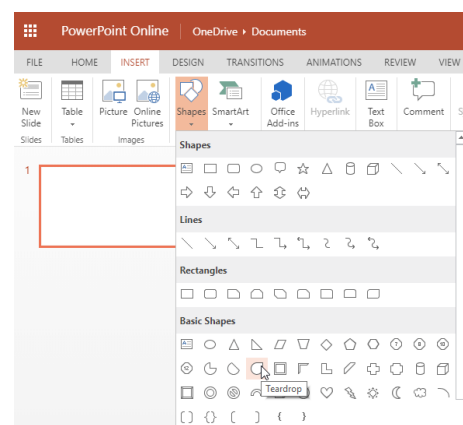
Insert Textbox

- i. Open MS Power point.
- ii. Under the Insert tab.
- iii. Click on text box
- iv. Select the desired rows and columns
- v. The table will be inserted on insert tab
- vi. Select



Insert Shape

- i. Open MS Power point.
- ii. Under the Insert tab.
- iii. Click on shapes
- iv. Select the desired shape and insert shape
- v. The shape will be inserted

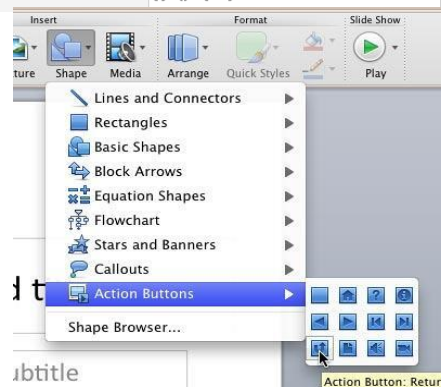


Action Button

Action buttons are built-in shapes you can add to a presentation and set to link to another slide, play a sound, or perform a similar **action**.

Insert Design and Backgrounds

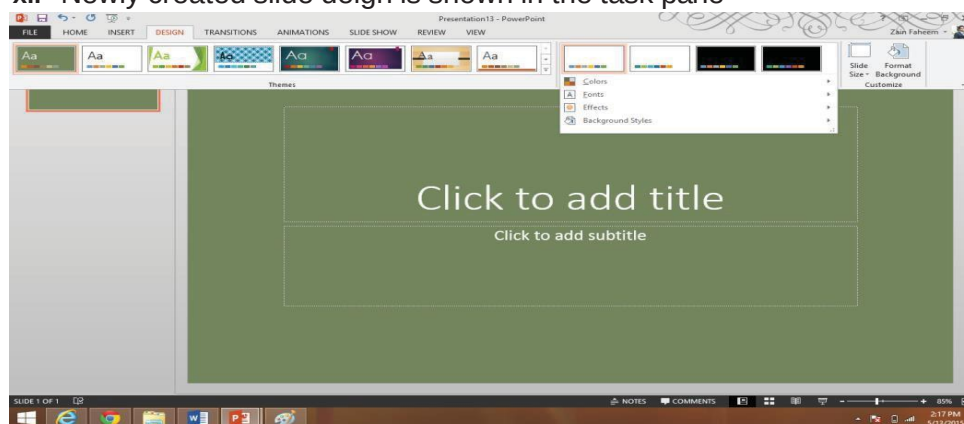
- i. Open MS Power point.
- ii. Under the design tab.
- iii. Click the theme and choose appropriate theme from the available list or add new theme from the saved file.



- iv. For creation of new theme select customize background option and choose on choice background form the list.

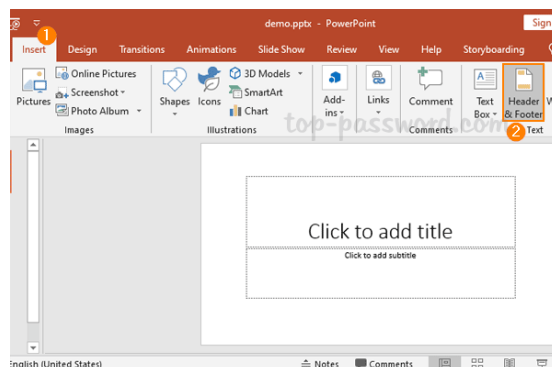


- v. Click the variant option.
- vi. Click Font and select appropriate font
- vii. Click Color and select suitable color scheme
- viii. Click Background styles and select desired background
- ix. Click Effect and select appropriate effect
- x. Click size of the Slide, it shows two **options, choose one option**
- xi. Newly created slide design is shown in the task pane



Insert header/footer, date and numbering to slides

- i. Open MS Power point.
- ii. Under the Insert tab.
- iii. Go text group
- iv. Click on header and footer
- v. Select header and footer
- vi. In header and footer also mention time and date



3.4.6 Apply a set of effects to animate the slide

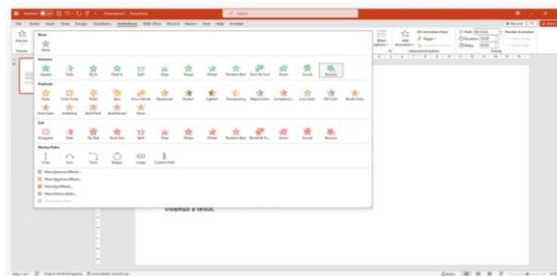
Animation

Animations are visual effects applied to individual items on the slide such as graphics, titles or bullet points. Animation can help to make a PowerPoint presentation more dynamic, visually interesting, automation and to grab the audience's attention. The most common types of animation effects include entrances, exits, emphasis and motion paths.

Applying an Animation to slides

- i. Select the text or object to apply animation
- ii. Click the animations tab from main menu
- iii. Click an animation effect from the animation group gallery.
- iv. Click the more arrow to see more options
- v. Animation applied to the object.
- vi. Click Effect options and select the effect to, how animation have effects.

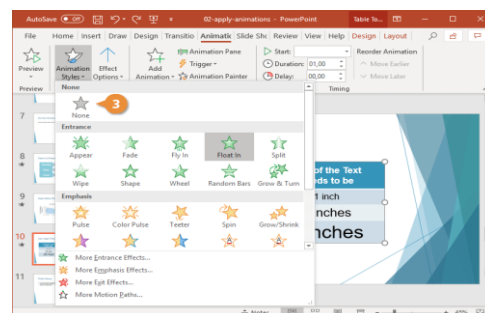
To specify the timing of the effects, on the **Animations** tab, use the commands in the **Timing** group



Perform custom Animation on one slide

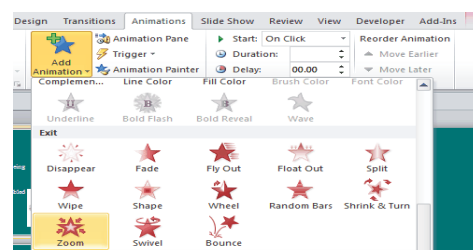
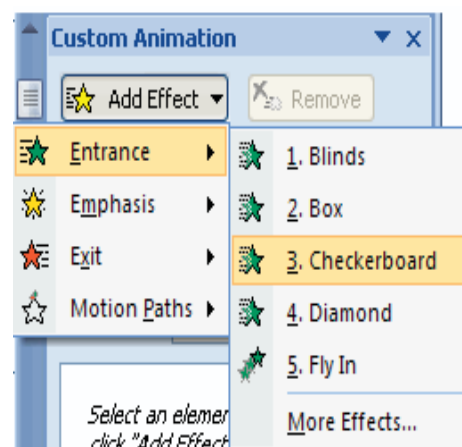
Custom animation allows you to consider the objects or the text boxes in a slide, one at a time, and to animate them as desired by the person not as given in the software.

- i. Select the slide to which the animation is to be applied.
- ii. Select the animations tab and the animation group.
- iii. Click on custom animation.
- iv. Click add Effect.



A menu appears with a list of effect categories.

- i. Entrance effects control how the element enters the slide.
- ii. Emphasis effects make the element do something after it enters the slide.
- iii. Exit effects control how it leaves the slide.
- iv. Motion paths allow you to specify where the element travels on the slide.
- v. Select one of the effects. Details about the effect appear in the Animation Pane.
- vi. In the Start field, use the drop-down menu to select an event which will trigger the animation.
- vii. In the Direction field, use the drop-down menu to select a direction for the animation. The significance of the direction depends on animation type.
- viii. In the Speed field, use the drop-down menu to select a speed for the animation.

**3.4.7 Apply Sound Effects**

Power Point supports multimedia in the slides. You can add audio or video clips to the slides which can be played during the presentation.

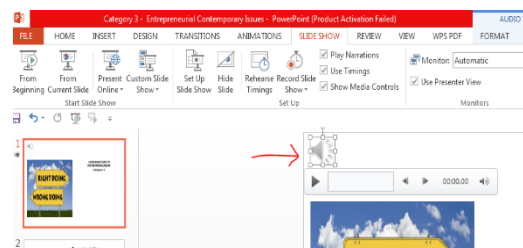
The following steps will help you add audio or video file to the slides.

Step - 1

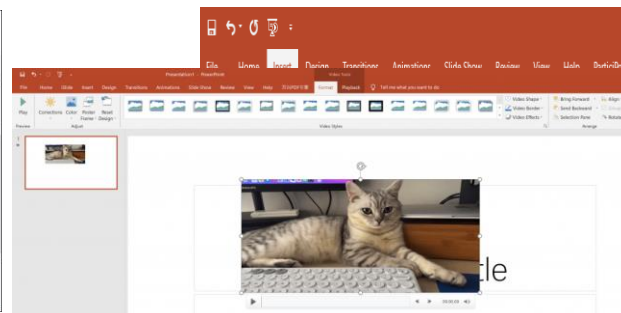
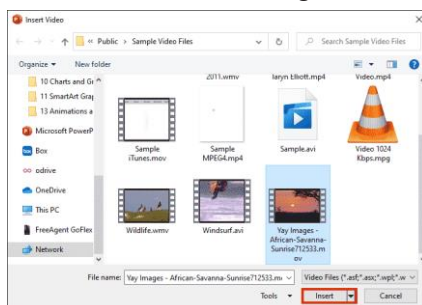
Go to the **Media** group under the **Insert** ribbon

Step - 2

To insert video file, select **Video** as media type and **Video from File** to insert a video from your computer or hard drive.

**Step – 3**

In the **Insert Video** dialog, browse for a video file and click Insert.

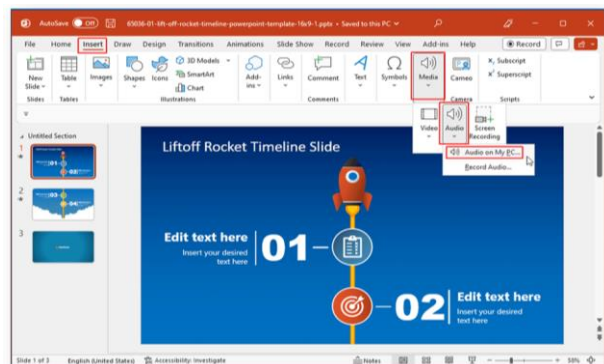


Step - 4

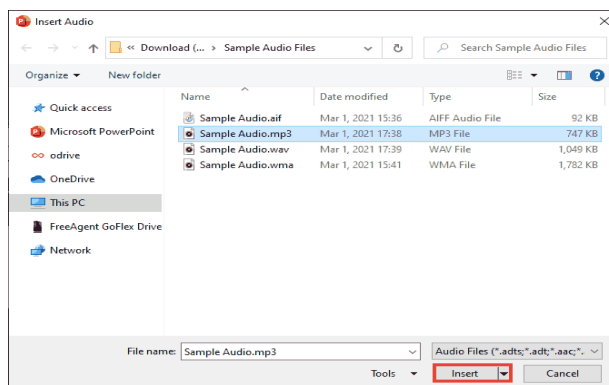
You will now see that a Video file is added to the slide

Step - 5

To insert audio file, select **Audio** as media type and **Audio from File** to insert an Audio from your computer or hard drive.

**Step - 6**

In the **Insert Audio** dialog, browse for an audio file and click **Insert**



Activity1:

Practice of inserting slides different layout according to the requirement of presentation.

Practice inserting slides with different layouts based on the presentation's needs. The task will be considered successful if students can:

Select appropriate slide layouts (e.g., Title, Content, Two Content).

Insert at least five slides with varied layouts.

Ensure clear and balanced formatting for readability and visual appeal.

Activity 2:

Practice of inserting text, tables, images into the slides.

Practice inserting and formatting text, tables, and images into slides. Success is measured by the ability to:

Format text with proper font size, style, and alignment.

Insert tables with clear data and correct alignment.

Add and position images to enhance visual appeal and clarity.

Activity 3:

Practice of applying effects, slide transition and sound effects according to requirement.

Practice applying effects, slide transitions, and sound effects based on presentation requirements. Success is measured by the ability to:

Apply appropriate slide transitions for smooth progression.

Use visual effects to enhance key elements (text, images).

Add relevant sound effects to match the presentation's tone and content.

SUMMARY

This module provides a comprehensive understanding of computer systems, from basic hardware and software management to more advanced tasks like troubleshooting and system configuration.

In MS Word, learners will become proficient in creating, formatting, and managing documents, including applying styles, inserting tables, and preparing documents for printing.

In MS Excel, they will be trained to organize, analyze, and present data using spreadsheets, including working with formulas, charts, and graphs to display data effectively.

Trainees will learn to craft professional presentations in MS PowerPoint, incorporating various multimedia elements such as text, images, animations, and transitions to create engaging, dynamic slideshows.

FAQs:**1. What are the Peripheral devices?**

Ans. A computer peripheral is an external device like a keyboard, mouse, or printer that provides input and output for the computer.

2. What is application software?

Ans. Application software is used in offices, homes, and schools to perform specific tasks, such as word processing, spreadsheets, databases, and graphics software.

3. What is the right way to uninstall a program?

Ans. The proper way to uninstall a program is by using the uninstall routine provided with the program or through the control panel.

4. What does scanning means?

Ans. Scanning a computer means detect and remove viruses and malwares from the computer.

5. What are computer viruses or bugs?

Ans. Computer viruses are small programs designed to spread between computers and disrupt their functioning.

6. What is external mass storage?

Ans. External mass storage devices are removable devices connected to a computer via a network or cable, like hard drives, USB flash drives, CDs, and floppy disks.

7. What is software troubleshooting process?

Ans. Software troubleshooting begins by identifying the problem, checking potential causes, and then finding solutions through measures and alternatives.

8. How do you save a document in Microsoft Word?

Ans. To save a document for the first time, press Ctrl+S, click the Save button on the Quick Access toolbar, or select Save from the File tab, all of which open a dialog box to name the document.

9. How do you format text, change font, and font size?

Ans. To format text, go to the Font group on the Home tab and click Bold, Italic, or Underline. To change the font and size, click the Font arrow for available fonts, then select the desired font size.

10. Describe way of creating a new table.

Ans. Click the Insert tab of ribbons and then click on down arrow of tables and select the number of columns and rows as desire. New table will be inserted

11. How do you save a spreadsheet in Microsoft Excel?

Ans. Click the Save button on the Quick Access toolbar or press Ctrl+S; then designate the drive and folder directory where the file should be located.

12. How do you format cells in a spreadsheet?

Ans. First, you highlight the entire block of cells you wish to format. You then can either right click the block of cells to format or select one of the formatting buttons on the toolbar.

13. What is a worksheet functions?

Ans. To apply formula in Excel a command name is known as functions. There are many categories of functions. For example, to add up values we use "SUM "function.

14. What type of data can be inserted in slides of Power point.

Ans. You can insert text, tables, which may contain text, graphics, sound, movies, hyperlinks, and other objects.

15. How do you create a new presentation?

Ans. You would click the Office button to open the File menu and choose New to display the New Presentation window. Double-click Blank Presentation to open a new presentation based

on the blank template.

16. How do you select and apply Theme colors?

Ans. Go to the Design tab and locate the Themes group. Hover over a theme to see a preview of it in the presentation. Click a theme to apply it to the slides.

MCQs:

Question	Option A	Option B	Option C	Option D
1. Identify the device through which data and instructions are entered into a computer	Software	Output device	Input device	Memory
2. The output shown on the computer monitor is called	VDU	Hard copy	Soft copy	Screen copy
3. Tabs stop position cannot be the following alignment?	Decimal Alignment	Center Alignment	Bar Alignment	Justify Alignment
4. How many maximum numbers of columns can be inserted in the word document?	45	50	55	63
5. With which of the following all formulas in excel starts?	/	*	\$	=
6. If you press ____, the cell accepts you typing as its contents?	Tab	Ctrl+Enter	Enter	Alt+Enter
7. Material consisting of text and numbers is best presented as	A table slide	A bullet slide	A title slide	All of the above
8. Which file format can be added to a power point show?	jpg	gif	wav	All a, b &c
9. To spell check which function key you will press?	F5	F6	F7	F8
10. Which of these toolbars allows changing of Fonts and their sizes?	Standard	Formatting	Options	None of above
11. Ctrl + D is short cut used for?	Open Dialogue Box	Font Dialogue Box	Save as Dialogue Box	Save Dialogue Box

12. Where can you find the horizontal split bar on MS Word screen?	On the top of vertical scroll bar	On the bottom of vertical scroll bar	On the left of horizontal scroll bar	On the right of horizontal scroll bar
13. The printed output from a computer is called	Copy	Soft copy	Hard copy	Paper

Answer Key

1	2	3	4	5	6	7	8
C	C	D	D	D	C	A	D
9	10	11	12	13			
C	B	C	B	C			

Module 4	Perform Basic Manual Drawing
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Learning Outcomes:

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

- Perform Freehand Sketching
- Draw Geometrical Sketches

Learning Unit 4.1	Perform Freehand Sketching
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Learning Outcomes

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

- Arrange drawing tools
- Prepare and proportionate drawing sheet
- Draw different types of lines
- Draw different objects
- Draw Orthographic Views of simple shapes(freehand)
- Draw both sides of paper

4.1.1 Techniques of Free Hand Sketching.

Freehand sketching is the practice of drawing without the use of guiding instruments like rulers or templates. This technique fosters creativity and personal expression, allowing artists to capture the essence of their subjects in a spontaneous manner.

Fundamental Techniques of Freehand Sketching:

- i. **Contour Drawing:**
Focuses on capturing the outline of a subject without lifting the drawing tool, emphasizing the subject's shape and proportions.
- ii. **Gesture Drawing:**
Aims to convey movement and posture through swift, fluid lines, often used to depict living subjects in action.
- iii. **Hatching and Cross-Hatching:**
Involves drawing parallel lines (hatching) or intersecting lines (cross-hatching) to create shading, depth, and texture.
- iv. **Stippling:**
Utilizes numerous small dots to build up shading and texture, offering a unique tonal effect.
- v. **Scribbling:**
Employs rapid, random strokes to convey energy and spontaneity, often used in preliminary sketches.

- **Rotate the Paper:** When drawing lines that are not parallel to the paper's edges, rotate the paper to position the line vertically or horizontally in front of you. This technique makes it easier to draw lines accurately.
- **Sketch Lightly:** Begin with light, gentle strokes to outline your drawing. This allows for easy adjustments before finalizing the sketch with darker lines.

Remember

Sketch daily to improve control & observation skills
Store sketches carefully

By consistently practicing these techniques and tips, you can enhance your freehand sketching abilities, leading to more accurate and expressive drawings.

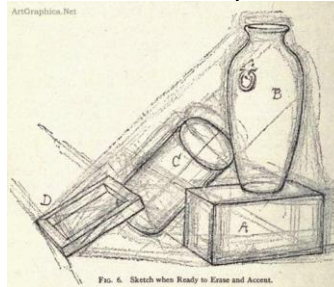


FIG. 6. Sketch when Ready to Erase and Accent.



4.1.2 Drawing tools

Artists and designers utilize a variety of drawing tools to bring their creative visions to life. These tools can be broadly categorized into traditional and digital mediums, each offering unique capabilities and experiences.

- Pencils:** Available in various grades from hard (H) to soft (B), pencils are fundamental for sketching and detailed work.



- Charcoal:**

Charcoal pencils are used for drawing, sketching, and creating expressive marks. They're a popular medium because they're responsive, produce rich tones, and can be easily blended and erased.

Uses

- **Detailed drawings:** Charcoal pencils are good for detailed drawings because of their point.
- **Quick sketching:** Charcoal is a fast and responsive medium that's good for quick

sketching.

- **Shading:** Charcoal pencils can be used to create highlights and shadows.
- **Contour hatching:** Follow the curved lines of an object to add depth and tone.



Remember

Wax-based pencils are softer and easier to blend while oil-based are firmer and more durable

Do you Know

Artist grade pencils richer pigments and bolder lines than student grade pencils

iii. Ink Pens:

Ink pens are primarily used for writing and drawing on paper, allowing users to apply ink to a surface for note-taking, letter writing, creating art. It provides precision and bold lines, suitable for detailed illustrations and technical drawings



iv. Erasers:

Essential for correcting mistakes and refining sketches; types include rubber and kneaded erasers.



- v. **Blending Stumps:** Used to smudge or blend graphite and charcoal, creating smooth gradients.



Remember

- Use a light touch
- Working in layers
- Use different sides
- Clean regularly
- Avoid over-blending

- vi. **Rulers and T-Squares:** Assist in drawing straight lines and accurate measurements; T-squares are specifically used for horizontal lines on drafting tables.



Remember

- Always align it properly for precise measurements
- Held firmly to prevent slipping
- Metal or wooden T-Square are more durable

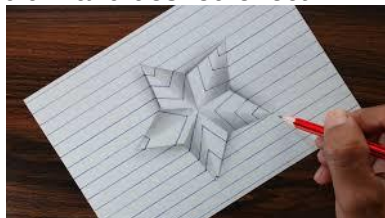
- vii. **Compasses and Protractors:** Essential for drawing circles, arcs, and measuring angles, commonly used in geometric and technical drawings.



Remember

- Keep the needle sharp for stability and accuracy
- A clean protector makes alignment easier

- viii. **Drawing Paper:** Comes in various textures and weights, chosen based on the medium and desired effect.



4.1.3 Drawing Materials

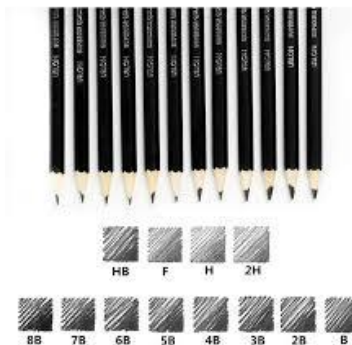
Drawing materials vary based on the medium and style you prefer. Here are some common materials:

Basic Drawing Materials:

- **Pencils:** Graphite pencils (H, HB, B grades)

Teaching and Learning Guide: Information Technology (CAD) **AutoCAD**

The accuracy and appearance of a drawing depend very largely on the quality of the pencils used. With cheap and low-quality pencils, it is very difficult to draw lines of uniform shade and thickness. The grade of a pencil lead is usually shown by figures and letters marked at one of its ends. Letters HB denote the medium grade, beginning of a drawing should be made with H or 2H pencil using it very lightly, so that the lines are faint, and unnecessary or extra lines can be easily erased. The final fair work may be done with harder pencils, e.g. 3H and upwards. Lines of uniform thickness and darkness can be more easily drawn with hard-grade pencils. H and HB pencils are more suitable for lettering and dimensioning. For freehand sketching, erasing is required to be such as HB should be used.

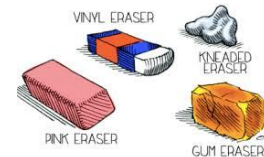


Remember

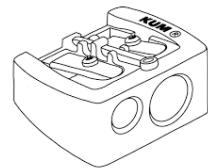
- H(Hard) Pencils, lighters, finer lines and harder lead.
- B(Black) Pencils, Softer, Darker Linens good for shading.
- HB&F Middle ground pencils, balanced between harder and darker

where considerable done, soft-grade pencils

- **Erasers:** Soft erasers is the most suitable kind of eraser for pencil drawings. It should be such as not to spoil the surface of the paper. Frequent use of rubber should be avoided by careful planning.



- **Sharpener:** Manual or electric
A pencil sharpener is a tool for sharpening a pencil's writing point by shaving away its worn surface. Pencil sharpeners may be operated manually or by an electric motor.



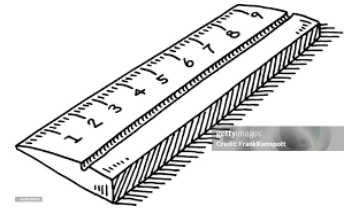
- **Paper:**
Drawing papers are available in many varieties. For ordinary pencil-drawings, the paper selected should be tough and strong. It should be uniform in thickness and as white as possible.

Sheet designation	Trimmed size (mm)	Untrimmed size (mm)
A0	841 × 1189	880 × 1230
A1	594 × 841	625 × 880
A2	420 × 594	450 × 625
A3	297 × 420	330 × 450
A4	210 × 297	240 × 330
A5	148 × 210	165 × 240

Remember

- A5-A6 good for quick sketches
- A4-A3 ideal for detailed drawings
- A2-A1-A0 best for posters, Technical Drawings or large-scale art

- **Ruler:** For precise lines and measurements
Scales are made of wood, steel, celluloid or plastic or card board. Stainless-steel scales are more durable. Scales may be flat or of triangular cross-section.



Advanced Drawing Materials:

- **Colored Pencils:**
Colored pencils can be used to create art by layering colors, shading, and creating texture.
- **Pastels:**
Two types of pastels are commonly used, dry/soft pastels, oil pastels. Soft pastels are best applied to paper or card with texture as the friction this offers makes it easier to deposit colour and hold it in place. Special pastel papers and cards allow for a greater number of layers to be applied.
- **Ink Pens:**
Common ink pen types include ballpoint pens, fountain pens, gel pens, which each have distinct ink flow and writing characteristics.
- **Markers:**
Markers can be used for drawing, coloring, and creating illustrations.

Remember

White enhances pastels softness while gold adds warmth and a touch of luxury.

4.1.4. Types and Weight of Lines

- **Thin Lines:** Used for details, textures, and light outlines.
- **Thick Lines:** Used for defining main shapes, contours, and depth.
- **Tapered Lines:** Often used in dynamic sketches, calligraphy, or expressive drawings.

AUTOCAD IMPORT	REVIT LINES	
		1 - 0.10mm
		2 - 0.22mm
		3 - 0.35mm
		4 - 0.5mm
		5 - 0.7mm
		6 - 1.0mm
		7 - 1.4mm
		8 - 2.0mm
		9 - 3.0mm

4.1.5 Types of Line Thickness in Drawing

- **Contour Lines:** Medium to thick, outlining objects.
- **Construction Lines:** Very light (thin and often erased later).
- **Cross-Contour Lines:** Medium, follow the shape's form to add depth.
- **Hatching & Cross-Hatching:** Thin lines for shading and texture.
- **Gesture Lines:** Varying thickness for expressive movement.

Remember

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

4.1.6 Seal / Title Strip/Block

In engineering drawings, a **title block** is an essential element that provides critical information about the drawing and the part or assembly it represents. Typically located in the lower right corner of the drawing sheet, the title block includes details such as:

- **Drawing Number:** A unique identifier for the drawing.
- **Title or Description:** The name or description of the part or assembly depicted.
- **Company or Organization Name:** The entity responsible for the drawing.
- **Scale:** The ratio of the drawing's dimensions to the actual object's dimensions.
- **Drawing Size:** The standard size designation of the drawing sheet.
- **Projection Method:** The type of projection used (e.g., first-angle or third-angle), often shown symbolically.
- **Drafter and Approvals:** Names or initials of the drafter, checker, approving officer, and dates of actions.
- **Material Specifications:** The material from which the part is to be made.
- **Revision Information:** Revision number or letter indicating the drawing's version.
- **Sheet Number:** If part of a multi-sheet set, the specific sheet's number.

Remember

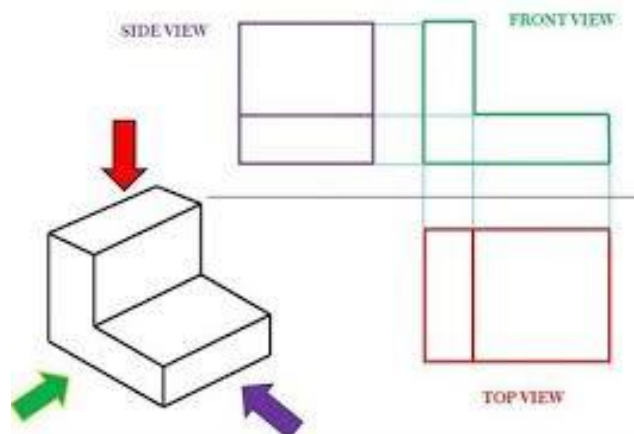
- Seal block contains crucial details like project name, drawing title, drawing no. revision history and date
- Must be clear and readable typically placed in the bottom right corner for

Title Block

	Name	Date	Training Institute Name
Drawn By			
Checked By			
Drawing No.	Drawing Name		Scale

4.1.7 Introduction to Orthographic Projections

Orthographic projection is a method of representing three-dimensional objects in two dimensions. It is widely used in engineering, architecture, and technical drawing to create accurate and scalable representations of objects. An orthographic projection consists of 3 orthographic views: the front view, the top view, and the side view.



Learning Unit 4.2**Draw Geometrical Sketches****Learning Outcomes**

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

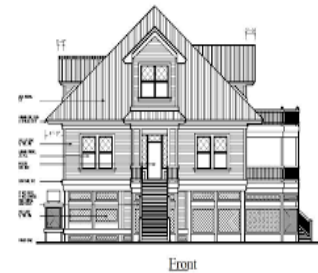
- Arrange drawing tools and sheet
- Draw isometric views of Basic geometrical shapes and curves (using tools).
- Recycle drawing papers

4.2.1 Types of views**Types of Views in Technical Drawing**

In technical and engineering drawings, different types of views are used to represent objects accurately. These views help in understanding the shape, size, and features of an object from different perspectives.

a) Principal Views**i. Front View (Elevation):**

- Shows the height and width.
- The most descriptive view of an object.

**ii. Top View (Plan):**

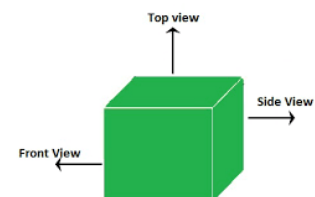
- Shows the width and depth.
- Viewed from directly above.



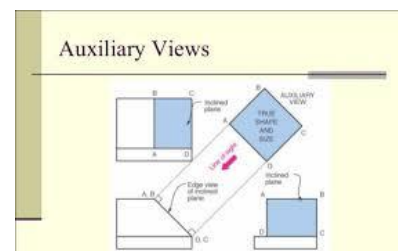
shutterstock.com - 675002338

iii. Side View (Profile View):

- Shows the height and depth.
- Can be left or right-side view.

**b) Auxiliary Views**

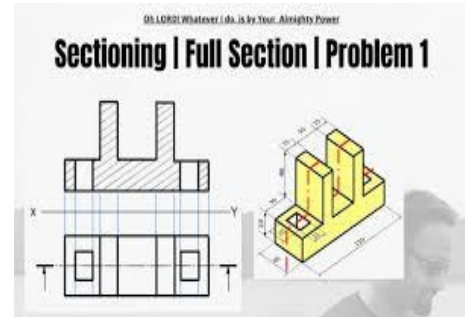
- Used to show inclined or slanted surfaces more accurately.
- Often used when principal views don't provide enough detail.



c) Sectional Views

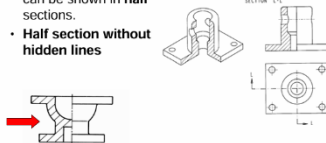
Used to show internal features by cutting through an object.

- Full Section: Cuts through the entire object.
- Half Section: Cuts through half of the object.
- Offset Section: Used for complex objects with multiple internal features.

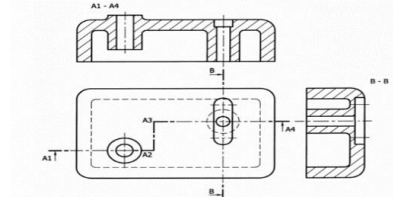


Half Section

- Symmetrical parts can be shown in **half** sections.
- Half section without hidden lines



Offset Section



d) Pictorial Views

- Represent objects in 3D for better visualization.



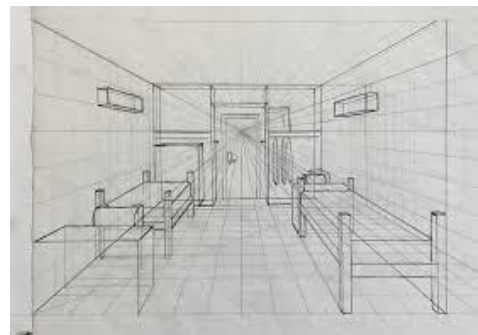
e) Isometric View

- Uses 30° angles to represent the object.
- Dimensions are proportional but not distorted.

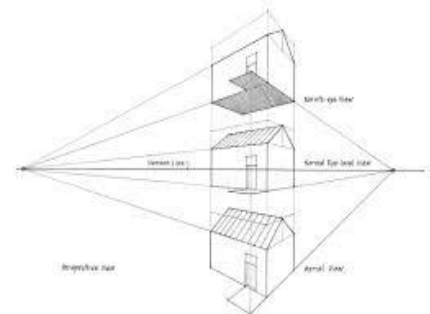
f) Perspective View

- Mimics how the human eye sees objects.
- Used in architecture and product design.

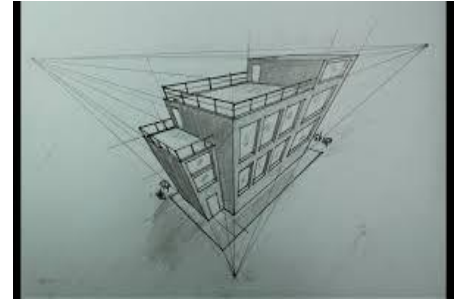
- **One-Point Perspective:** All lines converge at one vanishing point.



- **Two-Point Perspective:** Two vanishing points are used.



- **Three-Point Perspective:** Used for very realistic 3D effects.

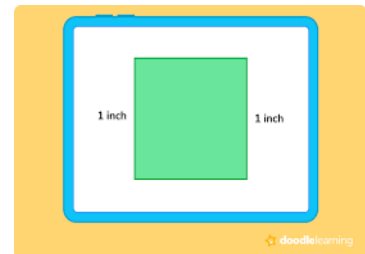


4.2.2 Geometrical shapes

Geometric shapes are mathematical shapes. They are perfect and regular. They are characterized by straight lines, angles and points. An exception to this would be a perfect circle as it has no straight lines or points. Other geometric shapes are squares, rectangles, triangles, parallelograms, hexagons etc.

- **Square.**

Square is one of the most common two-dimensional shapes with 4 sides of equal length.



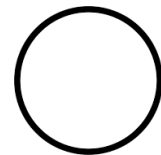
- **Rectangle**

A polygon with four sides and four right angles is called a **rectangle**. It has two parallel sets of sides, and the lengths of the opposite sides.



- **Circle**

A **circle** is a two-dimensional shape with a closed boundary. It has a round shape without any corners or lines.

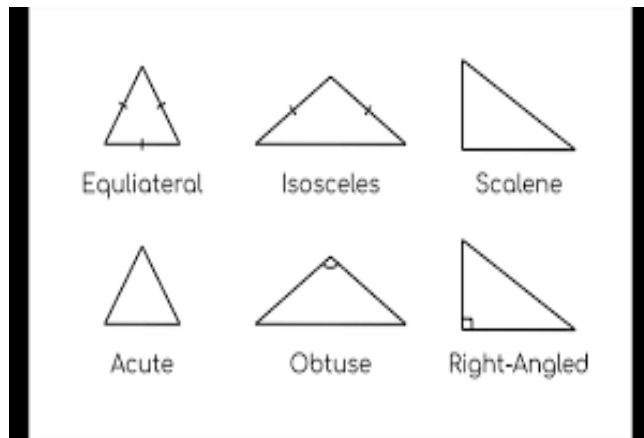


- **Triangle**

Just like a circle, the **triangle** is also a closed two-dimensional figure. However, it contains 3 sides.

There are some types of triangles listed below.



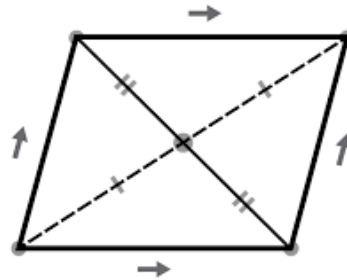


Remember

- **Radius (r)** – Distance from the center to any point on the circle.
- **Diameter (d)** – The longest chord, passing through the center.
- **Circumference (C)** – The perimeter of the circle.
- **Area (A)** – The space inside the circle

• Parallelogram

The term “**parallelogram**” refers to a four-sided polygon with two sets of parallel sides. It has opposite sides equal in length and opposite.

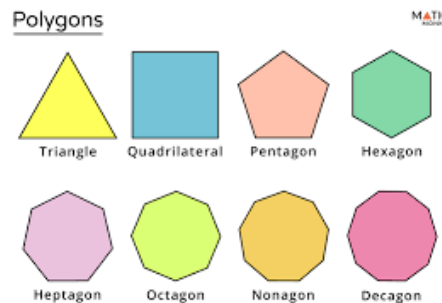


Remember

- **Opposite Sides:** Both pairs are parallel and equal in length.
- **Opposite Angles:** Equal in measure.
- **Consecutive Angles:** Adjacent angles are supplementary, summing to 180° .
- **Diagonals:** They bisect each other, dividing the parallelogram into two congruent triangles

• Polygons

A polygon is any 2-dimensional shape formed with straight lines. Triangles, quadrilaterals, pentagons, and hexagons are all examples of polygons. The name tells you how many sides the shape has. For example, a triangle has three sides, and a quadrilateral has four sides.



Remember

- **Regular Polygon:** All sides and interior angles are equal (e.g., equilateral triangle, square).
- **Irregular Polygon:** Sides and/or interior angles are not all equal.

Activity1:

Teaching and Learning Guide: Information Technology (CAD) **AutoCAD**

Practice to draw different objects.

Activity2:

Practice to draw elevations and top view of the objects/drawing (isometric die metric and oblique)

Activity3:

Practice to draw isometric/oblique views of different geometrical/angular shapes

SUMMARY

Performing basic manual drawing involves fundamental techniques such as understanding of shapes & lines, hand control & grip on pencil correctly for smooth strokes and better precision, shading & textures, hatching, cross-hatching, and blending to create depth, proportions & perspective and maintain correct proportions and use vanishing points for perspective drawing.

FAQs:

1. Write any four types of geometrical shapes?

Ans: Circle, Square, Rectangle, Triangle.

2. Define orthographic projection?

Ans: A method of representing 3D objects in 2D, showing top, front, and side views.

3. What is isometric view?

Ans: A 3D representation where all axes are equally foreshortened and angles are 120° .

4. Write any five tools used in freehand sketch drawing?

Ans: Pencils, Erasers, Rulers, Compass, Protractor.

5. Write types of triangles?

Ans: Equilateral, Isosceles, Scalene, Right-Angle, Acute, Obtuse.

6. What is the purpose of creating a seal block in technical sheets?

Ans: It validates the drawing by showing approval or certification.

7. Name the types of polygons.

Ans: Triangle, Quadrilateral, Pentagon, Hexagon, Octagon, etc.

8. How many types of perspectives are in use?

Ans: One-point, Two-point, Three-point perspective.

MCQs

Question	Option A	Option B	Option C	Option D
1. Which sketching technique uses light, quick strokes to outline the shape before adding details?	Cross-hatching	Contour drawing	Gesture drawing	Blending
2. What tool is commonly used for	Eraser	Tortillon (blending stump)	Ruler	Ink pen

blending in sketching?				
3. Stippling is a technique that involves:	Using parallel lines for shading	Creating tones with tiny dots	Smudging graphite for smooth shading	Drawing with continuous strokes
4. Which type of shading technique creates soft and smooth gradients?	Hatching	Cross-hatching	Stippling	Blending
5. What does the letter "H" on a drawing pencil indicate?	Hardness	Softness	Darkness	Thickness
6. Which pencil is the softest among the following?	2H	HB	4B	6H
7. What does the letter "B" in pencil grading stand for?	Bold	Black	Blending	Basic
8. Which pencil is commonly used for general writing and sketching?	6B	4H	HB	8B
9. What is the primary characteristic of charcoal pencils compared to graphite pencils?	They are harder and lighter	They produce darker and richer blacks	They are more precise and fine-tipped	They are waterproof
10. Which of the following is NOT a type of charcoal pencil?	Soft	Medium	Hard	Mechanical
11. What is the primary use of a T-Square?	Measuring angles	Drawing straight horizontal lines	Cutting paper	Mixing colors
12. In which profession is a T-Square most commonly used?	Architecture and drafting	Medicine	Cooking	Sculpture
13. What is a seal block primarily used for?	Cutting materials	Creating stamped impressions	Measuring angles	Sharpening pencils
14. Which of the following is a plane geometrical figure?	Sphere	Cube	Triangle	Cylinder
15. What is the sum of the interior angles of a quadrilateral?	180°	270°	360°	540°
16. Which of these figures has four	Rectangle	Trapezium	Square	Rhombus

equal sides and four right angles?				
17. What is the primary purpose of orthographic projection?	To create a realistic 3D image of an object	To represent a 3D object accurately in 2D views	To add artistic effects to a drawing	To simplify an object into a single view
18. Which field commonly uses orthographic projection?	Medicine	Engineering and architecture	Music production	Cooking

Answer Keys

1	2	3	4	5	6	7	8	9
C	B	B	D	A	C	B	C	B
10	11	12	13	14	15	16	17	18
D	B	A	B	C	C	C	B	B

Module 5	Develop 2D Drawings in AutoCAD
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Learning Outcomes:

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

- Develop 2D Objects
- Prepare Final Set of 2D Drawings

Learning Unit 5.1	Develop 2D Objects
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After completion of this learning unit, you will be able to:

- Setup user interfaces settings & save drawing interface for required specifications.
- Create 2D objects with given measurements.
- Edit 2D Objects to meet set standards.

5.1.1. Basic Drawings concepts

Types of Drawing

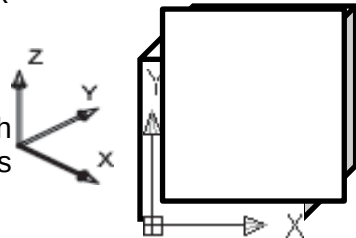
- Two-Dimensional drawing
- Three-Dimensional drawing

5.1.1.1. Two-Dimensional drawing:

A physical object in which length and width are real attributes. Any object can be drawn with respect to x and y coordinates.

5.1.1.2 Three-Dimensional drawing:

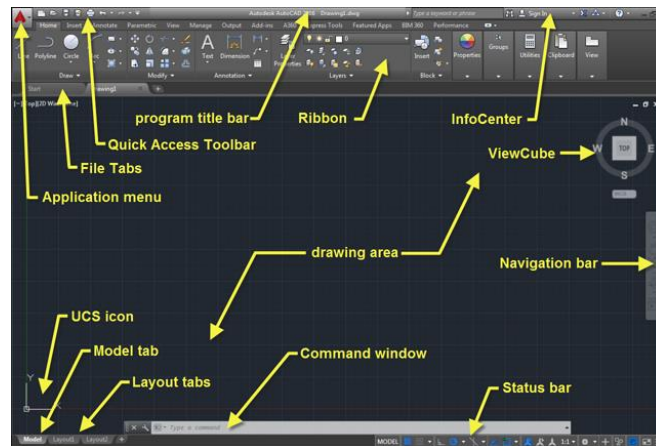
A physical object in which length, width, and depth are real attributes—a model, with X, Y, and Z-axes that can be rotated for viewing from different angles

**5.1.2 AutoCAD Interface Introduction**

AutoCAD is Automatic Computer-Aided Drafting and design (CAD), developed and marketed by Autodesk. AutoCAD was first released in December 1982 as a desktop app running on micro computers with internal graphic controllers. Since 2010, AutoCAD is released as a mobile-and web app as well, marketed as AutoCAD 360. AutoCAD is used in the civil, mechanical, architecture, electrical, electronics and graphic designers.

5.1.3. Introduction of AutoCAD workspaces (screen):

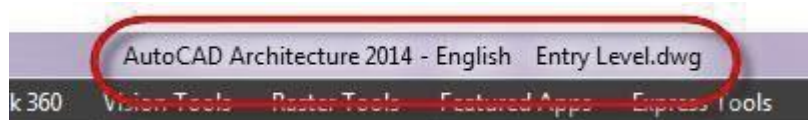
The collection of tools displayed after creating or opening a drawing is called a workspace.



Some useful toolbars are discussed here.

5.1.3.1. Title bar

Title bar is shown on the top of the screen and also include the file name.



5.1.3.2. Quick Access toolbar

It is located to the right of application menu and provides immediate access to some of most frequently used commands to complete tasks such as creating, opening, saving and plotting drawings. The Quick Access toolbar displays options to undo and redo changes to your file, save, print, the most use option can be added in access toolbar.



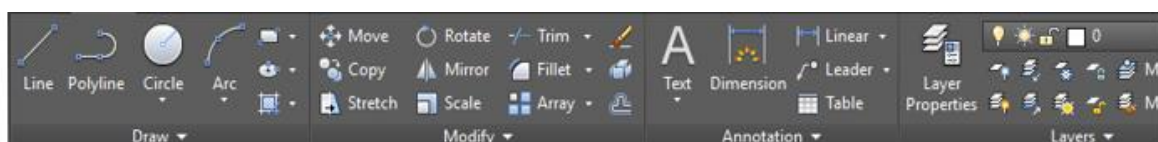
5.1.3.3. Menu Bar or Application Menu

Horizontal bar, typically located at the top of the screen below the title bar. It contains drop-down menus, including File, Edit, Insert, Format, Tools, Draw, Dimension, Modify, Parametric, Window, Help and Express.



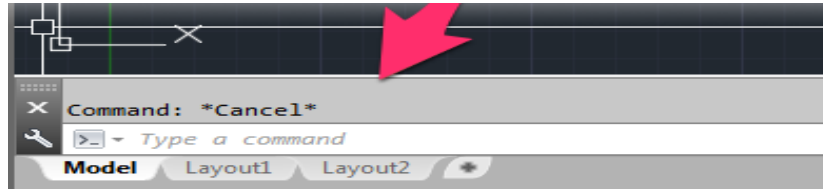
5.1.3.4. Ribbon

Ribbon includes different tabs and groups. It is located immediately below the title bar and serves the primary launch pad for nearly every command used to compose drawings in AutoCAD.



5.1.3.5. Command bar or Command prompt

Command line is located in the bottom left corner of CAD interface. AutoCAD Command line is like a combined control panel and index of all AutoCAD commands you run.



5.1.3.6. Status Bar

Status bar is located below the command line and is shown on the bottom of screen. Status bar has different elements, coordinate values, drawings tool, quick properties, models, layouts, quick view tools, navigation tools, annotation tools workspace and clear screen.

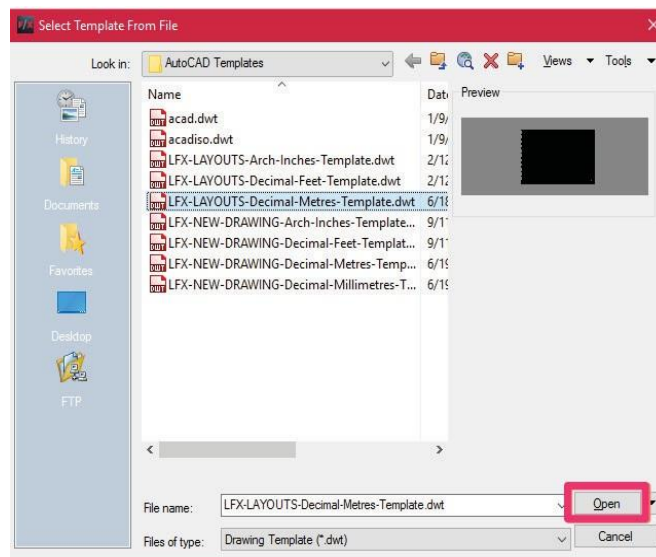
5.1.3.7. Create or Open New File

Create or open new file means to get a new drawing in AutoCAD or learner can also use a template already available in CAD templates library.

5.1.3.8. How to Open templates in AutoCAD

Create New Template: Learner can open or create a template by clicking

File ☐ New ☐ Select Template as shown in the figure.



Remember

Templates: is a pre-define layout available in AutoCAD Software which assist the learner.

5.1.4. Short keys of AutoCAD software

Function Keys

Teaching and Learning Guide: Information Technology (CAD) **AutoCAD**

The Following functions keys are labeled F1 through F11 :

F1	Windows Online Help
F2	Toggle Between Graphic Screen / Text Screen.
F3	Toggle OSNAP setting dialogue box.
F4	Toggle tablet mode on or off.
F5	3 Iso-plane modes to construct isometric drawing.
F6	Toggle the coordinates. On/off.
F7	Toggle the display of Grid on or off.
F8	Toggle to Ortho mode.
F9	Toggle Snap mode on or off. The SNAP command sets the current snap value.
F10	Toggle Polar tracking on or off.
F11	Object snap tracking on or off. Speakers

Here are some commonly used AutoCAD shortcut keys to speed up your workflow:

Ctrl + N → New Drawing	ARC → Arc	SC → Scale
Ctrl + O → Open Drawing	SPL → Spline	MI → Mirror
Ctrl + S → Save Drawing	M → Move	F → Fillet
Ctrl + P → Print/Plot	CO (or CP) → Copy	CH → Chamfer
L → Line	O → Offset	STRETCH → Stretch
C → Circle	TR → Trim	Z → Zoom
REC → Rectangle	EX → Extend	P → Pan
PL → Polyline	RO → Rotate	LA → Layer Manager
LT → Line type Manager	LE → Leader	Ctrl + Y → Redo
MA → Match Properties	B → Create Block	Ctrl + C → Copy
T → Single-line Text	I → Insert Block	Ctrl + V → Paste
MT → Multiline Text	X → Explode	Ctrl + X → Cut
DIM → Dimension	Ctrl + Z → Undo	ESC → Cancel Command

5.1.5. Dimensions, Text and Symbols

5.1.5.1 Dimension in AutoCAD

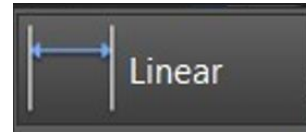
A dimension in AutoCAD is a measurement annotation that shows the size, length, angle, or other geometric properties of an object in a drawing.

Linear Dimension (DIMLINEAR)

Use to measure horizontal or vertical distances.

Procedure:

- Type DIM or DIMLINEAR in the command bar and press Enter.
- Click the first point (start of the dimension).
- Click the second point (end of the dimension).
- Move the mouse to place the dimension line and click to set it.

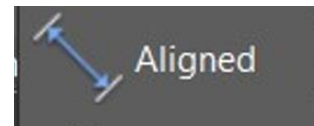


Aligned Dimension (DIMALIGNED)

Use for slanted or diagonal measurements.

Procedure:

- Type DIMALIGNED and press Enter.
- Click the first point of the dimension.
- Click the second point (aligned along the object).
- Move the cursor to position the dimension and click to place it.



Angular Dimension (DIMANGULAR)

Use to measure angles between two lines.

Procedure:

- Type DIMANGULAR and press Enter.
- Select the first line of the angle.
- Select the second line forming the angle.
- Move the cursor to adjust the angle's position and click to place the dimension.



Radial Dimension (DIMRADIUS)

Use to measure the radius of circles or arcs.

Procedure:

- Type DIMRADIUS and press Enter.
- Click on the arc or circle.
- Move the cursor outward to adjust the dimension.
- Click to place the dimension.

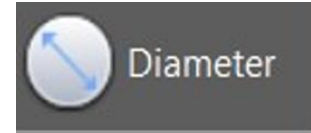


Diameter Dimension (DIMDIAMETER)

Use to measure the diameter of circles.

Procedure:

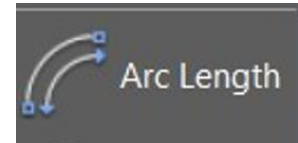
- Type DIMDIAMETER and press Enter.
- Click on the circle or arc.
- Move the cursor outward and click to place the dimension.

**Arc Length Dimension (DIMARC)**

Use to measure the actual length of an arc (not just radius or diameter).

Procedure:

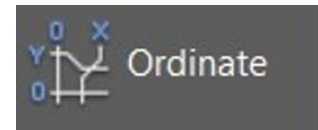
- Type DIMARC and press Enter.
- Click on the arc.
- Move the cursor outward and click to place the arc length dimension.

**Ordinate Dimension (DIMORDINATE)**

Use to display X and Y coordinates of a point.

Procedure:

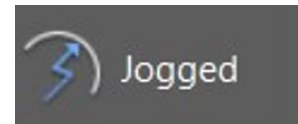
- Type DIMORDINATE and press Enter.
- Click the point you want to measure.
- Move the cursor to place the X or Y coordinate and click.

**Continuous Dimension (DIMCONTINUE)**

Use to create a chain of dimensions.

Procedure:

- First, create a Linear Dimension.
- Type DIMCONTINUE and press Enter.
- Click on the previous dimension's second point.
- Click additional points to continue the dimension chain.

**Leader Dimension (MLEADER / QLEADER)**

Use to create an annotation with a leader line.

Procedure:

- Type MLEADER (or QLEADER for older versions) and press Enter.
- Click the starting point of the leader line.
- Move the cursor and click to place the arrow.
- Type the annotation text and press Enter.

5.1.5.2. DIMEDIT Command in AutoCAD

The DIMEDIT command in AutoCAD is used to modify, rotate, move, or center existing dimensions. It is helpful for adjusting dimension text placement and

appearance without deleting and redrawing dimensions.

Usage of DIMEDIT Command

The DIMEDIT command allows you to perform the following actions:

1. **Home** – Moves the dimension text to its default position.
2. **New** – Allows you to edit and replace the dimension text.
3. **Rotate** – Rotates the dimension text to a specified angle.
4. **Oblique** – Tilts the extension lines of a dimension to match an angled surface.

How to Use the DIMEDIT Command?

1. Move Dimension Text to Default Position (Home)
2. Restores dimension text to its original position.

Procedure:

- Type DIMEDIT and press Enter.
- Type Home and press Enter.
- Select the dimension you want to reset.
- The text will return to its default position.

Edit Dimension Text (New)

Replaces the existing dimension text with new custom text.

Procedure:

- Type DIMEDIT and press Enter.
- Type New and press Enter.
- Select the dimension to modify.
- Type the new text and press Enter.

Example: Instead of "50", you can replace it with "50 mm".

Rotate Dimension Text

Changes the angle of dimension text.

Procedure:

- Type DIMEDIT and press Enter.
- Type Rotate and press Enter.
- Select the dimension to modify.
- Enter the rotation angle (e.g., 45°) and press Enter.

Oblique Dimension Lines

Tilts the dimension's extension lines to match an inclined surface.

Procedure:

- Type DIMEDIT and press Enter.
- Type Oblique and press Enter.
- Select the dimension to modify.
- Enter the oblique angle (e.g., 30°) and press Enter.

5.1.5.3. Text

Text in AutoCAD is essential for adding annotations, labels, dimensions, and descriptions to a drawing. AutoCAD provides two primary text types: Single-Line Text (DTEXT) and Multi-Line Text (MTEXT). These text types allow users to communicate

design intentions clearly.

Single-Line Text (DTEXT)

Single-line text is a basic text entity where each line is independent. It is useful for simple annotations like labels, names, and dimensions.

How to Create Single-Line Text

- Type TEXT or DTEXT in the command line and press Enter.
- Specify the insertion point by clicking anywhere in the drawing.
- Enter the text height (or press Enter to accept the default).
- Enter the rotation angle (or press Enter for default 0°).
- Type the text and press Enter to complete it.
- Press Enter again to exit the command.

Properties of Single-Line Text

- Each line is treated as an individual object.
- No formatting options (like bold, italic, or paragraph spacing).
- Easily movable and editable.
- Best for short text such as room names, part numbers, or simple notes.

Editing Single-Line Text

- Double-click on the text to edit it directly.
- Use the DDEDIT or ED command to modify text.
- Change properties like font, height, and rotation using Properties Palette (Ctrl + 1).

Multi-Line Text (MTEXT)

Multi-line text is more advanced and supports multiple lines in a single text box. It provides formatting options, making it useful for longer annotations, such as project descriptions, instructions, or notes.

How to Create Multi-Line Text

- Type MTEXT and press Enter.
- Click and drag a rectangle to define the text box.
- The Text Editor opens automatically.
- Type the required text inside the text box.
- Format the text using the ribbon (bold, italic, font changes, alignment, etc.).
- Click outside the text box or press Ctrl + Enter to finish.

Properties of Multi-Line Text

- Supports multiple lines, bullet points, and paragraph formatting.
- Allows different font styles and colors within the same text box.
- Can include symbols, fractions, and special characters (%%D for °, %%C for ø).
- More control over alignment, spacing, and text width.

Editing Multi-Line Text

- Double-click on the text to open the M Text Editor.
- Use the PROPERTIES palette (Ctrl + 1) to adjust text height, width, and style.

Text Styles (STYLE Command)

Text styles allow users to standardize text across a drawing by defining font, height, width, and alignment.

How to Create and Modify Text Styles

- Type STYLE and press Enter.
- The Text Style Manager opens.
- Click New to create a new style or modify to change an existing one.
- Choose a Font, set Height, adjust Width Factor, and set Oblique Angle (for slanted text).
- Click Apply and then Close.
- Use TEXT or MTEXT and select the style from the Properties panel.

Common Text Style Settings

- Standard: Default style in AutoCAD.
- Annotative Text: Adjusts size automatically based on drawing scale.
- Bold or Italic Text: Can be achieved by choosing appropriate fonts in the Style Manager.

Converting Text

AutoCAD provides tools to convert text from one form to another.

Converting Single-Line Text to Multi-Line (TXT2MTXT)

- Type TXT2MTXT and press Enter.
- Select the single-line text objects to convert.
- Press Enter to combine them into a multi-line text block.

Exploding Multi-Line Text to Single-Line (EXPLODE)

- Type EXPLODE and press Enter.
- Select an MTEXT object.
- Press Enter to finish.

5.1.5.4. Symbols

AutoCAD uses various symbols to represent different geometric, annotation, and engineering elements. These symbols help in technical drawings, schematics, and architectural plans.

Common AutoCAD Symbols**A. Geometric Symbols**

Symbol	Name	Description
∅	Diameter	Represents the diameter of a circle. Used in dimensions.
R	Radius	Shows the radius of an arc or circle.
∠	Angle	Used to indicate angular dimensions.
⌀	Round	Used to specify circular or rounded features.
Δ	Triangle	Used for datum reference or tolerance zones.

B. Dimension & Annotation Symbols

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Symbol	Name	Description
±	Tolerance	Represents plus/minus tolerance in dimensions.
⌞	Reference	Denotes a reference dimension (not an actual measurement).
⊥	Perpendicular	Indicates a 90-degree relationship between two objects.
//	Parallel	Shows that two lines or surfaces are parallel.
≠	Not Equal	Used in constraints to specify inequality.

C. Architectural & Structural Symbols

Symbol	Name	Description
	Door	Represents a door in floor plans.
	Window	Symbolizes a window in building drawings.
	Roof	Used in elevation drawings to indicate a roof.

D. Electrical Symbols

Symbol	Name	Description
	Ground	Represents electrical grounding.
	Transformer	Symbolizes an electrical transformer.
	Alternating Current (AC)	Used to indicate AC power supply.
	Direct Current (DC)	Represents DC power source.

E. Welding Symbols

Symbol	Name	Description
	Fillet Weld	Specifies a fillet weld.
	Spot Weld	Indicates a spot weld location.
	Seam Weld	Represents a continuous weld seam.

5.1.6. Scale and Paper Sizes in AutoCAD

5.1.6.1. Understanding Scale in AutoCAD

In AutoCAD, drawings are created in real-world dimensions using Model Space, while they are presented and printed at different scales in Layout Space.

Types of Scale in AutoCAD:

- Model Space Scale: Always 1:1 (real-world dimensions).
- Viewport Scale (Layout Space): Controls how the model is displayed in paper space.

Common Drawing Scales:

Scale	Ratio	Used for
1:1	Full Scale	Manufacturing drawings
1:2	Half Scale	Mechanical parts
1:10	10 times smaller	Architectural floor plans
1:50	50 times smaller	Site plans, large buildings
1:100	100 times smaller	City maps, large-scale drawings

How to Set Scale in Viewport (Layout Space)?

1. Switch to Layout and activate a Viewport.
2. Select the Viewport, then choose a scale from the Properties Panel (e.g., 1:50).
3. Lock the Viewport to prevent accidental changes.

5.1.6.2. Paper Sizes

AutoCAD supports different paper sizes based on ISO (A-series) and ANSI standards.

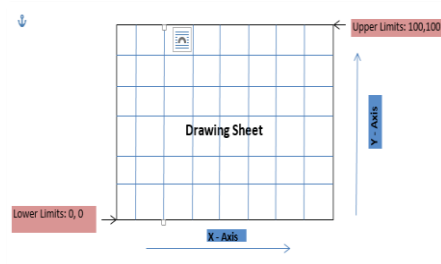
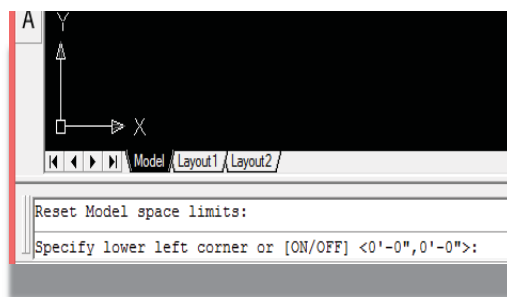
ISO (International Standard) A-Series Paper Sizes

Paper Size	Dimensions (mm)	Dimensions (inches)
A0	841 × 1189	33.1 × 46.8
A1	594 × 841	23.4 × 33.1
A2	420 × 594	16.5 × 23.4
A3	297 × 420	11.7 × 16.5
A4	210 × 297	8.3 × 11.7

5.1.7. Drawing Limits and Units

5.1.7.1. Drawing Limits

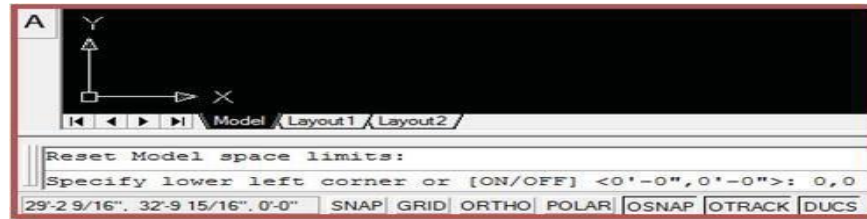
Drawing limits define the drawing boundaries, usually matching the sheet size. In AutoCAD, setting limits correctly helps display the grid over the working area. To show all grid limits, enable the Grid element from the status bar. Drawing Limits define drawing sheet with horizontal and vertical coordinates as shown below.



Procedure

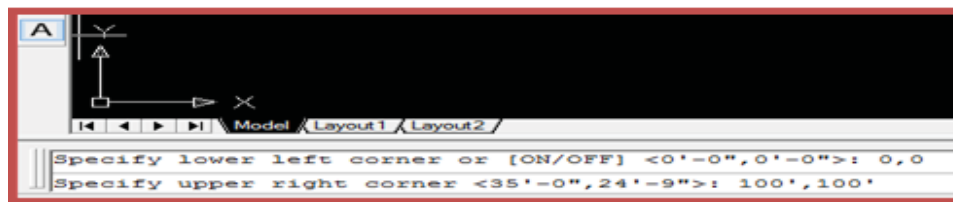
Step-1: Type **limits** command in command bar, you will get the following instructions.

Step-2: Define the lower Left corner as 0, 0



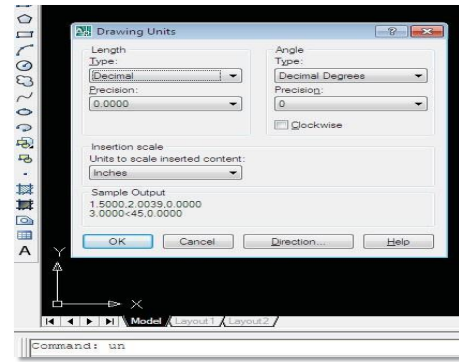
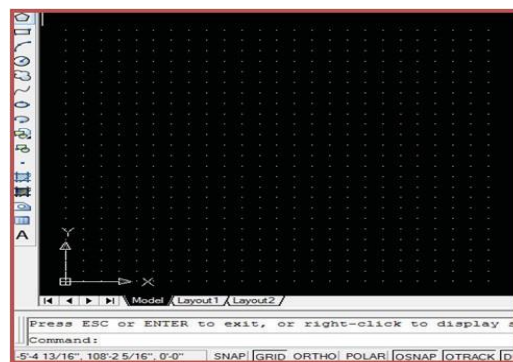
Step-3: Define the Upper Right corner as 100-feet, 100-feet.

Step-4: Grid Display: Now you can see the defined limits to On Grid elements in status bar

**5.1.7.2. Unit Control**

The dialogue box is separated into four main sections.

Length type: Which refers to linear units: Like Decimal, Architectural, Engineering etc.



Angles: Referring to angular units

Precision: Precision is used to help a user to specify the precision value is to be needed for the drawing. Ideally precision value varies in terms of number of zeros after the decimal or fraction values. More Zero after decimal more precision will occur in drawing.

Insertion Scale: Selection of different measurement as per length type, like feet or inches for Architectural drawing.

5.1.8. AutoCAD Commands and Tools

AutoCAD provides a wide range of **commands and tools** for creating, modifying, and annotating drawings efficiently. Below is a categorized list of essential **AutoCAD commands** and their uses.

A. Basic Drawing Commands

Command	Description
LINE	Draws a line between two points
POLYLINE	Creates a connected series of line segments
CIRCLE	Draws a circle
ARC	Creates an arc
RECTANGLE	Draws a rectangle
ELLIPSE	Draws an ellipse

B. Modify Commands

Command	Description
MOVE	Moves objects from one location to another
COPY	Creates a duplicate of selected objects
ROTATE	Rotates selected objects
SCALE	Resizes an object proportionally
MIRROR	Creates a mirrored copy of an object
OFFSET	Creates parallel copies of objects
TRIM	Cuts off parts of an object using another object as a boundary
EXTEND	Extends a line to meet another object
FILLET	Creates a rounded corner between two lines
CHAMFER	Creates a beveled edge between two lines
STRETCH	Stretches a portion of an object

C. Annotation Commands

Command	Description
TEXT	Creates a single-line text
MTEXT	Creates multi-line text
DIMLINEAR	Adds a linear dimension
DIMALIGNED	Creates a dimension aligned with an object
DIMRADIUS	Adds a radius dimension
DIMDIAMETER	Adds a diameter dimension
LEADER	Draws an annotation leader line

D. Layers & Properties Commands

Command	Description
LAYER	Opens the layer manager
LAYISO	Isolates a specific layer
LAYOFF	Turns off selected layers
MATCHPROP	Copies properties from one object to another

E. Blocks & Hatching Commands

Command	Description
BLOCK	Creates a block from selected objects
INSERT	Inserts a saved block
HATCH	Fills a closed shape with a pattern
ARRAY	Creates multiple copies of objects in a pattern

F. View & Navigation Commands

Command	Description
ZOOM	Zooms in or out

PAN	Moves the view without changing zoom
REGEN	Regenerates the drawing to update display

G. Selection & Inquiry Commands

Command	Description
DIST	Measures the distance between two points
ID	Displays the coordinates of a selected point
LIST	Displays properties of selected objects
SELECT	Selects objects in the drawing

H. Advanced & Utility Commands

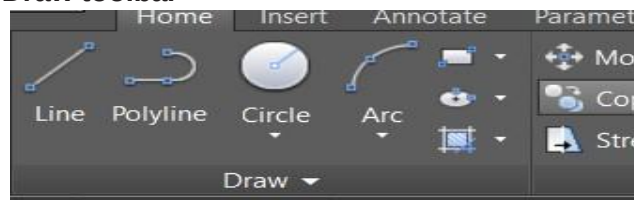
Command	Description
XREF	Attaches external references
PURGE	Removes unused objects from the drawing
AUDIT	Checks for errors in the drawing
RECOVER	Recovers a corrupt drawing file

I. File Management Commands

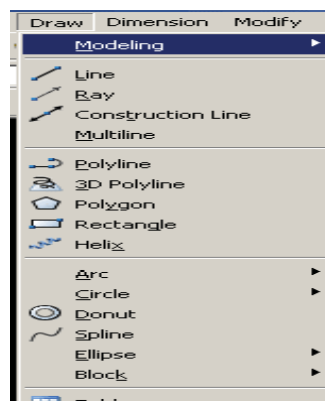
Command	Description
NEW	Creates a new drawing
OPEN	Opens an existing drawing
SAVE	Saves the current drawing
PLOT	Prints the drawing
EXPORT	Saves the drawing in another format

5.1.9. Functions of Creating, Editing and modifying tools

- Draw toolbar



- Draw Menu bar



5.1.10. Line:

Line Command is used to draw straight lines between two defined points.

Draw Manu	Draw Toolbar	Command Entry
Line		Line/L

Remember

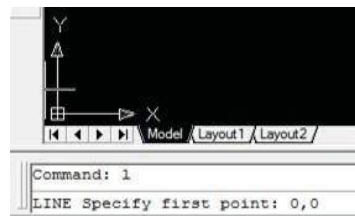
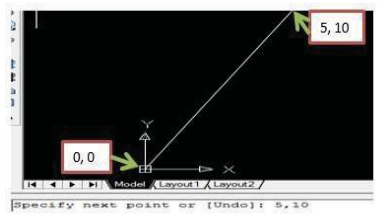
There are six types of lines using drafting AutoCAD

How to draw a line?

Step-1: Type L in command Bar

Step-2: Line Specify First Point: 0, 0 and Press Enter

Step-3: Line Specify Next Point: 5, 10 and Press Enter

**5.1.11. Draw Polyline**

A polyline is a single object composed of line and arc segments.

Methods to Draw a Polyline:

Menu Bar: Draw → Polyline → Click on the icon

Shortcut Key: PL → Ente

Command: PL POLYLINE

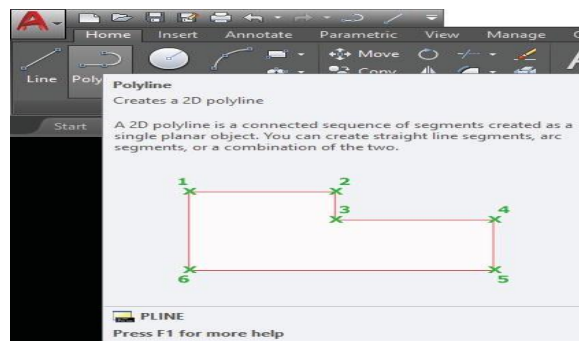
Specify start point: Select the point on the graphic window e.g. 2,2 enter key

Following message will be displayed in command line

Current line-width is 0'-0"

Specify next point or [Arc/Half width/Length/Undo/Width]:

To respond the message, give your options as per requirements as under.



- To draw the Arc type A and press enter **Half width**:
- To draw the halfwidth type H and press **Length**:
- To draw the Arc type L and press enter **Undo**:
- To draw the Arc type U and press enter **Width**:
- To draw the Arc type W and press enter

5.1.12. Draw Spline

Creates a smooth curve that passes through or near a set of fit points, or that is defined by the vertices in a control frame.

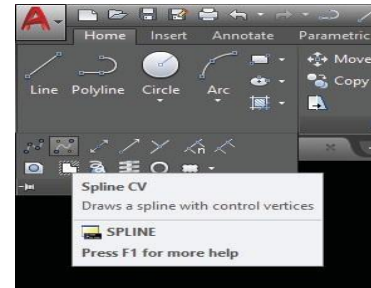
Methods to Draw a SPLINE

- Draw menu bar ☐ Spline ☐ click on icon or
- Short key
- SPL Press Enter

Command: SPL SPLINE

Command Line Messages for Polyline:

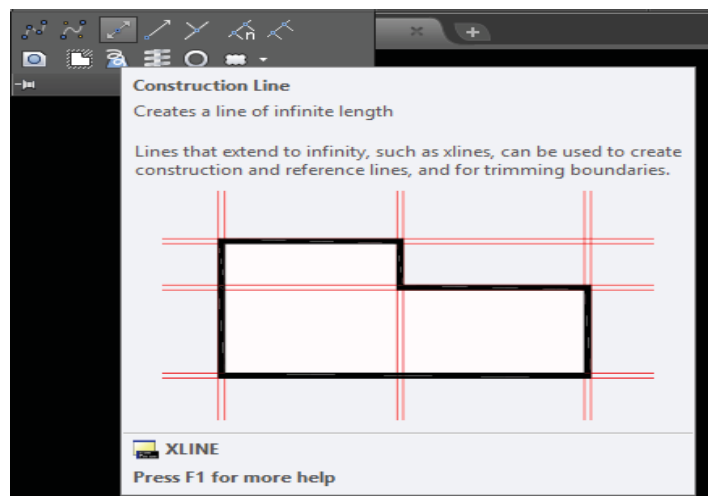
1. **Specify first point:** Select a point in the graphics window (e.g., 2,6 → Enter).
2. **Current settings:** Method=Fit Knots=Chord
3. **Specify first point or [Method/Knots/Object]:**
 - **Method:** Defines whether the spline uses fit points or control vertices.
 - **Knots:** Determines how curve segments blend between fit points (controlled by SPLKNOTS system variable).
 - **Object:** Converts 2D/3D spline-fit polylines into splines.



5.1.13. Draw Construction Line

Creates a construction line of infinite length.

Draw menu bar → construction Line → click on icon or short key
XL → Enter



Command: XL or XLINE

Following message will be displayed in command line

Specify start point: Select the point on the graphic window e.g. 2 enter key
Specify a point or [Hor/ Ver/ Ang/ Bisect/ Offset]:

Hor. (Horizontal): Draw the horizontal line

Ver. (Vertical): Draw the vertical line

Ang. (Angle): Draw the angle line

Bisect: Bisect an angle define by a vertex and two end points.

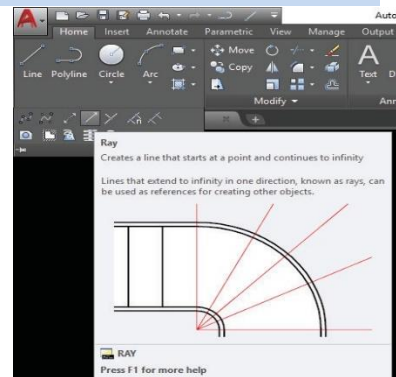
Offset: Draw construction line in offset.

5.1.14. Draw Ray line

A **Ray** is a linear object that starts at a point and extends infinitely in one direction.

Methods to Draw a Ray:

- **Menu Bar:** Draw → Ray → Click on the icon
- **Shortcut Key:** RAY → Enter

**Command: Ray**

Following message will be displayed in command line

RAY Specify start point: Select the point on the graphic window e.g. 6 enter key

Specify through point: To respond the message, give your options as per requirements

5.1.15. Draw Multi line

Multiline are composed of parallel lines, called elements. When you draw a multiline, you can use the STANDARD style, which has two elements

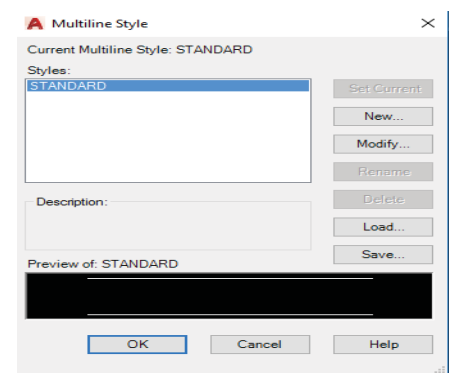
Draw menu bar → multi-Line → click on icon Or
short key ML → Enter

Multiline (ML)

Command: ML → Enter

Current Settings:

- Justification = Top
- Scale = 1.00
- Style = STANDARD

**Command Line Options:**

- **Justification:** Defines multiline position (Top, Bottom, Center).

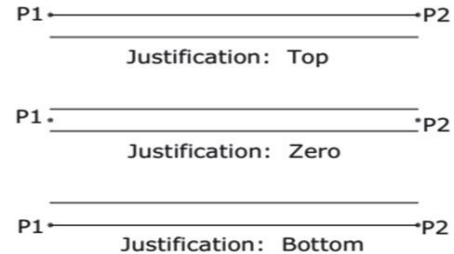
- Scale: Sets the spacing between multiline components.
- Style: Defines the multiline style (e.g., STANDARD, custom styles).

Example:

- Start point: 10,10 → Enter
- Next points: 22,10 → 22,22 → 10,22 → C (Close)

Justification Option

The justification determines how a multiline is drawn between the specified points. Three justifications are available for the **MLINE** command. They are **Top**, **Zero**, and **Bottom** as shown in following figure.

**Justification in multiline****Top**

This justification provides with the points produces a multiline in which the top line coincides with the points you selected on the screen.

Zero

This option will produce a multiline in which the zero offset position of the multiline coincides with the selected points.

Bottom

This option will produce a multiline in which the bottom line (the line with the least offset distance) coincides with the selected point when the line is drawn from the left to right.

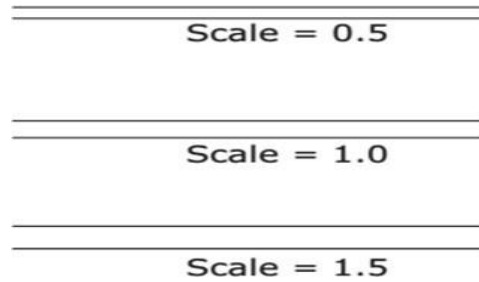


Figure: Different multiline scales

Scale Option

The scale option is used to change the scale of a multiline. For example, if the scale factor is 0.5, the distance between the lines (offset distance) will be reduced to half, as shown in following figure. Therefore, the width of the multiline will be half of what was defined of multiline style.

5.1.16. Line Type**Line Types in AutoCAD**

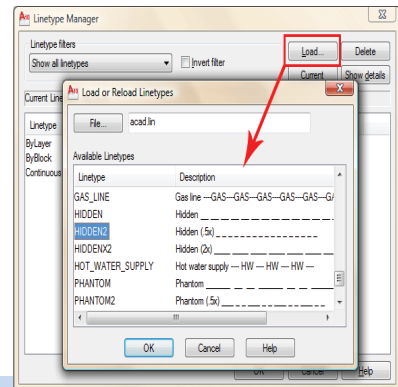
Line types can be **continuous** or **patterned** (dashes, dots, text, symbols). The **current line type** setting controls the default appearance of new objects.

Ways to Check/Change Line Type:

- **Ribbon:** Home tab → Properties panel (when no objects are selected).

Command Line:

- **Type:** LT → Enter
- **AutoCAD Window:** Displays line type settings and options.

**5.1.17. Line type Scale**

Line type scale controls the size and spacing of repetitions of the line type pattern for each drawing unit. There are a number of scaling options that can affect in line by followings steps.

- Type LTS enter and type scale factor.

HIDDEN - LINETYPE SCALE = 1

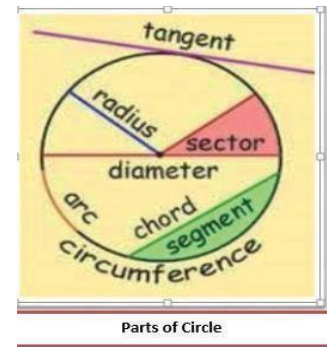
HIDDEN - LINETYPE SCALE = .5

HIDDEN - LINETYPE SCALE = 5

5.1.18. Circle Command and its parts

A circle is a simple closed shape

- The figure formed by the group of points that are an equal distance from a point, or center. The angles of a circle add up to 360 degrees.
- Circumference: Length of circle is called circumference.
- Radius: A straight line from the center to the circumference of a circle
- Diameter: A straight line passing from side to side through the center of a body or figure, esp. a circle or sphere.
- Chord: Any Straight Line which connects two points of circle is called chord, where as it does not pass from center of circle.
- Tangent: Any Straight Line which touches one point of circle is called Tangent.
- Arc: Part of a circle between any two points is called arc.
- Sector: Any area which is constructed by two Radiuses and an Arc is called Sector.
- Segment: Any area which is constructed by chord and an arc is called segment.

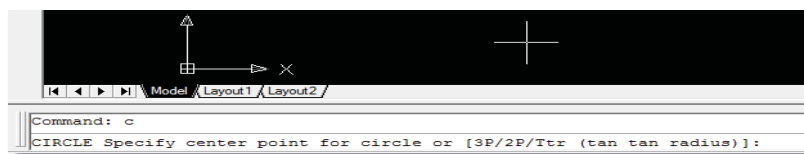


Procedure: How to create circle

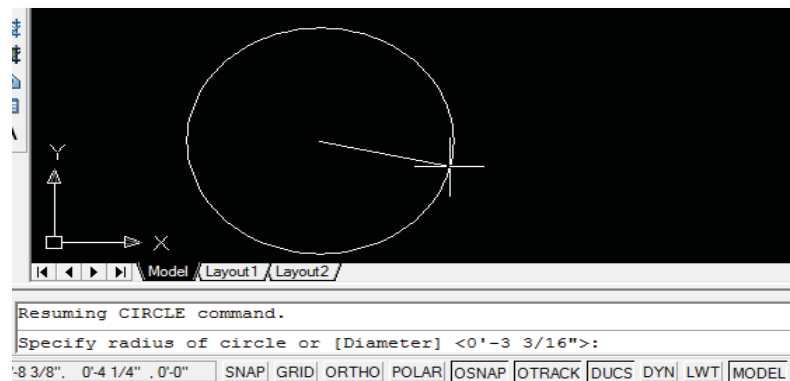
Draw Menu	Draw Toolbar	Command Entry
Circle		Circle/C



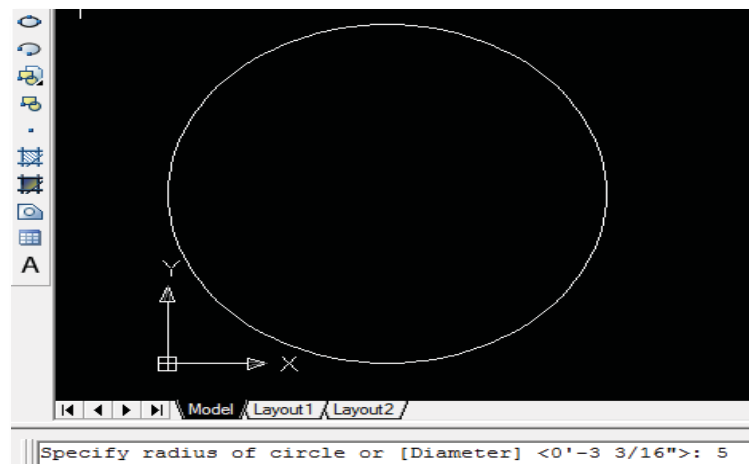
Step-1: Type C, Circle in command Bar and Press Enter



Step-2: Specify any Point for Centre I.e. 5, 5 and Press Enter



Step-3: Specify radius of Circle or Diameter: 5 and Press Enter.



- **Tan Tan Radius (TTR)**

Procedure: How to create circle with TTR

Step-1: Type C and press ENTER (You See: 3P/2P/TTR)

Step-2: Type T for (Tan Tan Radius (TTR))

Step-3: Specify point on object for first tangent of circle: Click on the First Tangent Element (Where the circle will touch)

Step-4: Specify point on object for second tangent of circle: Click on the Second Tangent Element (Where the circle will touch)

Step-5: Specify radius of circle <0'-0>: 2



- **3-Points circle:**

Procedure: How to create circle with 3-P

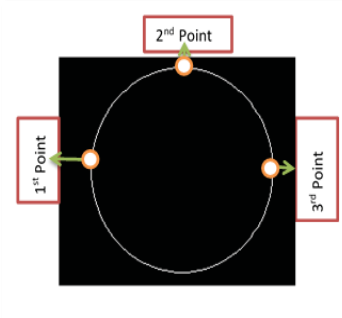
Step-1: Type C Command (see methods above)

Step-2: 3P/2P/TTR/<Center point>: Type 3p and then press.

Step-3: Specify first point on circle: Click on First Point.

Step-4: Specify second point on circle: Click on second Point.

Step-5: Specify third point on circle: Click on third Point



- **2-Points Circle**

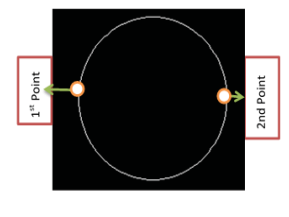
Procedure: How to create circle with 2-P

Step-1: Type C Command (see methods above)

Step-2: 3P/2P/TTR/<Center point>: Type 2P and then press.

Step-3: Specify first end point of circle's diameter: Click on First Point

Step-4: Specify second end point of circle's diameter: Click on second point



- **Tan Tan Tan (TTT)**

Another sub command of Circle you can activate from the Draw Manu: Draw → circle → TTT

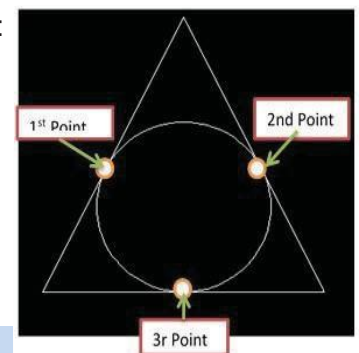
Procedure: How to create circle with TTT

Step-1: Click on Draw Manu: Draw → Circle → TTT

Step-2: 3p Specify first point on circle: _tan to. First Point

Step-3: 3p Specify second point on circle: _tan to. Second Point

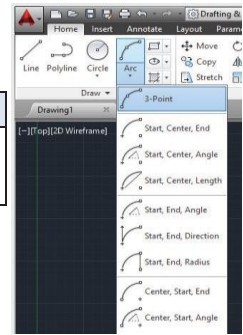
Step-4: 3p Specify third point on circle: _tan to. Third Point



5.1.19. Arc Command:

Arc is used to draw an arc between two lines from one point to the next.

Draw Manu	Draw Toolbar	Command Entry
Arc		Arc/A



Procedure

How to draw ARC

Command entry: arc

Specify start point of arc or [Center]: Specify a point, enter **c**, or press ENTER to start tangent to last line, arc, or polyline

To create an arc, you can specify combinations of center, endpoint, start point, radius, angle, chord length, and direction values.

Start Point

Specifies the starting point of the arc.

Note: If you press ENTER without specifying a point, the endpoint of the last drawn line or arc is used and you are immediately prompted to specify the endpoint of the new arc. This creates an arc tangent to the last drawn line, arc, or polyline.

Specify second point of arc or [Center /End]:

Second Point

Draws an arc using three specified points on the arc's circumference. The first point is the start point (1). The third point is the endpoint (3). The second point (2) is a point on the circumference of the arc.



Specify end point of arc: *Specify a point (3)*

You can specify a three-point arc either clockwise or counter clockwise.

Center

Specifies the center of the circle of which the arc is a part. Specify center point of arc:

Specify end point of arc or [Angle/chord Length]:

End Point

Using the center point (2), draws an arc counter clockwise from the start point (1) to an endpoint



that falls on an imaginary ray drawn from the center point through the third point (3).

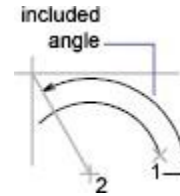
Teaching and Learning Guide: Information Technology (CAD) **AutoCAD**

The arc does not necessarily pass through this third point, as shown in the illustration.

Angle

Draws an arc counter clockwise from the start point (1) using a center point (2) with a specified included angle. If the angle is negative, a clockwise arc is drawn.

Specify included angle: *Specify an angle*



Chord Length

Draws either a minor or a major arc based on the distance of a straight line between the start point and endpoint.

If the chord length is positive, the minor arc is drawn counter clockwise from the start point. If the



chord length is negative, the major arc is drawn counter clockwise.

Specify length of chord: *Specify a length*

End

Specifies the endpoint of the arc. Specify end point of arc:

Specify center point of arc or [Angle/Direction/Radius]:

Center Point

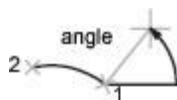
Draws an arc counter clockwise from the start point (1) to an endpoint that falls on an imaginary ray drawn from the center point (3) through the second point specified (2).

Angle



Draws an arc counter clockwise from the start point (1) to an endpoint (2), with a specified included angle. If the angle is negative, a clockwise arc is drawn.

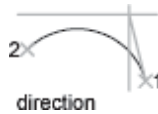
Specify included angle: Enter an angle in degrees or specify an angle by moving the pointing device counter clockwise.



Direction

Begins the arc tangent to a specified direction. It creates any arc, major or minor, clockwise or counter clockwise, beginning with the start point (1), and ending at an endpoint (2). The direction is determined from the start point.

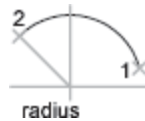
Specify tangent direction for the start point of arc:



Radius

Draws the minor arc counter clockwise from the start point (1) to the endpoint (2). If the radius is negative, the major arc is drawn. Specify radius of arc:

Center



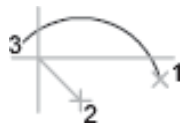
Specifies the center of the circle of which the arc is a part. Specify center point of arc:

Specify start point of arc:

Specify end point of arc or [Angle/chord Length]:

End Point

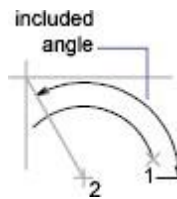
Draws an arc counter clockwise from the start point (2) to an endpoint that falls on an imaginary ray drawn from the center point (1) through a specified point (3).



Angle

Draws an arc counter clockwise from the start point (2) using a center point (1) with a specified included angle. If the angle is negative, a clockwise arc is drawn.

Specify included angle:

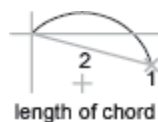


Chord Length

Draws either a minor or a major arc based on the distance of a straight line between the start point and endpoint.

If the chord length is positive, the minor arc is drawn counter clockwise from the start point. If the chord length is negative, the major arc is drawn counter clockwise.

Specify length of chord:



Tangent to Last Line, Arc, or Polyline

Draws an arc tangent to the last line, arc, or polyline drawn when you press ENTER at the first prompt.

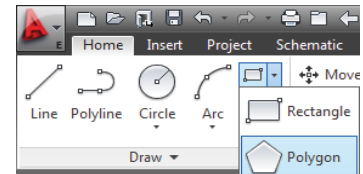


Specify end point of arc: *Specify a point (1)*

5.1.20. Rectangle

Creates a rectangular poly line from the specified the rectangle parameters (length, width, rotation) and type of corners (fillet, chamfer, or square).

Draw Menu	Draw Toolbar	Command Entry
Rectangle		rec



There is basic three types of rectangles, **area, dimension and rotation**.

Procedure

How to draw rectangular

Click Home tab ► Draw panel ► Rectangle. Specify the first corner of the rectangle. Specify the other corner of the rectangle.

OR

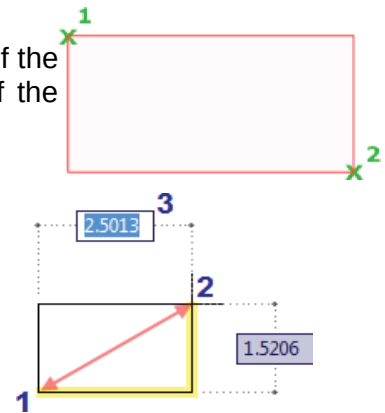
Short key REC Enter

Area

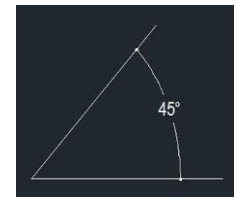
Creates a rectangle using the area and either a length or a width. If the Chamfer or Fillet option is active, the area includes the effect of the chamfers or fillets on the corners of the rectangle.

Dimensions

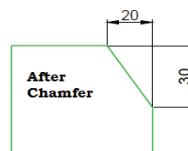
Creates a rectangle using length and width values.

**Rotation**

Creates a rectangle at a specified rotation angle.

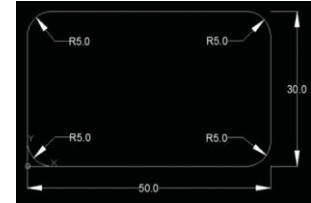
**Chamfer**

Sets the chamfer distances for the rectangle.



Elevation

Specifies the elevation of the rectangle.

**Fillet**

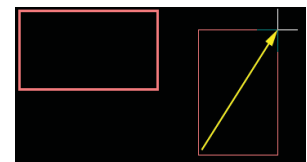
Specifies the fillet radius of the rectangle

Thickness

Specifies the thickness of the rectangle.

**Width**

Specifies the polyline width of the rectangle to be drawn.

**5.1.21. Polygon**

Polygons can be used to draw equilateral triangles, squares, pentagons, hexagons, and other multi-sided figures.

The following illustrations show polygons created using three methods: inscribed, circumscribed, and edge. In each case, two points are specifying.

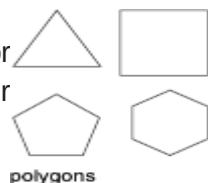
Draw Manu	Draw Toolbar	Command Entry
Polygon		POL

INSCRIBE
The radius is half the distance from a point

CIRCUMSCRIBE
The radius is half the distance from a midpoint of a flat

Command: polygon

Enter number of sides <current>: Enter a value between 3 and 1024 or press ENTER Specify center of polygon or [Edge]: Specify a point (1) or enter e

**Center of Polygon**

Defines the center of the polygon.

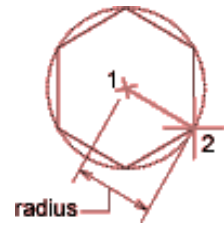
Enter an option [Inscribed in circle/Circumscribed about circle] <current>: Enter i or c or press ENTER

Inscribed in Circle

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Specifies the radius of a circle on which all vertices of the polygon lie. Specify radius of circle: Specify a point (2) or enter a value

Specifying the radius with your pointing device determines the rotation and size of the polygon. Specifying the radius with a value draws the bottom edge of the polygon at the current snap rotation angle.

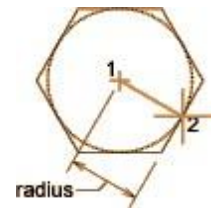


Circumscribed about Circle

Specifies the distance from the center of the polygon to the midpoints of the edges of the polygon.

Specify radius of circle: Specify a distance

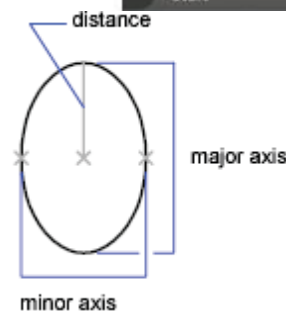
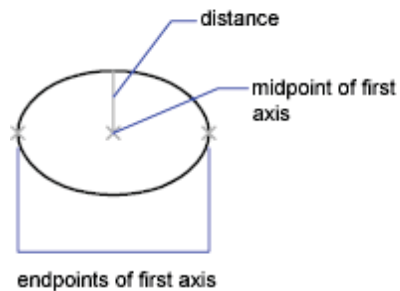
Specifying the radius with your pointing device determines the rotation and size of the polygon. Specifying the radius with a value draws the bottom edge of the polygon at the current snap rotation angle.



5.1.22. Ellipse

When you draw an ellipse, its shape is determined by two axes that define its length and width: the major (longer) axis and the minor (shorter) axis.

Draw Menu	Draw Toolbar	Command Entry
Ellipse		EL



Axis Endpoint

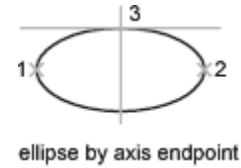
Defines the first axis by its two endpoints. The angle of the first axis determines the angle of the ellipse. The first axis can define either the major or the minor axis of the ellipse.

Specify other endpoint of axis: Specify a point (2)

Specify distance to other axis or [Rotation]: Specify a distance by entering a value or locating a point (3), or enter r

Distance to second Axis

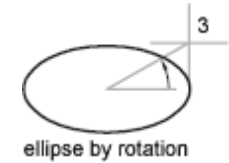
Defines the second axis using the distance from the midpoint of the first axis to the endpoint of the second axis (3).

**Rotation**

Creates the ellipse by appearing to rotate a circle about the first axis.

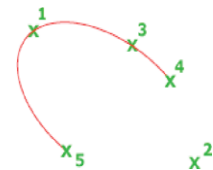
Specify rotation around major axis: Specify a point (3), or enter a positive angle value less than 90

Move the crosshairs around the center of the ellipse and click. If you enter a value, the higher the value, the greater the eccentricity of the ellipse. Entering 0 defines a circular ellipse.

**Arc**

Creates an elliptical arc.

The first two points of the elliptical arc determine the location and length of the first axis. The third point determines the distance between the center of the elliptical arc and the endpoint of the second axis. The fourth and fifth points are the start and end angles.



The angle of the first axis determines the angle of the elliptical arc. The first axis can define either the major or the minor axis depending on its size.

Specify axis endpoint of elliptical arc or [Center]: Specify a point or enter **c**

5.1.23. Hatch

Fills an enclosed area or selected objects with a hatch pattern, solid fill, or gradient fill. In hatch apply different material as required and justify the scale

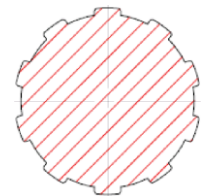
Draw Menu	Draw Toolbar	Command Entry
Hatch		H

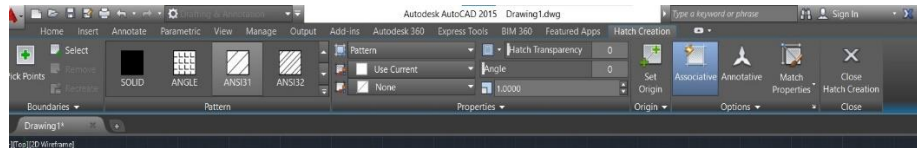
Command: Hatch

The Hatch and Gradient dialog box are displayed. If you enter -hatch at the Command prompt, options are displayed.

Note: By default, the program will not create a hatch pattern that consists of over 10,000 hatch segments. The limit is set by the Max Hatch setting in the registry. To reset the limit to 50,000, for example, enter (setenv "MaxHatch" "50000") at the Command prompt. The limit can be reset to any value between 100 and 10,000,000. You can choose from several methods to specify the boundaries of a hatch.

- Specify a point in an area that is enclosed by objects.
- Select objects that enclose an area.
- Drag a hatch pattern into an enclosed area from a tool palette or Design Center.

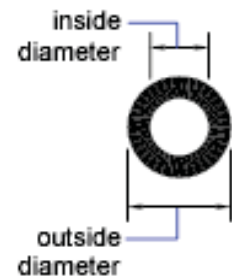




5.1.24. Donut

Creates a filled circle or a wide ring or Donut is special type of circle that describes inside outside circle in a same time.

A donut consists of two arc polylines that are joined end-to-end to create a circular shape. The width of the polylines is determined by the specified inside and outside diameters. If you specify an inside diameter of 0, the donut is a filled circle.



Draw Manu	Draw Toolbar	Command Entry
Donut		DO

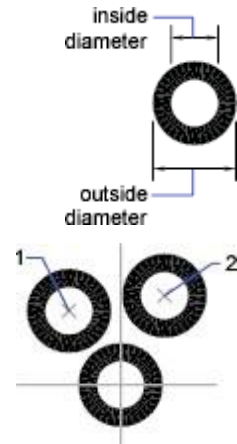
Specifies the inside diameter of the donut as shown.

Command: donut

A donut consists of two arc polylines that are joined end-to-end to create a circular shape. The width of the polylines is determined by the specified inside and outside diameters. To create solid-filled circles, specify an inside diameter of zero.

Specify inside diameter of donut <current>: Specify a distance or press ENTER
If you specify an inside diameter of 0, the donut is a filled circle.

Specify outside diameter of donut <current>: Specify a distance or press ENTER
Specify center of donut or <exit>: Specify a point (1) or press ENTER to end the command.



The location of the donut is set based on the center point. After you specify the diameters, you are prompted for the locations at which to draw donuts. A donut is drawn at each point specified (2). How the interior of a donut is filled depends on the current setting of the FILL command?

5.1.25. Point

To set point style and size

POINT Creates a point object.

Draw Manu	Draw Toolbar	Command Entry
Point		point

Command entry: point

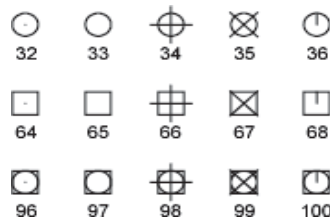
Specify a point:

Points can act as nodes to which you can snap objects. You can specify a full three- dimensional

location for a point. The current elevation is assumed if you omit the Z coordinate value. The PDMODE and PDSIZE system variables control the appearance of point objects. PDMODE values 0, 2, 3, and 4 specify a figure to draw through the point. A value of 1 specifies that nothing is displayed.



Specifying the value 32, 64, or 96 selects a shape to draw around the point, in addition to the figure drawn through it:



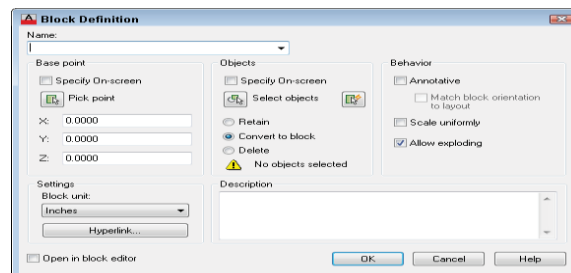
5.1.26. Block

A block is simply a collection of objects (it could be one object) that has a name. Blocks have several advantages:

- You can insert them again and again, saving time. In fact, you can insert them into other drawings as well.
- A block uses less electronic space than individual objects, so your drawing file is smaller.
- By updating a block's definition, you can update all the blocks in the drawing.

How do you create a block?

To create a block, follow these steps:



- Draw the objects that you want in the block.
- Choose Home tab> Block panel> Create to start the BLOCK command. The Block Definition dialog box opens.
- Type a name in the Name text box. The name can have spaces.
- You need to specify a base point. That's the point at which you'll insert the block. In the Base Point section, click Pick Point. Be sure to use an object snap for accuracy! You'll immediately be returned to the dialog box.
- In the Objects section, click the Select Objects button. Select the objects and press Enter to return to the dialog box. **Tip:** You can select the objects before using the command and they'll show up in the dialog box.

- vi. Just below, choose Retain, Convert to Block, or Delete. These options control what happens after you create the block.
- vii. In the Behavior section, you can make a block Annotative (more info here), force it to scale uniformly and choose whether to allow exploding.
- viii. In the Settings area, choose the block unit. You can choose Unit less but if you choose a unit, AutoCAD will try to scale the block appropriately when you insert it into another drawing. You can also add a hyperlink if you want.
- ix. Finally, you can add a description in the Description box. A description is helpful in the Design Center, when you want to insert the block from another drawing.
- x. Click OK to complete the box. If you chose Delete, the objects disappear. You can use the OOPS command to bring them back.

5.1.27. Types of file extensions for saving files

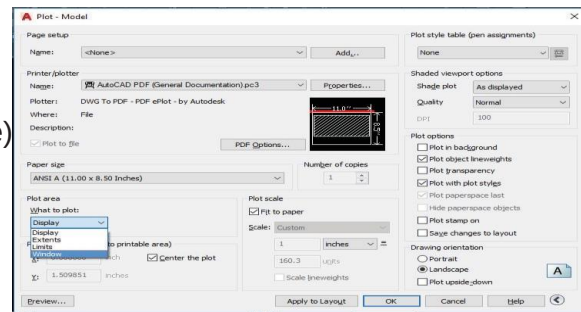
Plotting for Save drawing in different format (e.g. dwg., PDF, JPG. etc.).
In this unit learner able to print out the Drawing in different formats like

- .PDF
- .JPG etc.

Method of Saving Drawing in PDF

Step 1:

Applying command print in AutoCAD then show the dialog box of print / plot like (show in picture) Then click the PDF option.

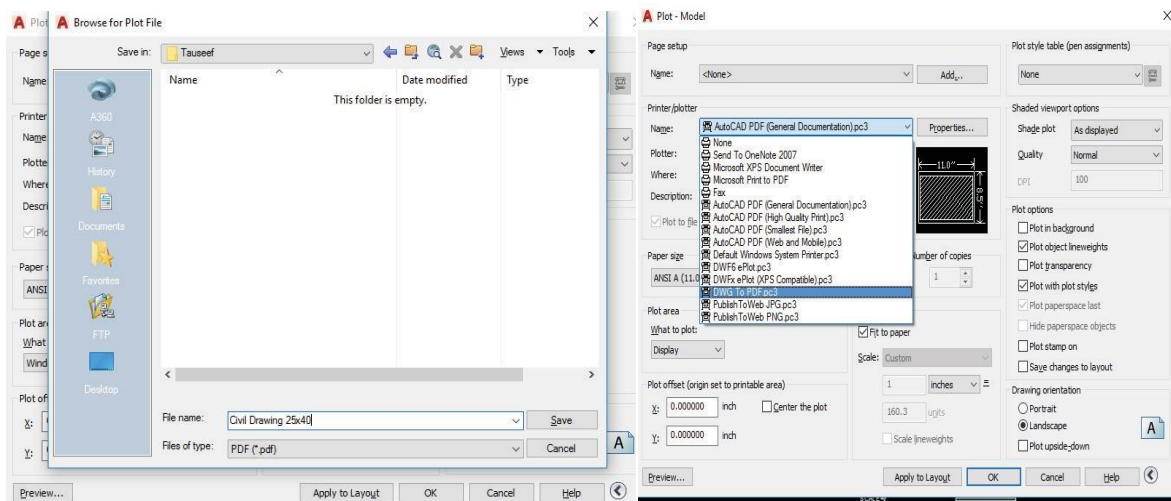


Step 2:

Select the Drawing with Window option lick (showing in the picture) and click the OK option

Step 3:

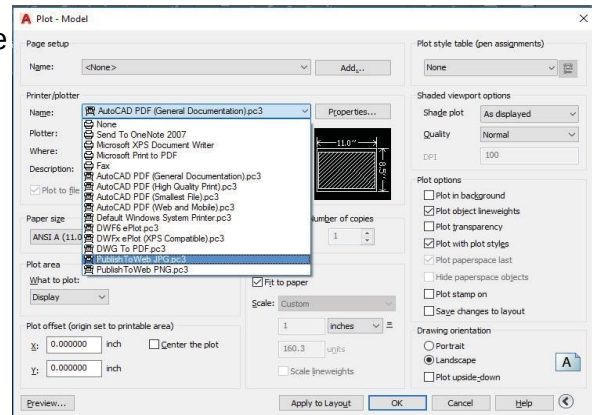
Then give the path where you want save drawing lick (showing in the pictures)



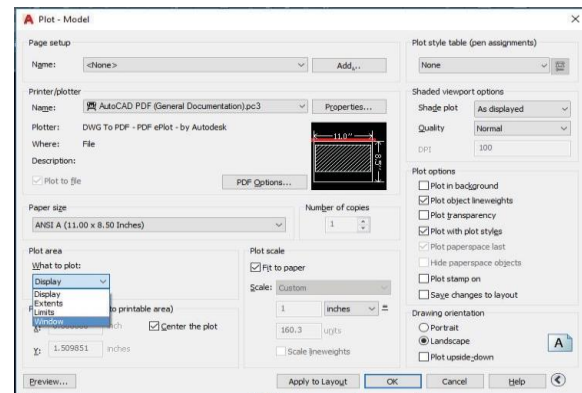
Method of Saving Drawing in JPG.

Step 1:

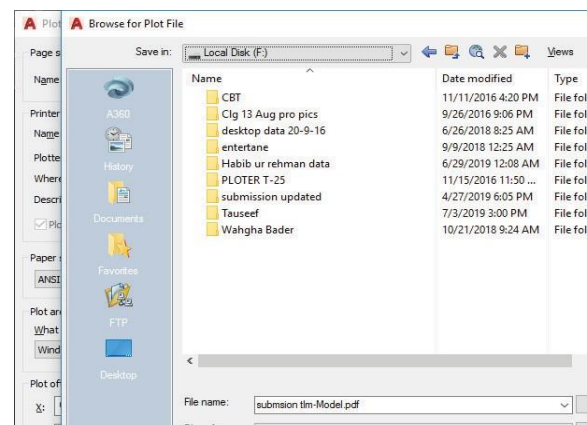
Applying command print in AutoCAD then show the dialog box of print / plot like (show in the picture)
Then click the JPG option

**Step 2:**

Select the Drawing with Window option lick (showing in the picture) And click the OK option

**Step 3:**

Then give the path where you want save drawing lick (showing in the pictures)

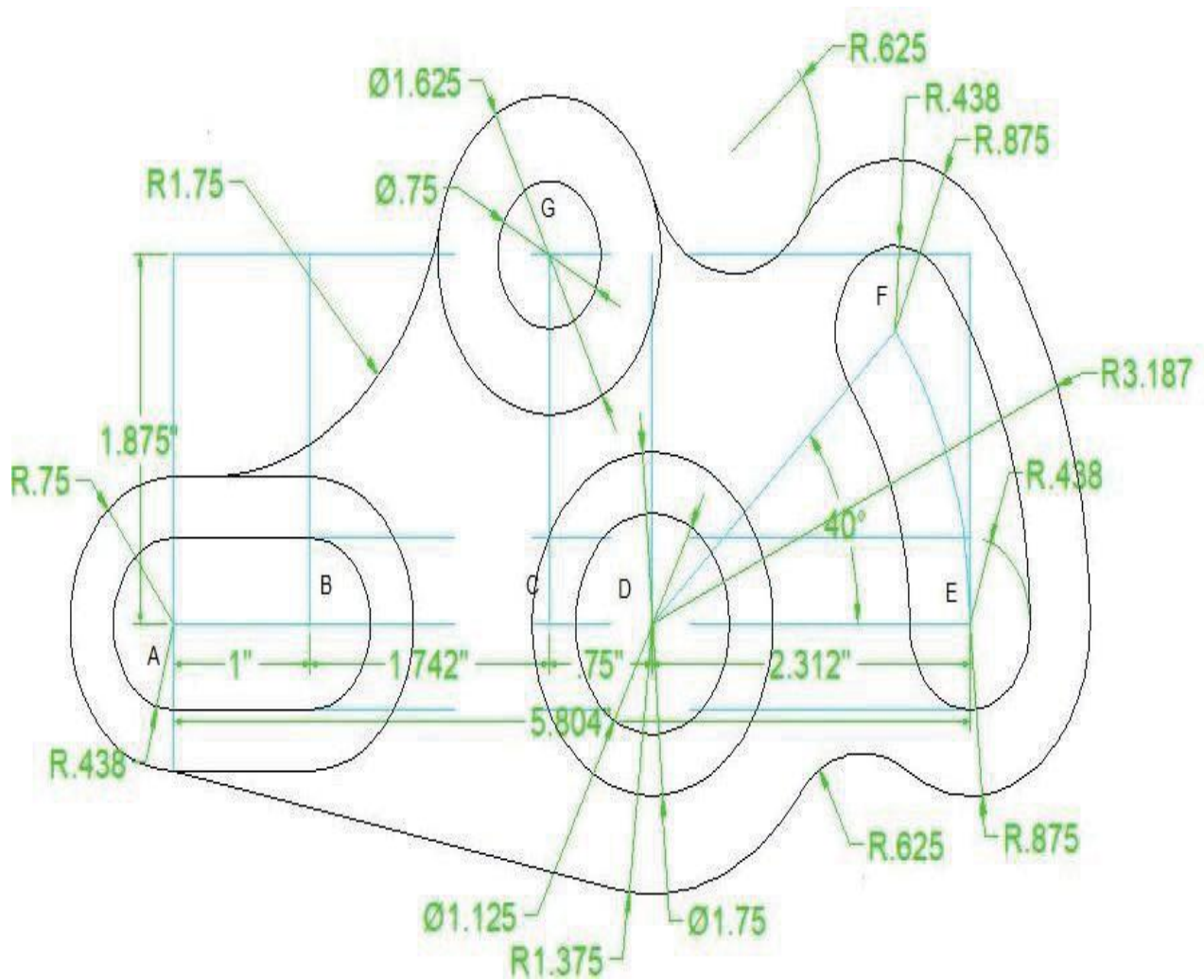
**Activity - 1**

Create 2D 'House Plan' in AutoCAD having dimensions of the plan given below with the following requirements.

- i. Plot size 35' x 70'
- ii. Three Bed Rooms, including two bed room with attached baths
- iii. One kitchen
- iv. TV Lounge (As per space)
- v. Car Porch (Terrace)
- vi. Proper Ventilation
- vii. Space Utilization

Activity - 2

Prepare the following object with its defined dimension.



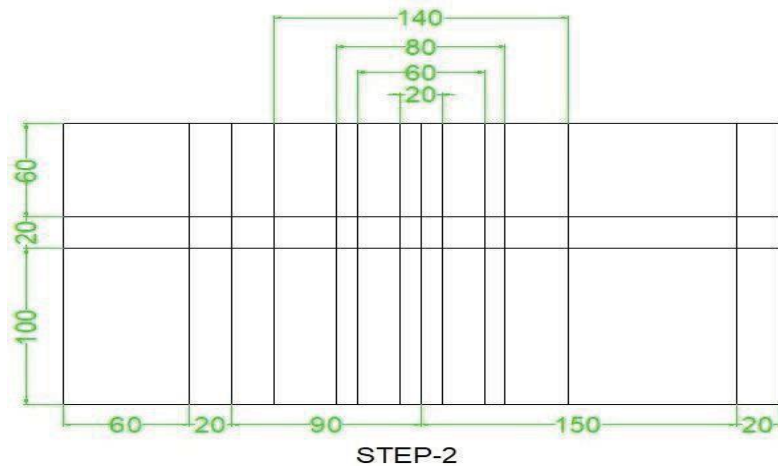


- i. Open the template acadiso.dwt.
- ii. Perform drafting settings i.e. format units to decimal with accuracy of 01 mm. create 3 text styles using Arial fonts of text height 10 mm, 15 mm & 20 mm. Load line center line and create layers i.e. Object, center line, text, dimension. Draw a line 340 mm long horizontally taking its origin point at 50, 120 and a line 180 mm long vertically up from the same coordinates.
- iii. Now take off sets for vertical line to the right and for horizontal line to the upside as shown in the following figure step one:



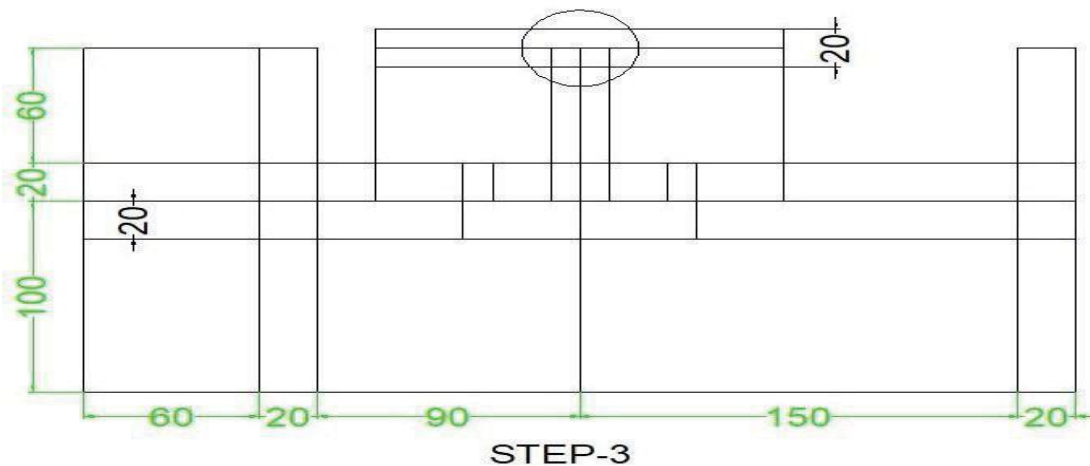
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Take offsets of vertical center line on both sides for the distances as 10 mm, 30 mm, 40 mm & 70 mm as shown in the figure below Step-2



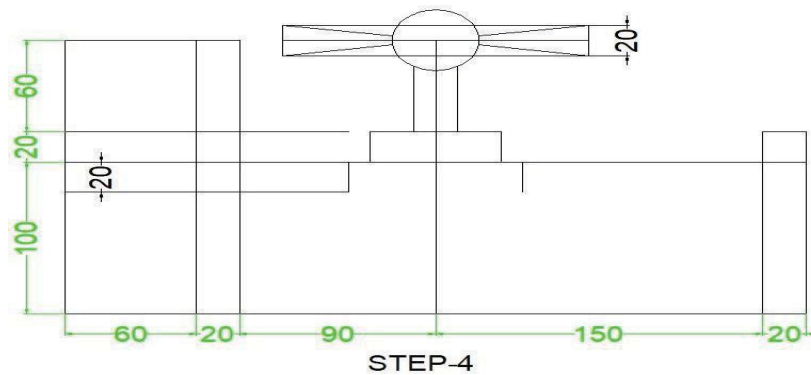
Step: 3

Draw a circle of radius 20 mm at top of center line. Take an offset of 20 mm to downward of second line from bottom. Take off sets on both side of top horizontal line to create knob. Then trim the lines as per figure given below STEP-3.

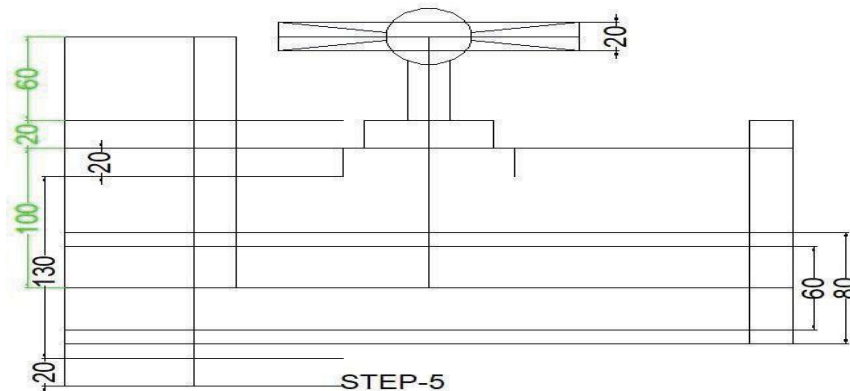


Step: 4

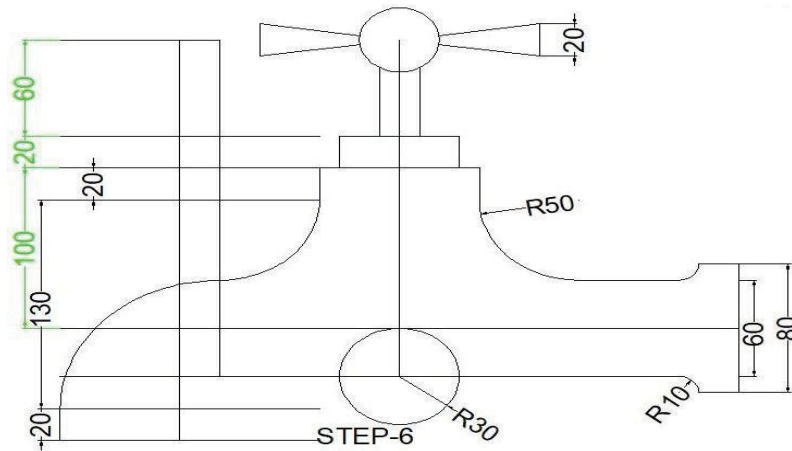
Draw inclined lines from center of circle and trim the lines as given in figure Step-4

**Step: 5**

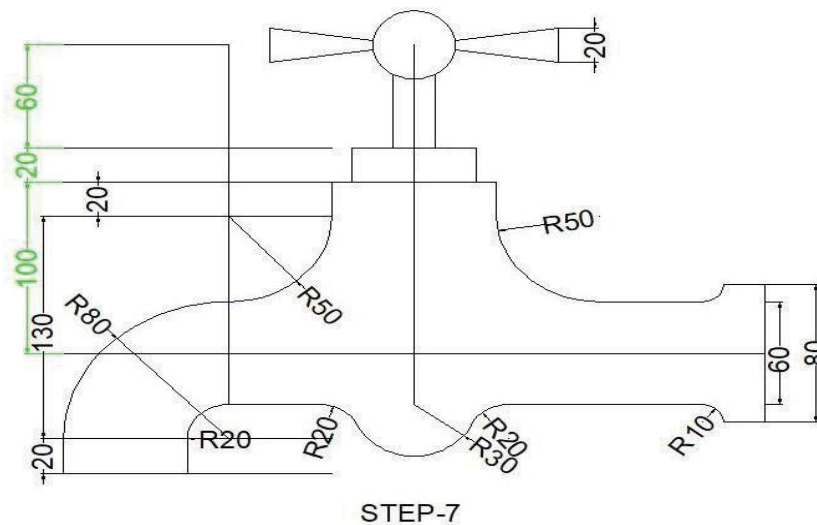
- i. Take the offsets to upward and downward of the bottom line for a distance of 30 mm and 40 mm.
- ii. Take the offset to downwards for a distance of 130 mm
- iii. Further take offset for a distance of 20 mm of this created line (line through offset command).
- iv. Extend the vertical lines up to the bottom line
- v. Trim accordingly as shown in the figure below Step-5.

**Step: 6**

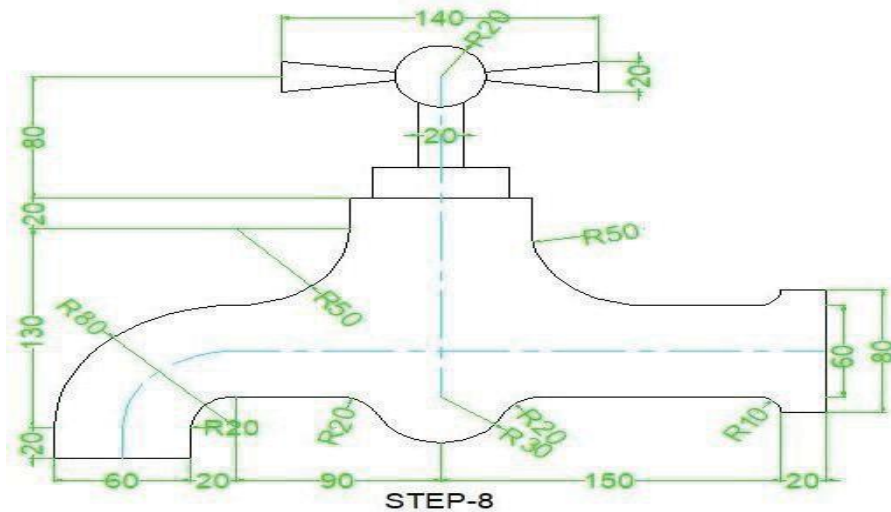
- i. Create fillets.
- ii. Firstly, set the radius of 50 mm in the fillet command.
- iii. Create the fillet of this radius i.e. 50 mm to both sides of the body of knob.
- iv. Set the radius of 80 mm in the fillet command.
- v. Create the fillet of this radius i.e. 80 mm to the body to create bend to downwards.
- vi. Set the radius of 20 mm in the fillet command.
- vii. Create the fillet of this radius i.e. 20 mm to both the sides of threaded body to reduce the size of body.
- viii. Create a circle of radius of 20 mm at bottom of center line drawn vertically as shown in figure Step-6.

**Step:7**

- i. Trim the circle to from upper side.
- ii. Trim the horizontal body line passing through circle.
- iii. Set the radius of 20 mm in the fillet command.
- iv. Create the fillet of this radius i.e. 20 mm to both the sides of this semicircle obtained after trimming.
- v. Also create fillet for exit bend of tap.
- vi. Trim the horizontal and vertical extra lines to have the final shape of drawing.

**Step: 8**

- i. Using offset command for a distance of 30 mm create remaining portion of center line.
- ii. Convert both the center lines i.e. vertical and body center lines from continuous to the symbol of center line.
- iii. Format the dimension styles for 10 mm text height.
- iv. Draw linear dimensions individual and continuous dimensions for both the horizontal and vertical sides.
- v. Draw radius dimensions for all fillets (arcs). The drawing will look exactly as shown in the figure Step-8 shown below.

**Learning unit-5.2****Prepare Final Set of 2D Drawings****Learning Outcome:**

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

- Develop 2D Drawing with given project specification and measurements.
- Plot/print drawing on scale according to required size & orientation.
- Use AI Tools for assistance.
- Importance of digital portfolio

5.2.1 Types of Technical Drawings

Technical drawings are used in engineering, architecture, manufacturing, and construction to visually communicate the design, specifications, and assembly of objects. Below are the main types of technical drawings:

5.2.1.1 Engineering Drawings

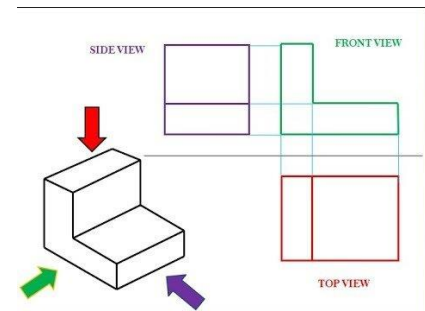
Used in mechanical, electrical, and civil engineering to represent machine parts, circuits, and structures.

i. Orthographic Projection

- Shows multiple views (top, front, side) of an object.
- Used in manufacturing and construction.

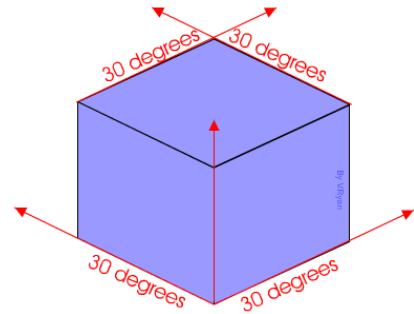
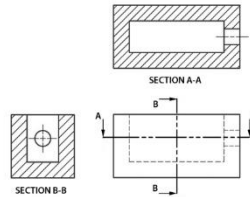
ii. Isometric Drawing

- A 3D representation where all three axes are at 120° angles.
- Useful for visualizing components before production.



iii. Sectional Drawing

- Shows internal details by cutting through the object.
- Types: Full Section, Half Section, Offset Section.



iv. Assembly Drawing

- Displays how different parts fit together.
- Includes exploded views for clarity.

v. Detail Drawing

- Provides dimensions and materials for a single component.

5.2.1.2 Architectural Drawings

Used for buildings and structures.

i. Floor Plan

- Shows a horizontal cut of a building from above.
- Includes walls, doors, windows, and furniture layout.

ii. Elevation Drawing

- Displays the exterior view of a building from the front, side, or rear.

iii. Section Drawing

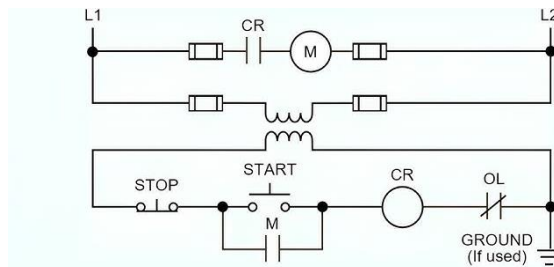
- Cross-sectional view showing internal construction details.

iv. Site Plan

- Shows the building location, landscape, roads, and utilities.

5.2.1.3 Electrical Drawings

Used for electrical installations and circuits.



i. Circuit Diagram (Schematic)

- Represents electrical components using standardized symbols.

- ii. **Wiring Diagram**
 - Shows the physical layout of electrical wiring.
- iii. **Panel Layout**
 - Displays the arrangement of electrical panels and components.
- iv. **Structural Drawings**
 - Used in civil engineering for bridges, buildings, and infrastructure.
- v. **Foundation Plan**
 - Shows footing and foundation details.
- vi. **Piping and Instrumentation Diagrams (P&ID)**
 - Used in industries like oil, gas, and chemical plants.
- vii. **Piping Layout**
 - Shows the routing of pipes, valves, and equipment.

5.2.2 Printing/Plotting with or without Scale

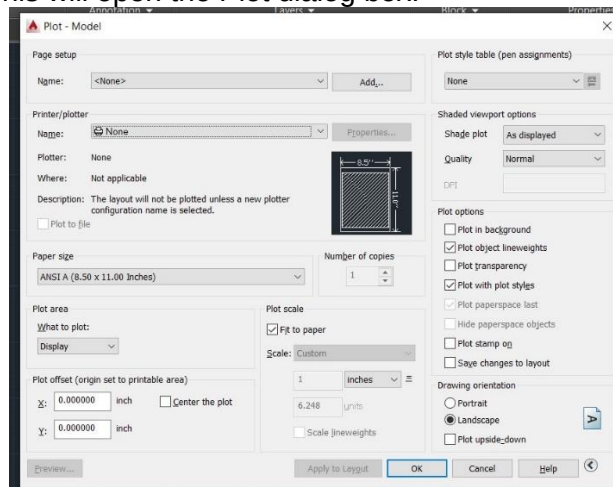
When printing (plotting) in AutoCAD, you can choose to **print to scale** (to maintain real-world proportions) or **without scale** (fit to paper). Below are both methods explained step by step:

5.2.2.1 Printing with Scale (Maintains Accuracy)

Printing to scale ensures that the drawing matches real-world dimensions when printed.

Steps to Plot with Scale:

- i. **Open the Plot (Print) Command**
 - Type PLOT in the command line and press Enter.
 - This will open the Plot dialog box.



- ii. **Select Printer & Paper Size**
 - Printer/Plotter: Choose the printer or plotter you want to use.
 - Paper Size: Select the correct paper size (e.g., A4, A3, A1).
- iii. **Set the Plot Area**
 - Under Plot Area, choose one of the following:

- Window → Click on the Window button and select the area you want to print.
- Extents → Prints everything in the drawing.
- Layout → Prints everything in the layout tab.

iv. Set the Scale Properly

- Uncheck "Fit to Paper" (If checked, AutoCAD will resize the drawing to fit the sheet, which may not be to scale).
- Set the Plot Scale manually:
 - 1:1 (For full-scale printing, e.g., for manufacturing drawings).
 - 1:50 (For architectural floor plans).
 - 1:100 (For site plans and large projects).
- If your drawing is in millimeters (mm), ensure 1 mm = 1 unit is set.
- If your drawing is in feet/inches, choose the appropriate scale accordingly.

v. Set the Drawing Orientation

- Select Portrait or Landscape, depending on how your drawing should be printed.

vi. Preview and Print

- Click Preview to check the output.
- If everything looks correct, click OK to print the drawing.

Shortcut Method (Command Line Printing with Scale)

If you prefer to use the command line for quick printing, follow these steps:

1. Type PLOT and press Enter.
2. Enter Printer Name (e.g., "HP Plotter").
3. Enter Paper Size (e.g., A3, A1).
4. Type Window, then select the drawing area.
5. Enter Scale (e.g., 1:50).
6. Press Enter, then OK to print.

Remember

Always use Layouts for precise scaling.

5.2.2.2 Printing Without Scale (Fit to Paper)

This method resizes the drawing to fit the selected paper, but the scale will not be accurate.

Steps to Plot Without Scale:

i. Open the Layout Tab or Model Space

- You can print from either Model Space or Layout Space.

ii. Open the Plot Dialog Box

- Type PLOT and press Enter.
- Select the Printer/Plotter and Paper Size.

iii. Select "Fit to Paper"

- Under Plot Scale, check Fit to Paper.
- This automatically resizes the drawing to fit the sheet.

iv. Choose Plot Area

- Under Plot Area, select:
- Window (Select the area you want to print).

- Extents (Prints everything in the drawing).

v. Preview and Print

- Click Preview to check the output.
- Click OK to plot.

5.2.3 How AI Can Help You in AutoCAD

ChatGPT can assist you in AutoCAD 2D and 3D drawing, automation, troubleshooting, and learning by providing real-time support, command explanations, and script automation. Below are some key ways ChatGPT can help you improve your efficiency in AutoCAD.

5.2.3.1 Learning AutoCAD Commands & Shortcuts

ChatGPT can explain AutoCAD commands, shortcuts, and best practices.

Example:

- Question: What is the use of the OFFSET command in AutoCAD?
- ChatGPT Answer: The OFFSET command creates parallel copies of selected objects at a specified distance.

Remember

ChatGPT is a
Free AI Tool

How ChatGPT Helps:

- Provides step-by-step instructions for any AutoCAD command.
- Suggests keyboard shortcuts for faster work.

5.2.3.2 AutoCAD AI-Powered Drafting Assistance

ChatGPT can guide you in setting up layers, dimensions, blocks, and layouts.

Example:

- Question: How can I create a title block in AutoCAD?
- ChatGPT Answer: Use the RECTANGLE and MTEXT commands, then save it as a BLOCK for reuse.

How ChatGPT Helps:

- Provides ready-made AutoCAD templates (title blocks, symbols, etc.).
- Gives layering best practices to keep drawings organized.

5.2.3.3 Troubleshooting AutoCAD Errors

ChatGPT can help fix common AutoCAD errors.

Example:

- Problem: *AutoCAD is not snapping to points properly.*
- Solution: Enable "OSNAP" by typing *OSNAP* and selecting the required snap options.

How ChatGPT Helps:

- Provides command-based solutions for error fixing.
- Suggests system variable adjustments to improve performance.

5.2.3.4 AI-Powered Drawing & 3D Modeling Assistance

ChatGPT helps with 2D drafting, 3D modeling, and rendering commands.

Example:

- Question: How do I create a 3D model from a 2D drawing?
- ChatGPT Answer: Use EXTRUDE and PRESSPULL commands to convert 2D shapes into 3D solids.

How ChatGPT Helps:

- Guides on converting 2D to 3D in AutoCAD.
- Explains rendering and visualization settings.

5.2.3.5 AI-Based Design Optimization & Best Practices

ChatGPT suggests the best AutoCAD workflows for efficiency.

Example:

- Question: How to organize layers in AutoCAD for a building plan?
- ChatGPT Answer: Use separate layers for walls, doors, windows, furniture, and electrical components.

How ChatGPT Helps:

- Provides CAD standards for architectural and engineering drawings.
- Suggests file management best practices for large projects.

5.2.4 Importance of a Digital Portfolio

A digital portfolio is an online collection of a person's work, skills, and achievements, often used by professionals, students, and creatives to showcase their expertise. It serves as a modern resume that highlights skills, experience, and accomplishments in a visually appealing way.

5.2.4.1 Professional Branding

A digital portfolio helps build and maintain a professional online presence, allowing individuals to stand out in competitive industries. It reflects expertise, creativity, and experience.

5.2.4.2 Easy Accessibility

Unlike traditional portfolios, a digital portfolio can be shared globally via a link. Potential employers, clients, or collaborators can view it anytime, increasing opportunities.

5.2.4.3 Showcasing Skills & Experience

A well-organized portfolio provides a clear representation of a person's skills, projects, and achievements, making it easier for recruiters or clients to assess suitability for a job or project.

5.2.4.4 Increases Credibility

Having a portfolio with real work samples builds trust and credibility. Employers or clients can see past projects and verify an individual's capabilities before making hiring decisions.

5.2.4.5 Better Than a Resume

A resume lists qualifications, but a digital portfolio visually demonstrates skills with real-world examples like images, reports, designs, or coding projects.

5.2.4.6 Useful for Multiple Industries

Teaching and Learning Guide: Information Technology (CAD) **AutoCAD**

Whether you're a graphic designer, engineer, teacher, writer, photographer, or developer, a digital portfolio is beneficial for showcasing work and attracting opportunities.

5.2.4.7 Helps in Networking & Job Search

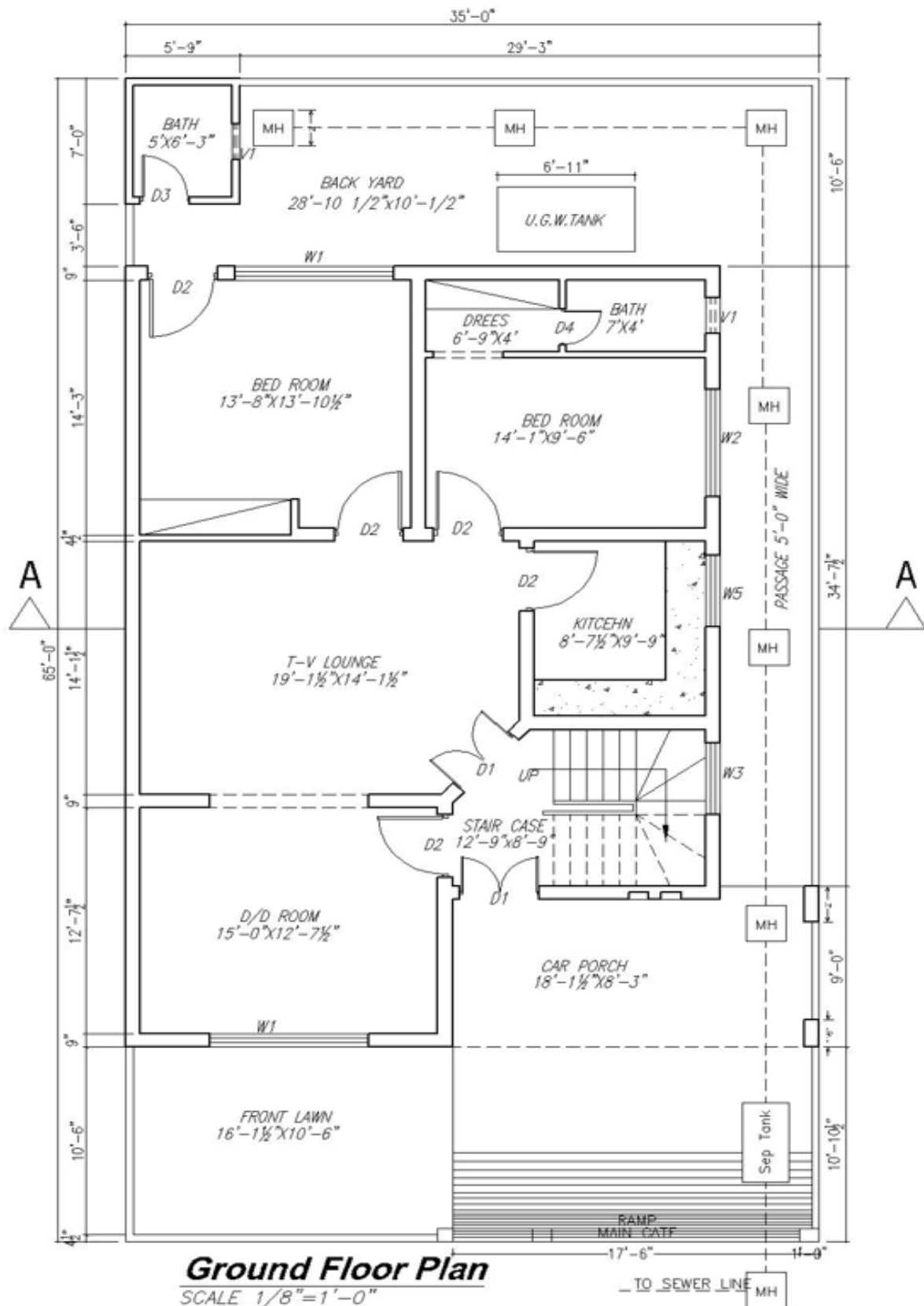
A portfolio linked to social platforms (LinkedIn, personal website, or job portals) can increase visibility and help connect with potential employers or clients.

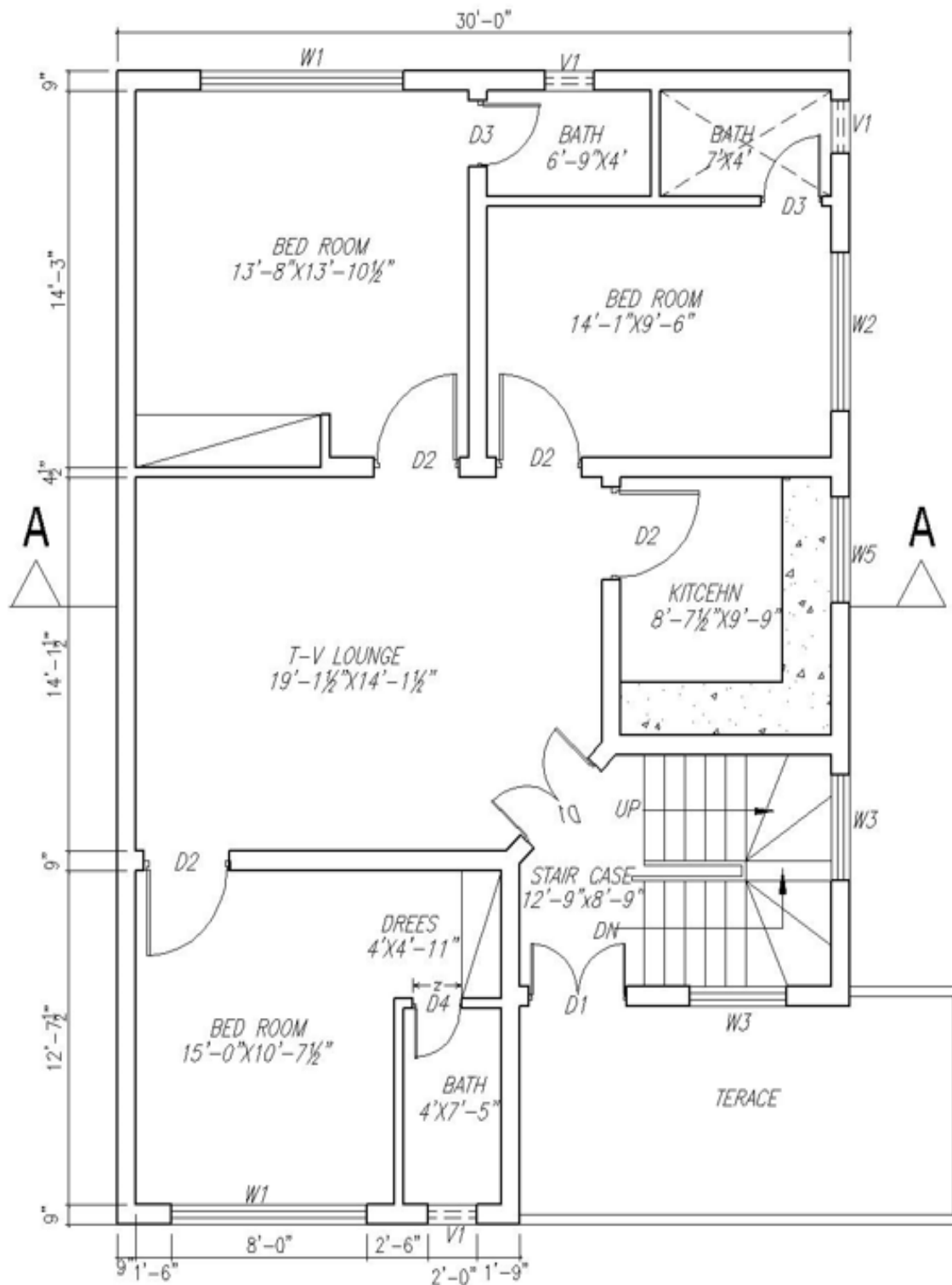
Activity 1 :

Create 2D 'House Plan' in AutoCAD having dimensions 35 x 65 feet with the following requirements.

- i. Five Bed Rooms, including four bed room with attached baths
- ii. Two kitchens
- iii. Two TV Lounges (As per space)
- iv. Drawing & dinning room
- v. Car Porch (Terrace)
- vi. Proper Ventilation
- vii. Space Utilization
- viii. Foundation detail
- ix. Site plan

Note: And also make elevation legends and deferent section,

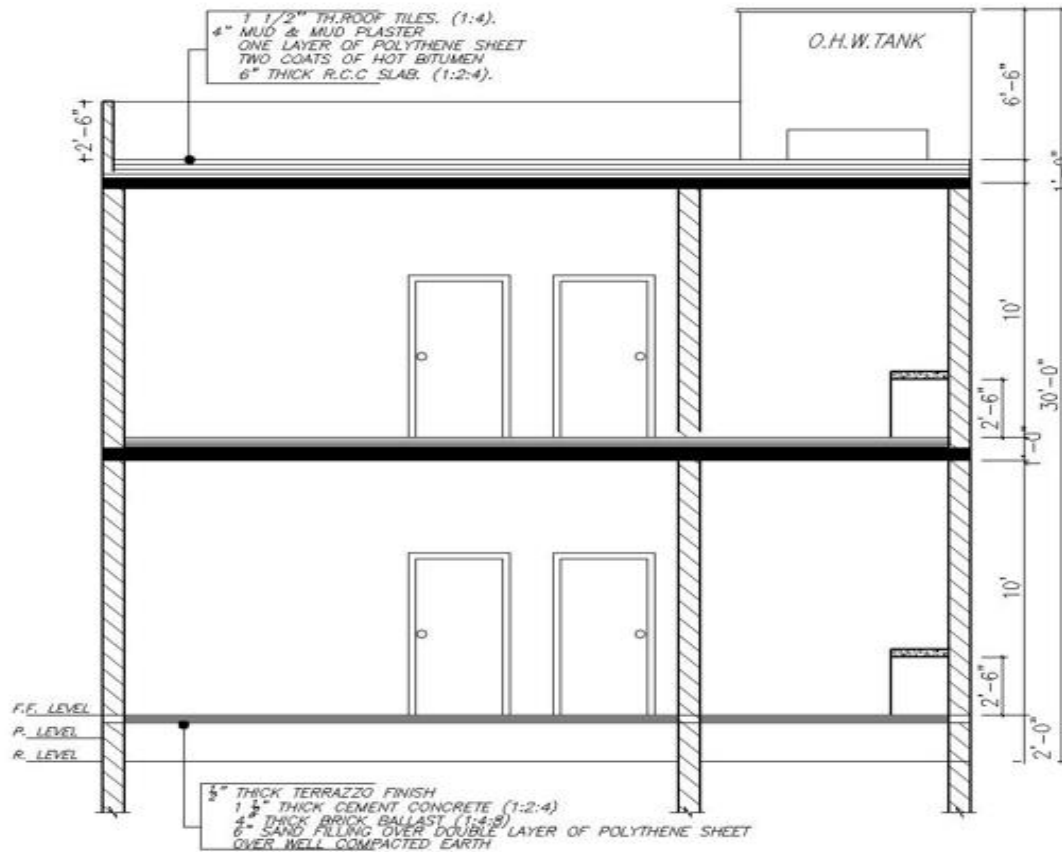




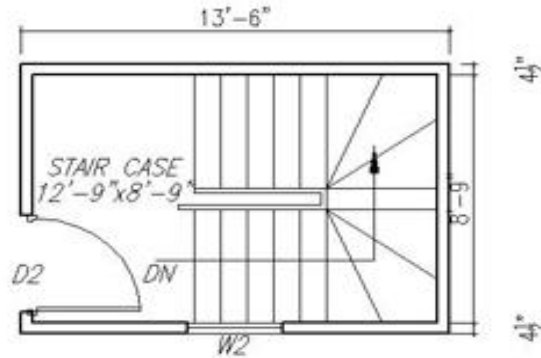
First Floor Plan

SCALE 1/8"=1'-0"

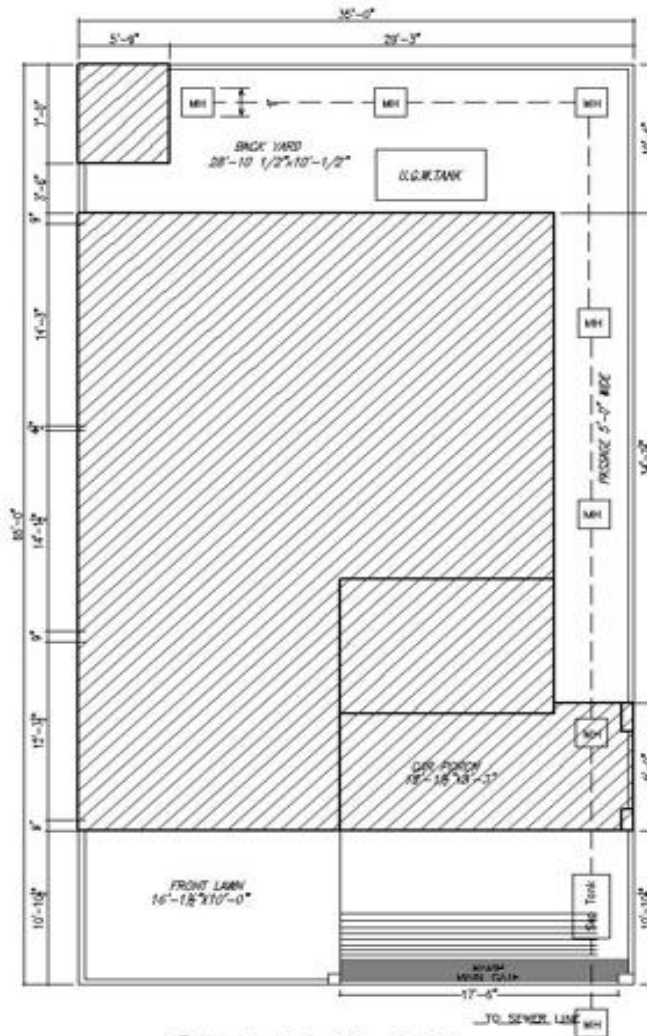
PAGE 040



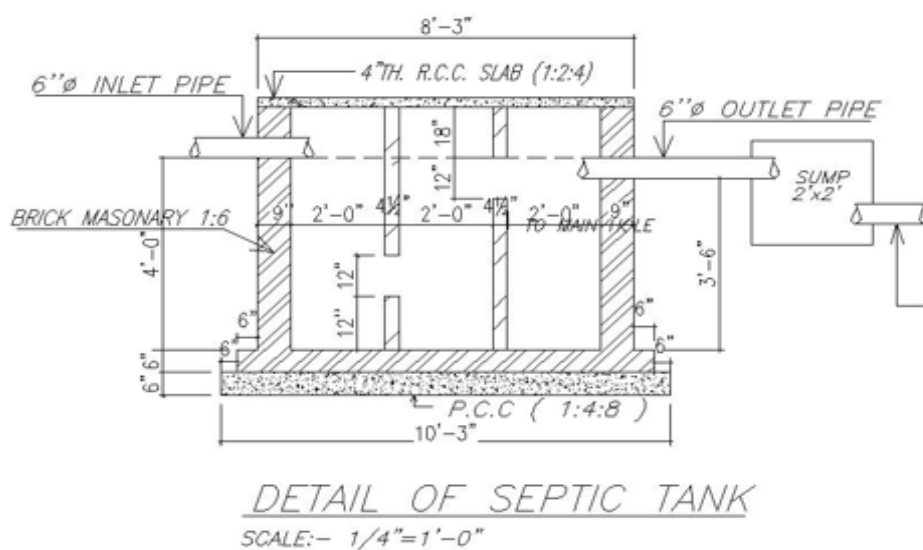
SECTION A-A
 SCALE 1/8"=1'-0"

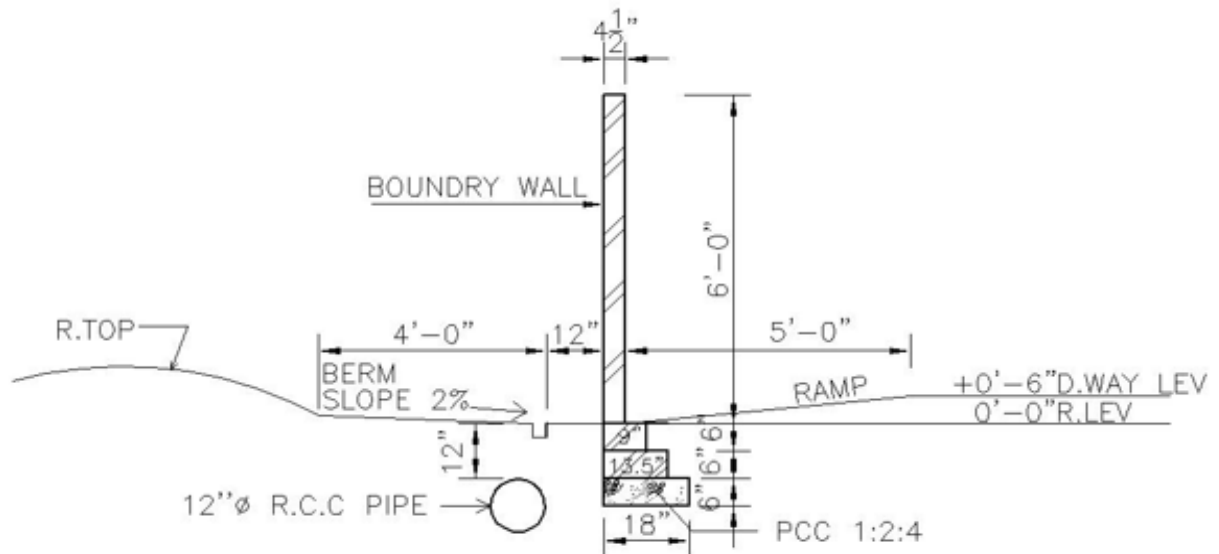


MUMTY DETAIL
SCALE 1/8"=1'-0"



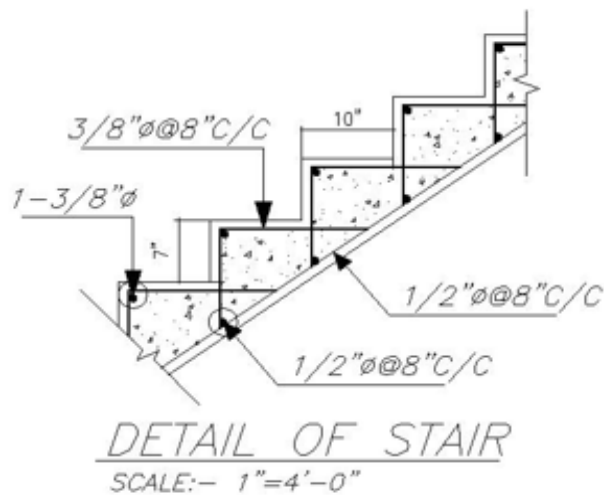
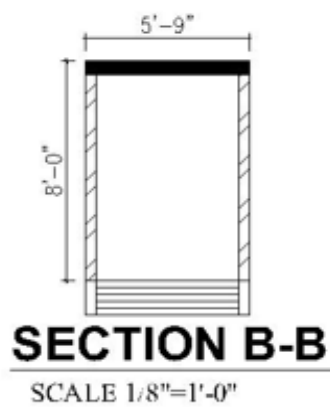
SITE PLAN
SCALE 1/16"=1'-0"

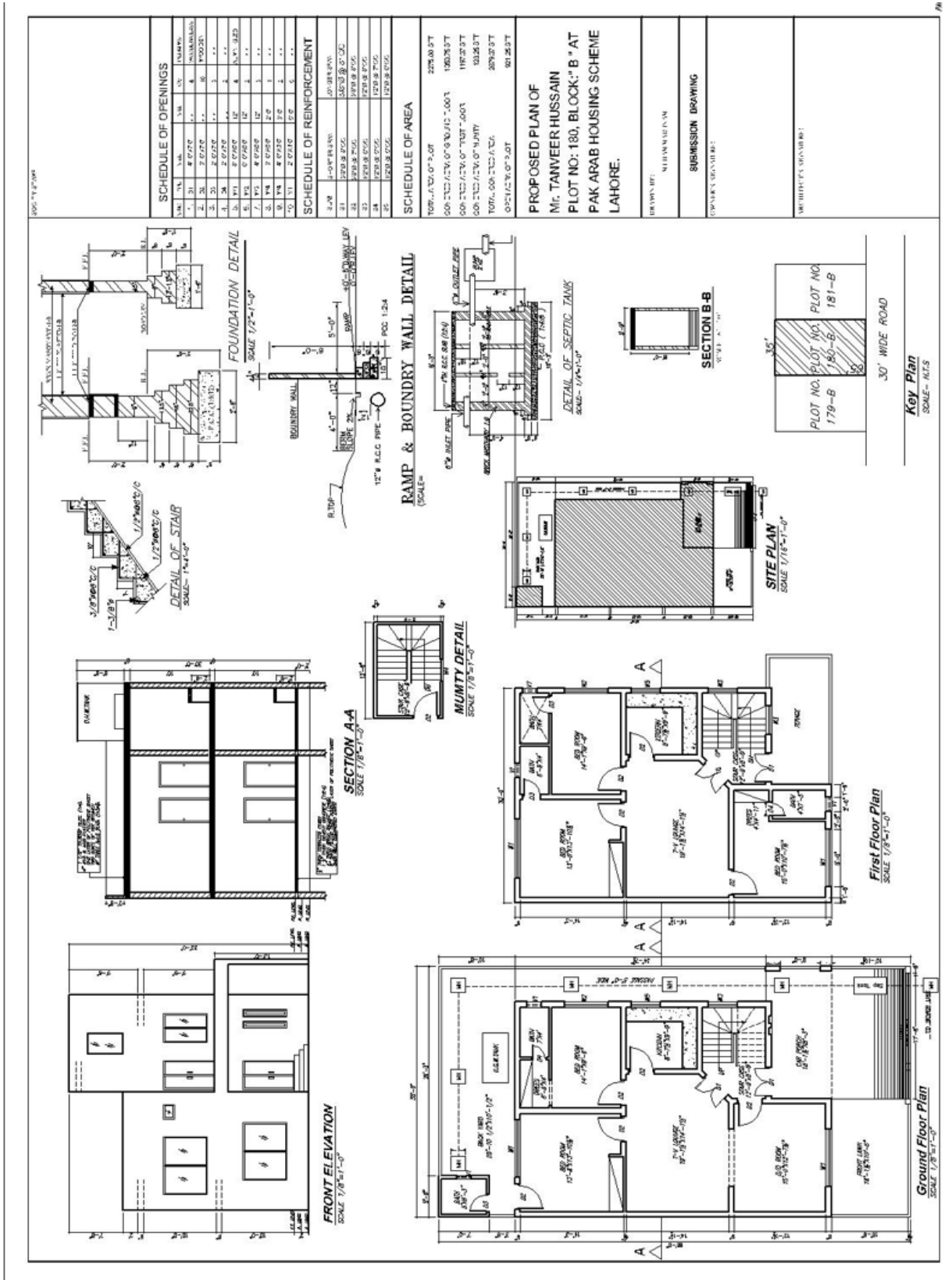




RAMP & BOUNDARY WALL DETAIL

(SCALE=





Activity 2:

Make orthographic projection of following isometric drawing and also make sectional views in middle of X and Y directions.

SUMMARY

This module is designed to provide skills and knowledge to create 2-Dimensional drawings by using various tools and commands. Trainees can create and modify objects and drawings in AutoCAD to meet specific targets according to job requirements.

FAQs:**1. What is AutoCAD?**

Ans. AutoCAD is a CAD (Computer-Aided Design) software used for creating engineering drawings and designs.

2. What is the shortcut for saving a file in AutoCAD?

Ans. Use CTRL + S or type SAVE command.

3. What is the default file format of AutoCAD?

Ans. The default file format is .DWG (Drawing).

4. What is the shortcut for the Line command?

Ans. Type L and press Enter.

5. Which command is used to draw a circle?

Ans. The C command is used.

6. What is the shortcut for the Offset command?

Ans. The O command is used.

7. What is the difference between Trim and Extend?

Ans. TRIM removes extra parts of a line, while EXTEND lengthens a line.

8. What is the shortcut for the Mirror command?

Ans. The MI command is used.

9. What is the shortcut for the Copy command?

Ans. The CO or CP command is used.

10. What is the shortcut for the Rotate command?

Ans. The RO command is used.

11. What is the function of the Scale command?

Ans. The SC command is used to increase or decrease the size of an object.

12. Why are layers important in AutoCAD?

Ans. Layers help organize different objects by categorizing them.

13. How to open layer properties?

Ans. Use the LA command.

14. What is the function of Grid and Snap?

Ans. The grid provides a reference, and Snap helps in placing objects at exact points.

15. Which command is used to write text?

Ans. DT (Single Line Text) and MT (Multi-Line Text) commands are used.

16. Which command is used to add dimensions?

Ans. The DIM command is used.

17. What is the function of the Hatch command?

Ans. The Hatch command is used to apply patterns or shading to an object.

18. What does the Leader command do?

Ans. The LE command attaches text with an arrow.

19. What is the difference between Polyline and Line?

Ans. A polyline is a connected segment, whereas a simple line consists of separate segments.

20. What is the shortcut for the Pan command?

Ans. The P command is used.

MCQs:

Questions	Option A	Option B	Option C	Option D
1. Which command convert discrete 2D objects in polyline?	Union	Subtract	Join	Polyline
2. When drawing in 2D, what axis do you NOT work with?	X	Y	Z	WCS
3. To print the selected project, you will choose to regulate what to plot?	Display	Extents	Limits	Window
4. What is the difference between the Scale command from the	Scale for single object, while the Zoom whole plan	No difference	A Scale can grow / shrink a shape up 10 times, while	A Scale changes the size of objects, while the Zoom

command Zoom?			the Zoom has no limits	changes the visibility of the project
5. What is the function of the LINE command in AutoCAD?	To draw a polygon.	To draw a straight line between two points	To draw an arc	To create a 3D model
6. What does the OFFSET command do?	Moves an object from one place to another	Creates a parallel copy of an object at a specified distance	Rotates an object	Extends an object
7. Which command is used to trim excess parts of an object?	Extend	Trim	Erase	Move
8. How can you draw a circle with a specific radius?	Use the CIRCLE command and specify the center and radius	Use the ARC command	Use the ELLIPSE command	Use the RECTANGLE command
9. What is the purpose of using Layers in AutoCAD?	To divide the drawing into sections for better organization	To make a 3D model	To apply colors only	To increase the file size
10. Which command is used to add dimensions in AutoCAD?	Measure	Dim	Length	Scale
11. What is the function of the TEXT command?	To add textual information in a drawing	To create a table	To label blocks	To delete text
12. Which command is used to make a copy of an object in AutoCAD?	Copy	Mirror	Duplicate	Move
13. What is the minimum allowable number of layers in a drawing?	0	5	1	2

14. How many SNAP points does an object have?	1	4	5	Depend on object
15. Which one is AutoCAD Extension.?	Dwg	Dxf	Dot	dws

ANSWER KEY

1	2	3	4	5	6	7	8
C	C	D	D	B	B	B	A
9	10	11	12	13	14	15	
A	B	A	A	C	D	A	

Module 6	Develop 3D Model in AutoCAD
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Learning Outcomes:

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

- Develop 3D Objects
- comprehend Complex 3D Surfaces
- Develop 3D Model
- Render 3D Mode

Learning Unit 6.1	Develop 3D Objects
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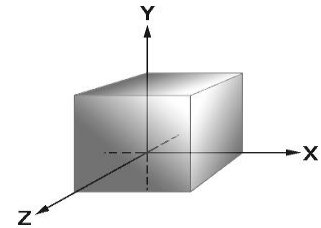
Learning Outcomes:

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

- Setup & save 3D drawing interface for required specifications.
- Create 3D objects with given measurements

6.1.1 3D and its concepts**What is 3D?**

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).

**6.1.2 Functions of 3D tools and commands**

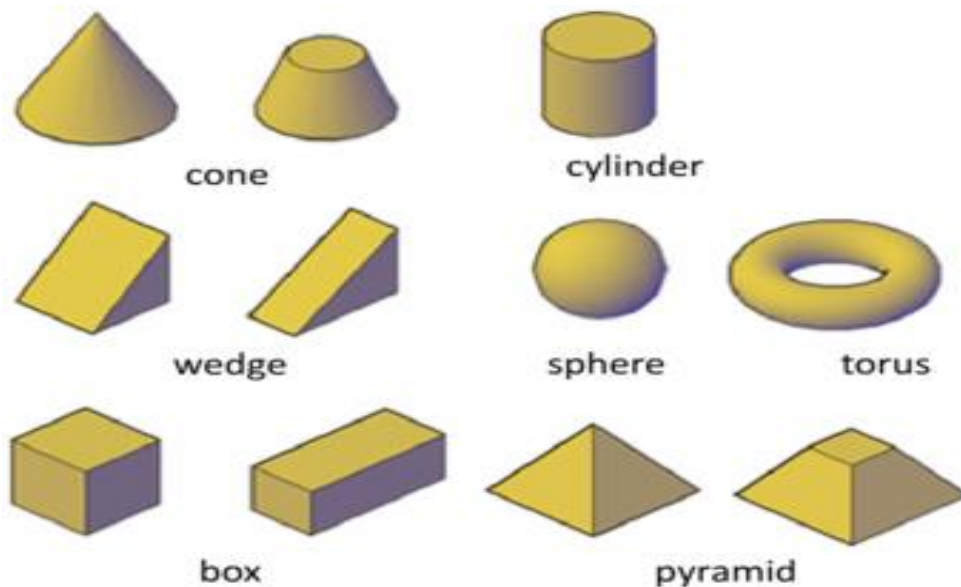
The functions of 3D tools and commands in AutoCAD program is to create, modify, analyze, and visualize three-dimensional objects. These tools and commands enable users to design complex models, simulate real-world conditions, and produce accurate technical drawings or renderings

6.1.3 Types of 3D shapes and Building Model**Basic Geometric Primitives**

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

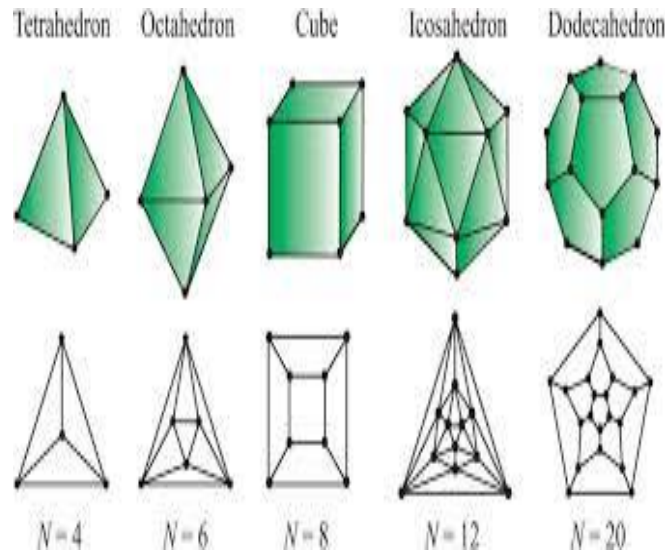
- i. **Cube**
 - A six-faced shape with all sides equal (e.g., a dice).
 - Properties: 6 faces, 12 edges, 8 vertices.
- ii. **Sphere**
 - A perfectly round shape with all points on its surface equidistant from the center (e.g., a ball).
 - Properties: No edges or vertices, perfectly symmetrical.
- iii. **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.
- iv. **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.
- v. **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.
- vi. **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).
- vii. **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.

**Building Model Types**

Building models represent structures for visualization, planning, or construction. Some common types include:

i. conceptual model

- Used in the early design phase to explore ideas.
- Made from simple materials like foam, cardboard, or clay.

**ii. Architectural Models**

- **Massing Model** – Represents the general shape and size of a building.
- **Site Model** – Shows a building in relation to its surroundings.
- **Presentation Model** – A detailed, realistic model for showcasing design concepts.

**iii. Structural Models**

- Demonstrates load distribution and construction techniques.
- Used by engineers to study building stability.

**iv. Digital 3D Models**

- Created using software like AutoCAD, Revit, or Sketch Up.
- Used for virtual visualization and BIM (Building Information Modeling).

v. Scale Models

- Miniature versions of buildings for exhibitions and presentations.

- Made with materials like wood, plastic, or resin.
- vi. **Functional Models**
- Includes moving parts or lighting to demonstrate real-world functionality.
 - Used in smart city planning and energy-efficient designs.

6.1.4 Types of views (Isometric, top, bottom, front, left, etc.)

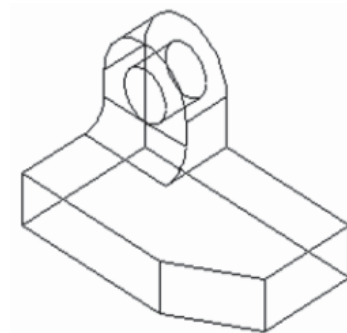
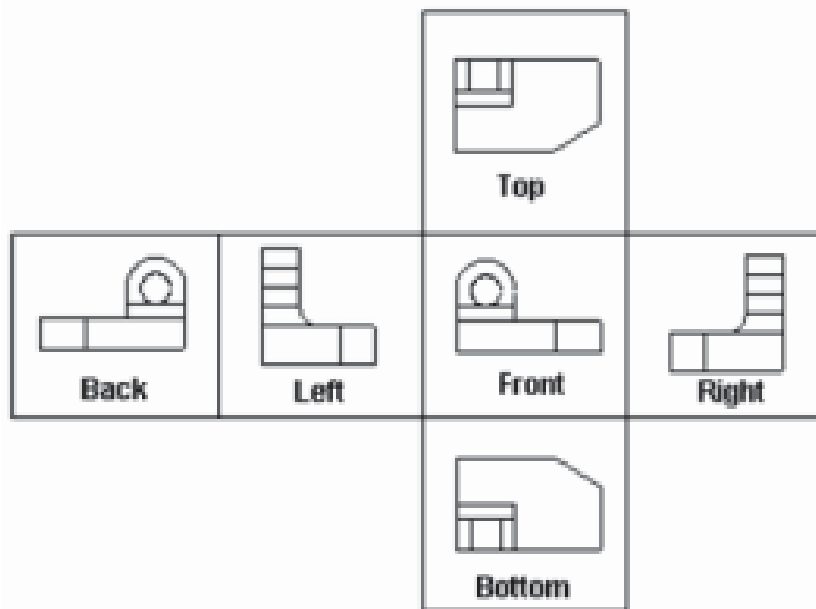
In AutoCAD, different types of views are used to visualize a 3D model from different angles. These views help in designing, analyzing, and presenting a drawing accurately. Below are the common types of views in AutoCAD:

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.



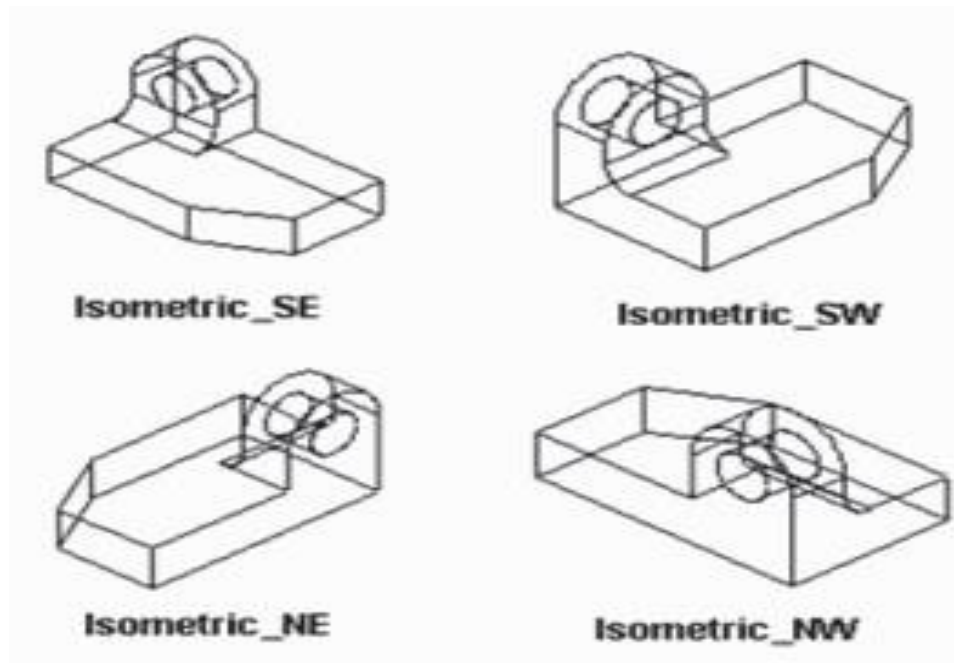
Left View: Looks at the YZ plane while facing +X.

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

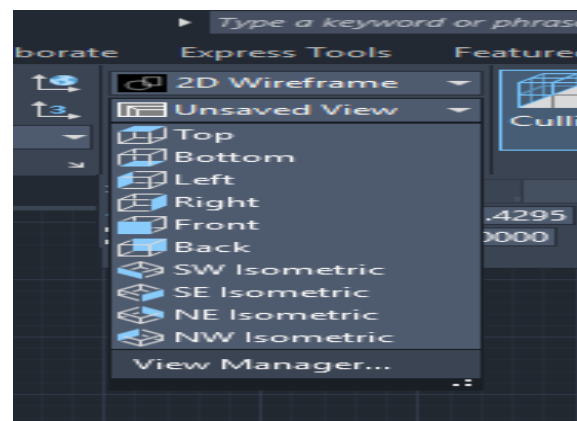
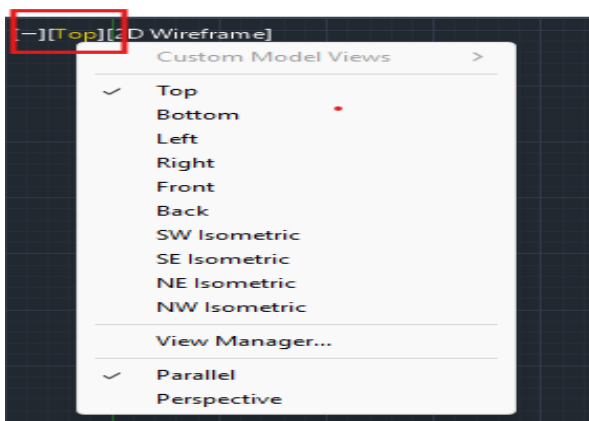
Back View: Looks at the XZ plane while facing -Y.

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.

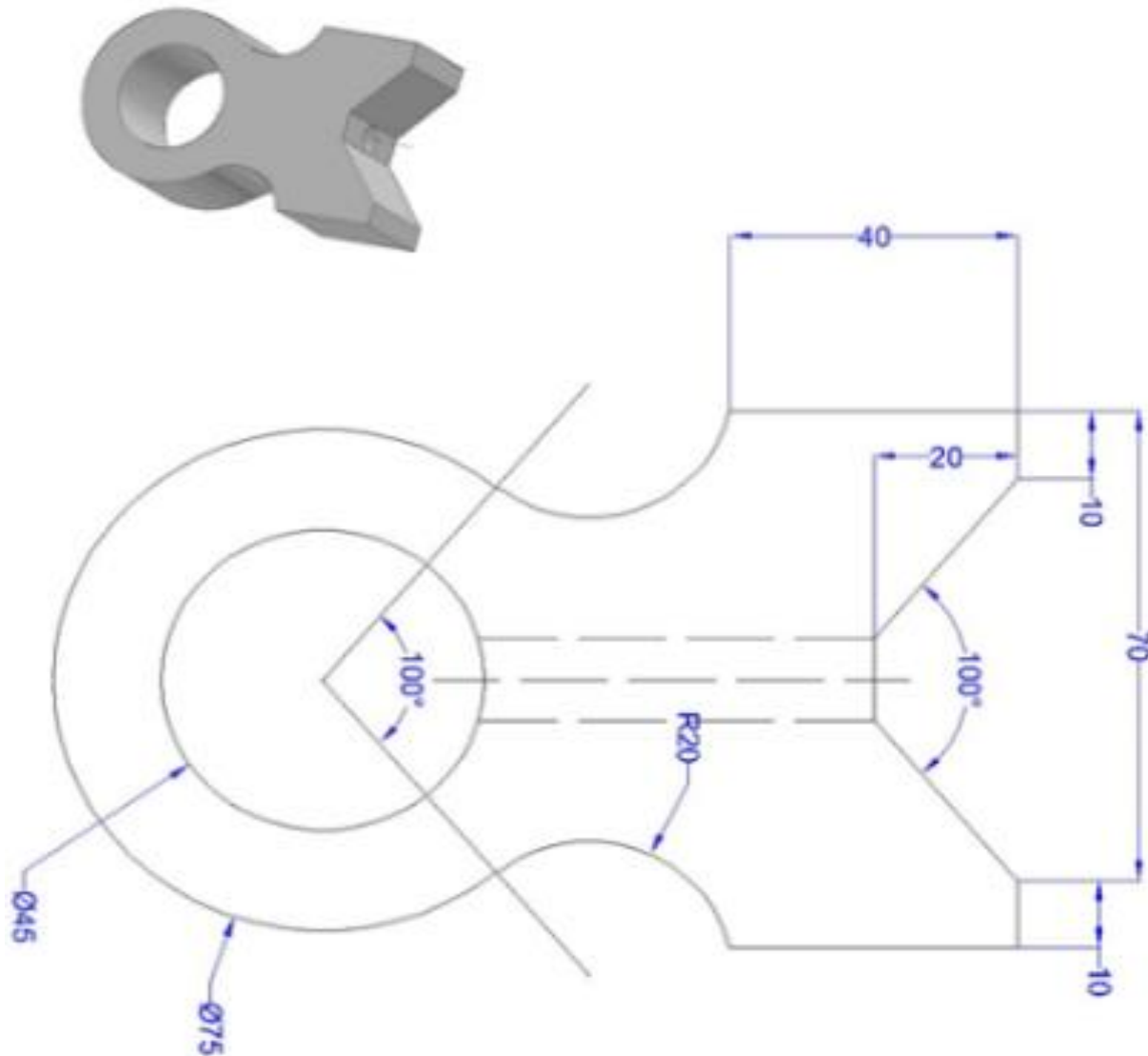


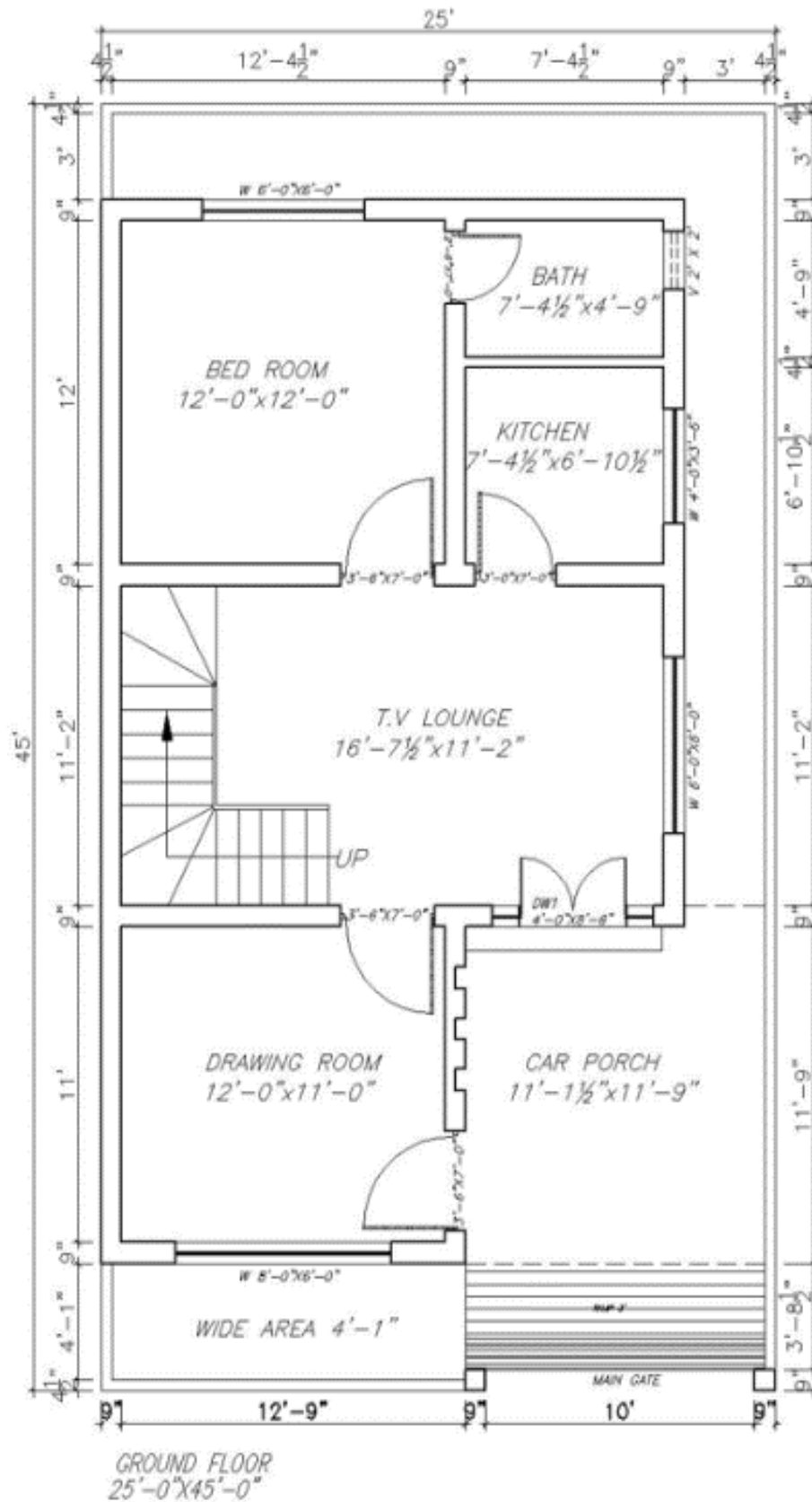
The last four views on the toolbar are isometric - angled views. The views are named for compass directions (Isometric SE is the view looking from the southeast). You can change the different view from view port, view control as well as from view tap



Activity 1:

Draw and practice different 3D models in civil / mechanical.





Learning Unit 6.2**Comprehend Complex 3D Surfaces****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

6.2.1 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

6.2.1.1 Union: (UNI)

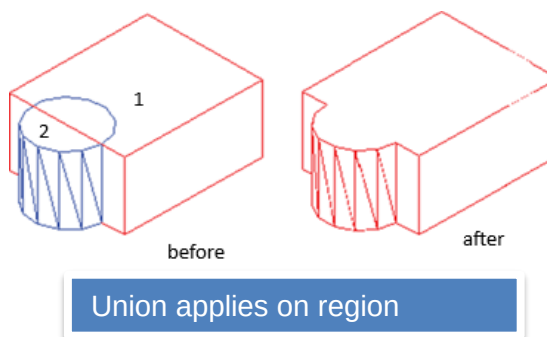
You can combine two or more 3D solids, surfaces, or 2D regions into a single, composite 3D solid, surface, or region.

The Union command typically works with objects of the same type. You can combine solids with solids or regions with regions. Mixing object types (like trying to union a solid with a region directly) usually won't work.

Through Short Cut Key

UNI enter

Type **UNI** at the Command Line ☐ Select all objects at once or one by one ☐ enter or right click of Mouse

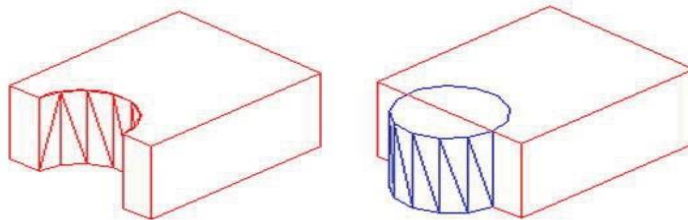
**6.2.1.2 Subtract (SU)**

With **SUBTRACT**, you can create a 3D solid by subtracting one set of existing 3D solids from another, overlapping set. You can create a 2D region object by subtracting one set of existing region objects from another, overlapping set. You can select only regions for use with this command.

It's widely used in 3D modeling to create holes, cutouts, and complex shapes by removing one solid from another. For example, you can use it to create a hole for a window in a 3D wall.

Type **SU** at the Command line ☐ enter then, you select the object from which you want to subtract.

Then, you select the object(s) you want to subtract. then ☐ enter.

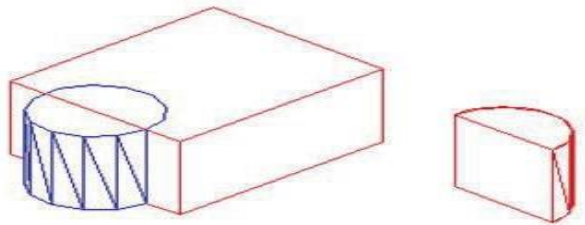


6.2.1.3 Intersect (IN)

Create a 3D solid, surface, or 2D region from overlapping solids, surfaces, or regions. With **INTERSECT**, you can create a 3D solid from the common volume of two or more existing 3D solids, surfaces, or regions. If you select a mesh, you can convert it to a solid or surface before completing the operation.

Through Short Cut Key

Type **IN** at the Command Line ☐ Select objects ☐ enter



6.2.2 3D Navigate control Pre-set views such as 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, and when people say "3D Navigate control" they are generally talking about a collection of tools that help you to change your viewpoint. Here's a breakdown of the key elements:

3D Navigation Tools:

6.2.2.1 View Cube:

- This is a prominent interactive tool that allows you to rotate your 3D view.
- You can click on its faces, edges, and corners to quickly switch to standard orthographic and isometric views.
- It also allows you to rotate the model freely.
- It is a very fast way to change between standard views.



6.2.2.2 Navigation Bar:

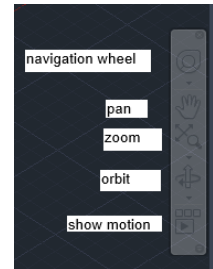
This bar provides access to various navigation tools, including:

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.



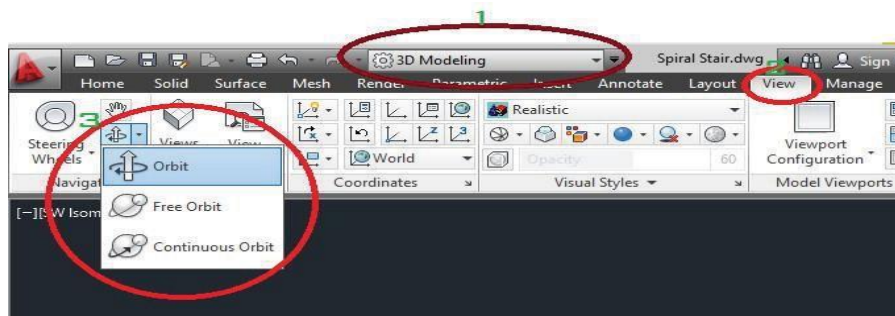
6.2.2.3 3D Orbit (3DR)

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

6.2.2.4 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

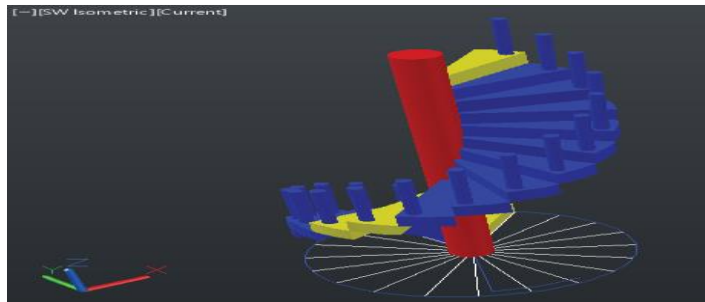


Sr#	Name	Command	Description
1	Orbit	Orbit/3dorbit	Constrains orbiting to the XY plane or the Z direction.

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. Works like the Adjust Distance option.
9	Pan	3DPAN	Changes the cursor to a hand cursor and moves the view in the direction that you drag.

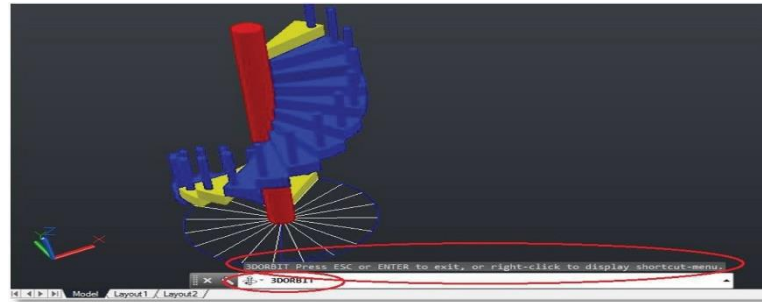
6.2.2.5 Procedure Apply Orbiting to Drawing STEP BY STEP

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 drawing as shown in the figure below.



Step-1: Type orbit/3dorbit command in command bar <Enter>

Step-2: You can orbit/revolve the drawing according to XY plane or the Z direction During any orbiting you can get other functions as shown



below:

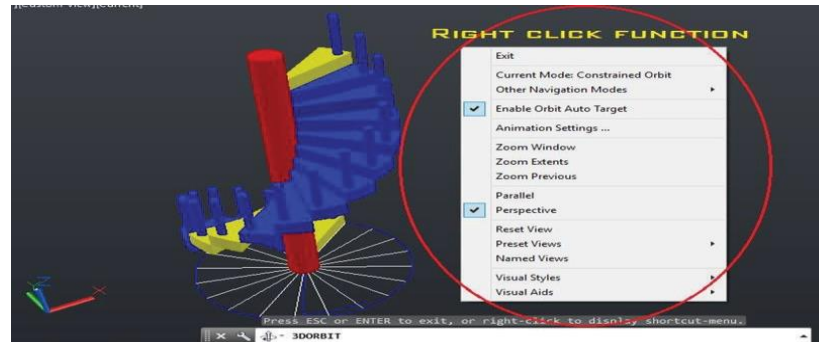
Whenever you apply any orbit, you will get the option “Press ECS or ENTER to exit or right- click to display shortcut-menu”.

- **Use of ECS Button**

When you press ECS button during orbiting, as the name describe ECSAPE, you will get release or exit from the orbit command, and will get ready to prompt other commands of AutoCAD

- **Use of Right Click**

Whenever you right-click during orbiting you will get the following



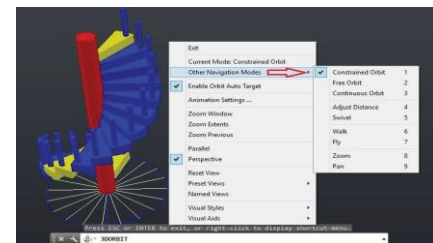
shortcut-menu as shown in the figure below

6.2.2.6 Discover Other Navigational Modes

As we discussed other navigation from where you can get the nine orbiting types as shown in the figure

Step-1: Type orbit/3dorbit command in command bar <Enter>

Step-2: Right click at the drawing area, you will get the following



6.2.2.7 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.

6.2.2.8 Developing Pan and Zoom in 3D Orbit

You can easily develop Zoom and Pan command during orbiting, the function of zoom and pan as the same as we discussed in previous module, 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.

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

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

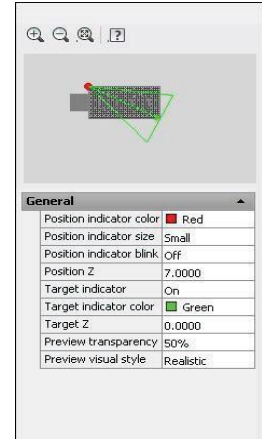
When you walk through a model, you travel along the XY plane. When you fly through a model, you are not constrained by the XY plane, so you appear to “fly” over an area in a model.



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



6.2.2.10 Preset Views

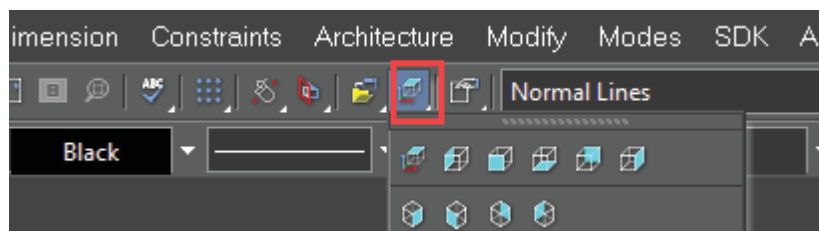
The view is the area of the drawing space that appears on your screen. As your drawing becomes larger and more complex, it's important to find views that let you work at the right location in your drawing, at an appropriate level of detail.

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.

6.2.2.11 Preset 3D Viewports: -

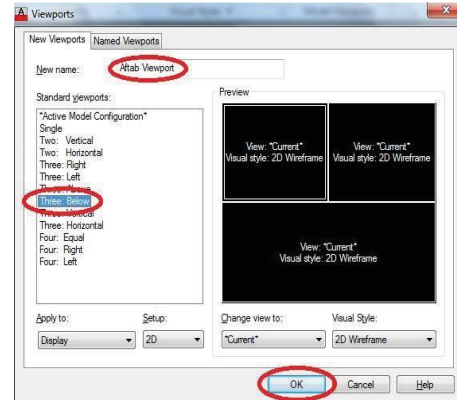
You can use Command to split the windows: by typing the **VPORTS** command in command line.

Step-1: Type: VPORTS

You will get the following figure

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

- i. If you do not enter a name, the viewport configuration is applied but not saved.
- ii. If a viewport configuration is not saved, it cannot be used in a layout.
- iii. If you specify a name, it can be saved and can be used in a layout.



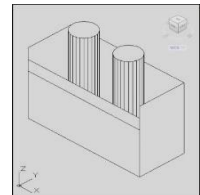
Step-3: Whenever you used the viewport again you will get the layout named Aftab Viewport as shown in figure below

Visual Style: -

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

6.2.2.12 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.



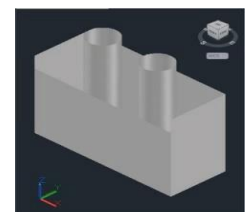
6.2.2.13 Conceptual

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.



6.2.2.14 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.



6.2.2.15 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

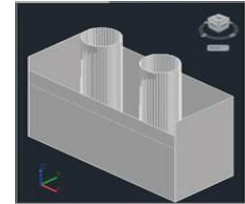
along with the material applied.

6.2.2.16 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.

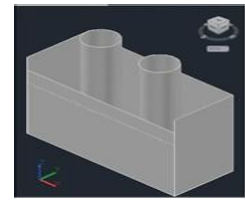
6.2.2.17 Shaded with edges

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



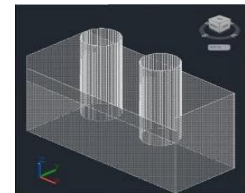
6.2.2.18 Shades of Gray

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



6.2.2.19 Sketchy

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

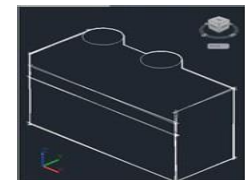


6.2.2.20 Wireframe

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.

6.2.2.20 9 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.



6.2.2.21 Perspective projection and parallel projection

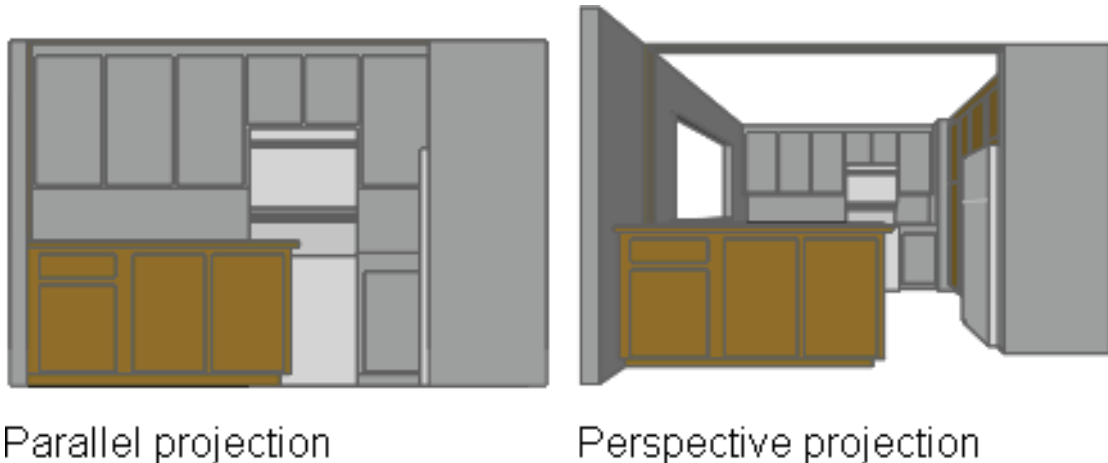
You can create realistic visual effects in a drawing by defining either parallel or perspective projections of a model.

The difference between perspective views and parallel projections is that 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.



Define Parallel Projections

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

- i. Choose a preset 3D view from the View toolbar.
- ii. Enter a coordinate or angles that represent your viewing location in 3D.
- iii. Change to a view of the *XY* plane of the current UCS, a saved UCS, or the WCS.
- iv. Change the 3D view dynamically with your pointing device.
- v. 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.

6.2.3 3D Primitives: Familiarity with basic 3D shapes like 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.

You can create several basic 3D shapes, known as solid primitives: boxes, cones, cylinders, spheres, wedges, pyramids, and torus (donuts).

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

- i. Box
- ii. Cone
- iii. Cylinder
- iv. Pyramid
- v. Sphere
- vi. Wedge
- vii. Tours

6.2.3.1 Box

Teaching and Learning Guide: Information Technology (CAD) **AutoCAD**

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.

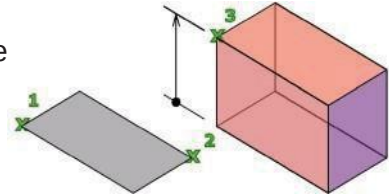
Through Short Cut Key ☐ BOX enter

Type **Box** at the Command Line ☐ Specify Start point ☐ Put the Value of @ X and Y Co-ordinate ☐ Put the value of height ☐ enter

Box Options

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

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



Cube

Use the Cube option of the BOX command to create a box with sides of equal length.

Length

Create a box with length, width, and height values you specify. If you enter values, the length corresponds to the X axis, the width to the Y axis, and the height to the Z axis. If you pick a point to specify the length, you also specify the rotation in the XY plane.

Center point.

Use the Center option to create a box using a specified center point.

6.2.3.2 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.

Initially, the default base radius is not set to any value. During a drawing session, the default value for the base radius is always the previously entered base radius value for any solid primitive.

Through Short Cut Key ☐ Cone enter

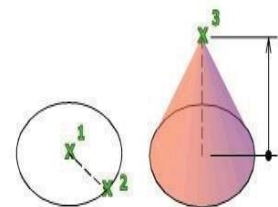
Application

Type **Cone** at the Command Line Specify center point of base put the base radius value Put the Value of Height enter

Cone Option

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

- i. Center Point
- ii. Axis Endpoint
- iii. Frustum
- iv. 3P
- v. Elliptical
- vi. TTR (Tangent, Tangent, Radius)



Center Point

When you specify the center point, the Cone is positioned so that its central axis is parallel to the Z axis of the current user coordinate system (UCS). Latitudinal lines are parallel to the XY plane.

Axis Endpoint

Use the Axis Endpoint option when you want to reorient the cone by placing the tip or axis endpoint anywhere in 3D space.

Frustum

Use the Top Radius option to create a frustum of a cone, which tapers to an elliptical or planar face.

3P (Three Points)

The 3P (Three Points) option defines the size and plane of the base of the cone anywhere in 3D space.

Elliptical

Use the Elliptical option to create a cone base whose axes are of different lengths.

TTR (Tangent, Tangent, Radius)

Use the TTR (Tangent, Tangent, and Radius) option to define points on two objects. Depending on the radius distance, the new cone is located as near as possible to the tangent points you specify. You can set up tangency with circles, arcs, lines, and some 3D objects. The tangency points are projected into the current UCS. The appearance of tangency is affected by the current level of smoothness.

6.2.3.3 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

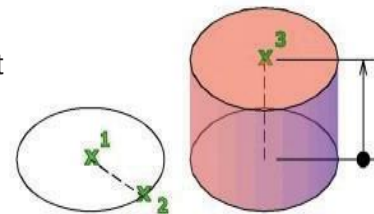
☐ Cylinder enter

Application

Type Cyl at the Command Line ☐ Specify center point of base put the Value of Height enter

Cylinder Options

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



Axis End point

Use the Axis Endpoint option to set the height and rotation of the cylinder. The center point of the top plane of the cylinder is the axis endpoint, which can be located anywhere in 3D space.

3P (Three Points)

Use the 3P (Three Points) option to define the base of the cylinder. You can set three points anywhere in 3D space.

Elliptical

Use the Elliptical option to create a cylinder base whose axes are of different lengths.

TTR (Tangent, Tangent, Radius)

Use the TTR (Tangent, Tangent, and Radius) option to define points on two objects. Depending on the radius distance, the new cylinder is located as near as possible to the tangent points you specify. You can set up tangency with circles, arcs, lines, and some 3D objects. The tangency points are projected onto the current UCS.

6.2.3.4 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. Initially, the default base radius is not set to any value. During a drawing session, the default value for the base radius is always the previously entered base radius value for any solid primitive.

Use the Top Radius option to create a pyramid frustum.

Through Short Cut Key Pyr enter

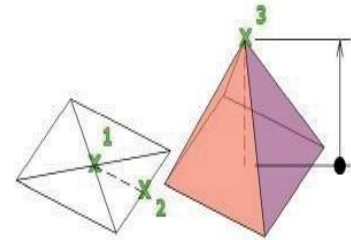
Application

Type Pyr at the Command Line Specify center point of base put the base radius value 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

**Sides**

Use the Sides option to set the number of sides for the pyramid.

Edges.

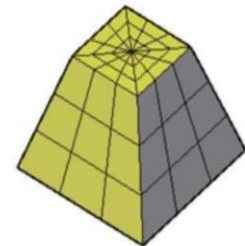
Use the Edges option to specify the dimension of the sides at the base.

Frustum

Use the Top Radius option to create a frustum, which tapers to a planar face. The frustum face is parallel to and has the same number of sides as, the base.

Axis Endpoint

Use the Axis Endpoint option to specify the height and rotation of the pyramid. This endpoint is the top of the pyramid. The axis endpoint can be located anywhere in 3D space.

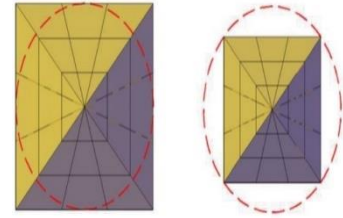
**Inscribed or circumscribed perimeter.**

Specify whether the pyramid base is drawn inside or outside of the radius

Circumscribed Inscribed

6.2.3.5 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. You can control the smoothness of curved 3D solids, such as a torus, in a shaded or hidden visual style with the FACETRES system variable.



Through Short Cut Key Sphere enter

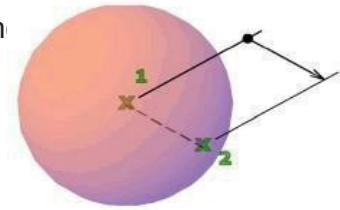
Application

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)



Center Point

Specify the center point of the sphere. When you specify the center point, the sphere is positioned so that its central axis is parallel to the Z axis of the current user coordinate system (UCS). Latitudinal lines are parallel to the XY plane.

Radius	Defines the radius of the sphere.
Diameter	Defines the diameter of the sphere.

2P (Two Points)

Define the circumference of the sphere by specifying two points anywhere in 3D space. The plane of the circumference is defined by the Z value of the first point.

3P (Three Points)

Define the circumference of the sphere by specifying three points anywhere in 3D space. The three specified points also define the plane of the circumference.

TTR (Tangent, Tangent, Radius)

Define the sphere with a specified radius tangent to two objects. The specified tangency points are projected onto the current UCS.

6.2.3.6 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

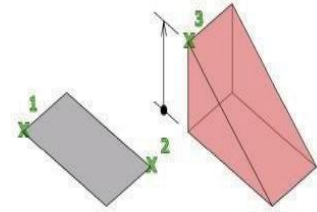
Type Wedge at the Command Line ☐ Specify Start point ☐ Put the Value of @ X and Y Co-ordinate ☐ Put the Value of Height ☐ enter

Wedge Option

Teaching and Learning Guide: Information Technology (CAD) AutoCAD

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

- i. Center
- ii. Cube
- iii. Length
- iv. 2pints with weight)



Center

Create the wedge by using a specified center point.

Cube

Set all edges of the mesh wedge base to be of equal length.

Length

Create a wedge with length, width, and height values you specify. The length corresponds to the X axis, the width to the Y axis, and the height to the Z axis. If you pick a point to specify the length, you also specify the rotation in the XY plane.

2 point (with Height)

Specify that the height of the wedge is the distance between the two specified points.

6.2.3.7 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. You can control the smoothness of curved 3D solids, such as a torus, in a shaded or hidden visual style with the FACETRES system variable.

Through Short Cut Key

Tor enter

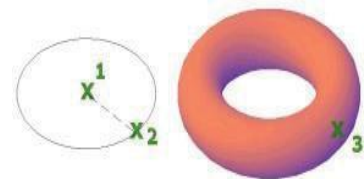
Application

Type Tor at the Command Line ☐ Specify center point of Torus Put the radius value of Torus
☐ 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.

- i. 3p
- ii. 2p
- iii. TTR
- iv. Radius



3P (Three Points)

Use the 3P (Three Points) option to define the size of the torus anywhere in 3D space. The three points also define the plane of the circumference. Use this option to rotate the torus as you create it.

2P (Two Points)

Use the 2P (Two Points) option to define the size of the torus anywhere in 3D space. The plane of the circumference matches the Z value of the first point.

TTR (Tangent, Tangent, Radius)

Use the TTR (Tangent, Tangent, and Radius) option to define points on two objects. Depending on the specified radius distance, the path of the torus is located as near as possible to the tangent points you specify. You can set up tangency with circles, arcs, lines, and some 3D objects. The tangency points are projected into the current UCS.

Radius

Define the radius of the torus: the distance from the center of the torus to the center of the tube. A negative radius creates a solid shaped like an American football.

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

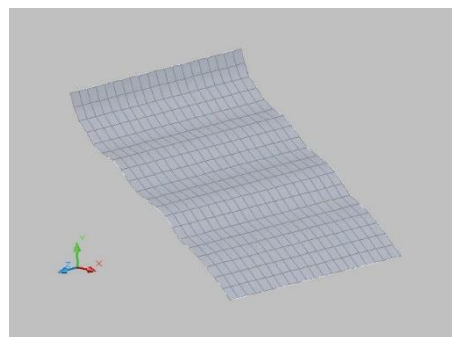
6.2.4.1 Edge Surfaces

Regenerates a three-dimensional model with hidden lines

Type **EDGESURF** at the command prompt.

Command: **EDGESURF** Current wire frame density: SURFTAB1=20 SURFTAB2=10

Select object 1 for surface edge: **P1** Select object 2 for surface edge: **P2** Select object 3 for surface edge: **P3** Select object 4 for surface edge: **P4**



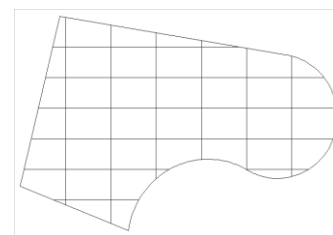
6.2.4.2 Plane surface

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

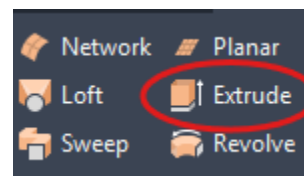


6.2.4.3 Extrude Surface

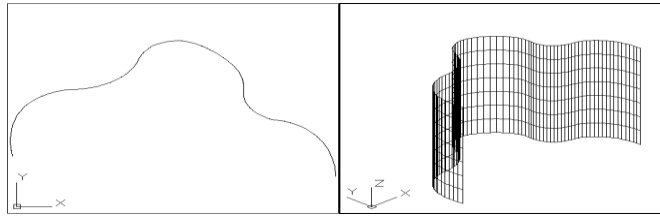
The **extrude** command creates a **3D surface** by extending a 2D object along a specified direction. Unlike extruded solids, extruded surfaces have no thickness unless later converted into solids.

Steps to Create an Extruded Surface:

- i. **Draw a 2D Shape** (e.g., line, circle, spline, or polyline).
- ii. Type **EXTRUDE** in the command line and press **Enter** or select extrude surface from ribbon



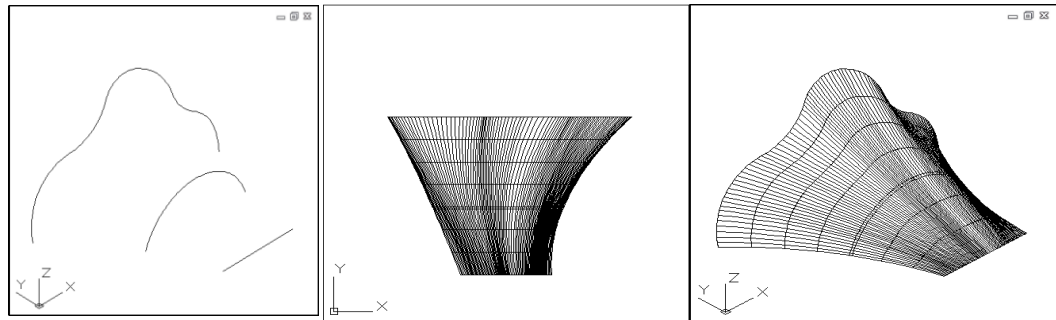
- iii. Select the 2D shape. Specify the extrusion height or direction.



6.2.4.4 Loft Command

The **LOFT** command creates a **3D surface** by smoothly connecting multiple cross-sections (profiles). It is commonly used to generate complex and freeform surfaces in **architectural, mechanical, and product design**.

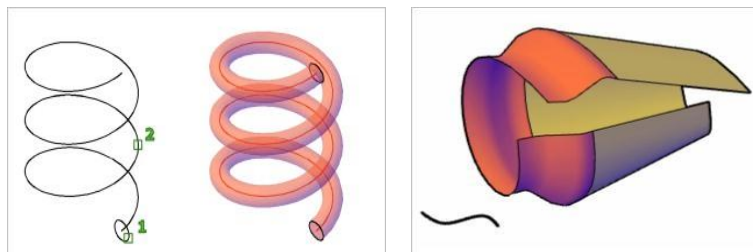
- i. Create open or closed curves (splines, arcs, polylines, etc.) in different planes.
- ii. Type **LOFT** in the command line and press **Enter**. or select from menu
- iii. Click the profiles in the desired order.
- iv. Choose from different lofting options: **Normal** AutoCAD generates a smooth transition between profiles. **Railed** Uses guide rails for more control over the shape. **Point-Based** Controls lofting using a point to influence the shape.
- v. **Press Enter to Create the Surface.** the lofted surface is generated.



6.2.4.5 Sweep Command

The **SWEEP** command is used to create **3D surfaces** by extruding a **2D profile along a specified path**. This is useful for modeling pipes, tubes, and other complex curved surfaces.

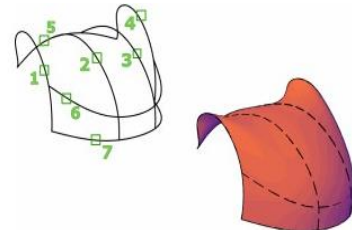
- i. Draw a **2D shape** (e.g., circle, rectangle, or custom profile).
- ii. Draw a **path** (line, arc, spline, or polyline) along which the profile will be swept.
- iii. **Activate the Sweep Command:**
- iv. Type **SWEEP** in the command line and press **Enter**. or select from menu
- v. Select the **profile** first -entre, then select the **path**.



6.2.4.6 Surface Network

The **Network Surface** tool creates a **3D surface** by connecting multiple intersecting curves in different directions. It is commonly used for **complex freeform and organic shapes** in architecture, automotive, and product design.

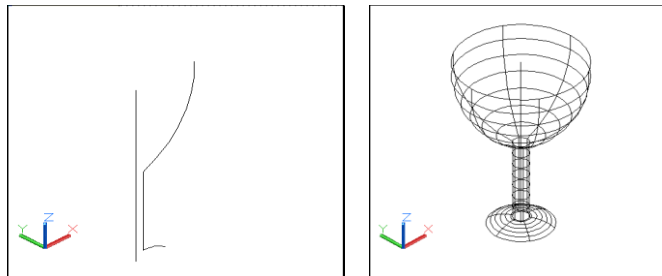
- i. Create at least **two U-direction** and **two V-direction** curves.
- ii. These curves can be **splines, arcs, or polylines** intersecting in a grid-like pattern.
- iii. **Activate the Network Surface Command:**
- iv. Type NETWORKSRF in the command line and press **Enter**.
- v. Select the **curves in both U and V directions**.
- vi. **Press Enter to Generate the Surface.**



6.2.4.7 Revolve Surface

The **REVOLVE** command creates a **3D surface** by rotating a **2D profile** around an axis. This is commonly used for designing **cylindrical, spherical, and symmetrical objects** such as bottles, wheels, and machine components.

- i. Create an open or closed shape using **lines, arcs, splines, or polylines**.
- ii. Ensure the profile is positioned correctly relative to the axis of rotation.
- iii. Type REVOLVE in the command line and press **Enter**.
- iv. Select the **profile** to be revolved.
- v. Select the **axis** (two points defining the rotation axis).
- vi. Enter a value (**e.g., 360° for a full revolution, or a custom angle**).
- vii. Press **Enter** to generate the revolved surface.

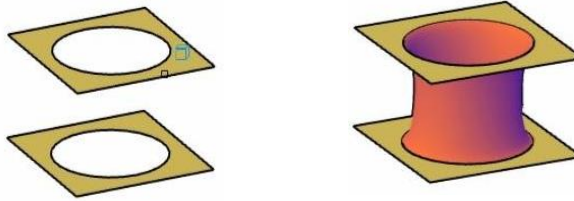


6.2.4.8 Surface Blend

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

6.2.4.9 Surface Patch

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

- i. Ensure you have a surface with a hole or gap that you want to patch.
- ii. Make sure the edges of the hole are clearly defined.
- iii. Type "SURFPATCH" or "PATCH" in the command line and press Enter.
- iv. Alternatively, locate the Patch command within the Surface tab of the ribbon.
- v. Select the edges of the hole or gap that you want to patch.
- vi. Ensure you select all the edges that define the boundary of the hole.
- vii. The order of selection is not usually important.
- viii. Once you've selected all the edges, press Enter to complete the selection.
- ix. AutoCAD will generate a surface that fills the hole or gap.
- x. Inspect the patched surface to ensure it meets your requirements.

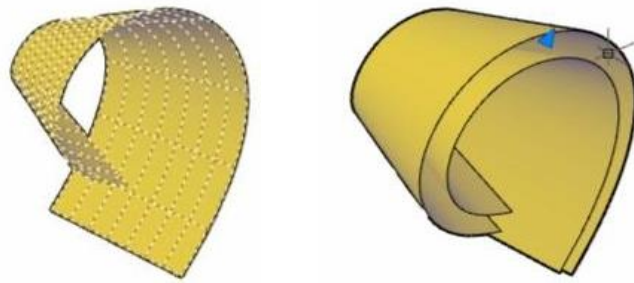


6.2.4.10 Offsetting Surfaces

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.

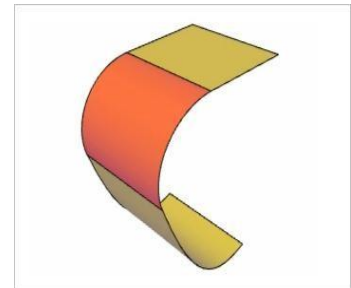
- Some versions of auto cad will give you the option to create a solid object from the offset. If this is desired, select the solid option.



6.2.4.11 Surface Fillet

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

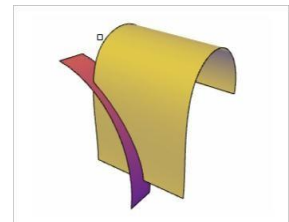
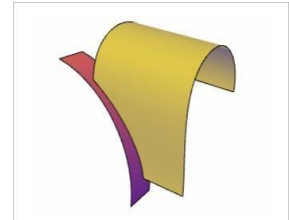
- Ensure the surfaces you want to fillet intersect or have edges that can be smoothly connected.
- It may be necessary to trim or extend surfaces to achieve a proper intersection.
- the object should not be a single entity
- activate fillet, select first object then second object.



6.2.4.12 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



6.2.4.13 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.

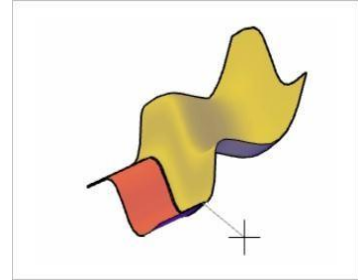
- Type "SURFUNTRIM" in the command line and press Enter. or find it within the surface portion of the ribbon
- You may be prompted to select the edges of the trimmed areas you want to restore.

- Alternatively, you might have the option to select the entire surface to untrim all trimmed areas.
- Press Enter to finalize the "SURFUNTRIM" operation.

6.2.4.14 Surface Extend

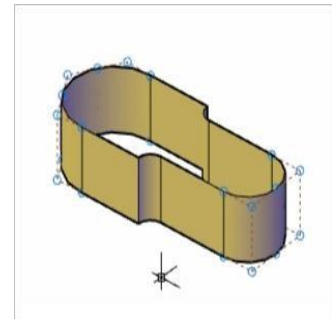
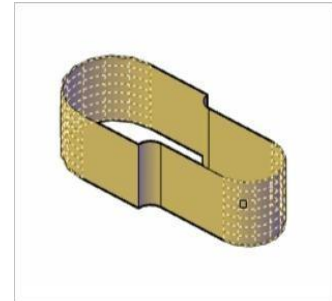
"Surface Extend" command is used to lengthen or expand the boundaries of a surface.

- 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



6.2.4.15 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



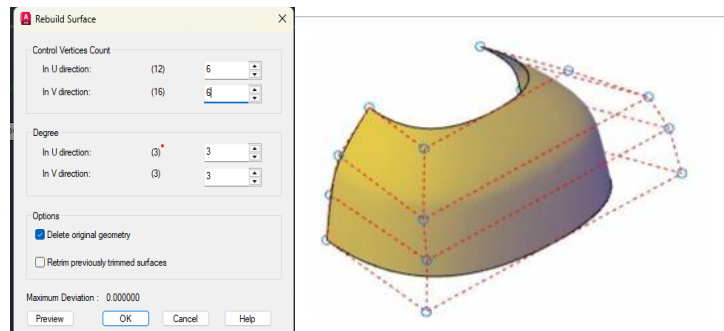
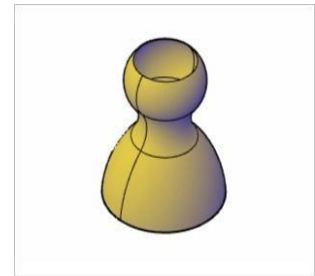
6.2.4.16 Shows NURB vertices and Surface CV – Hide

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.

6.2.4.17 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.

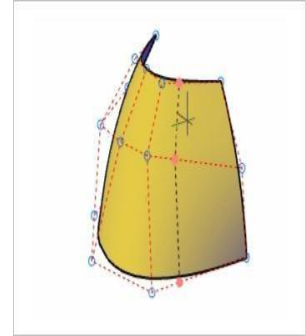
- Begin by selecting the NURBS surface that you want to rebuild.
- Type "CVREBUILD" in the command line and press Enter.
- Alternatively, you can find the command within the Surface editing sections of the ribbon.
- The "Rebuild Surface" dialog box will appear.
- This dialog box provides options for:
- 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



6.2.4.18 Surface CV Add

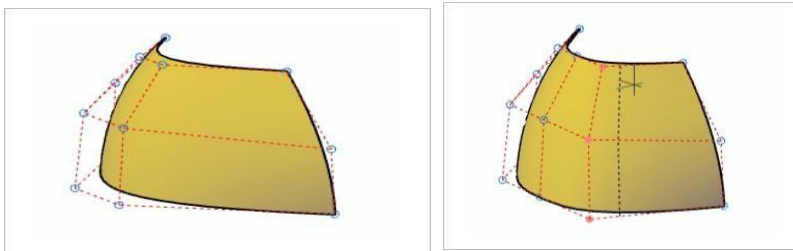
The "Surface CV Add" command allows you to add control vertices (CVs) to a NURBS surface, providing finer control over its shape.

- 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.



6.2.4.19 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.

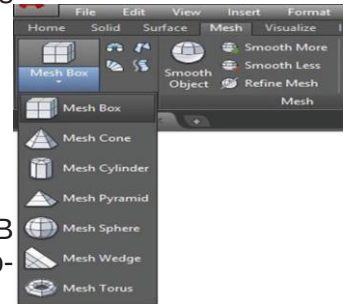
6.2.5 Mesh Modeling Tools

Basic Mesh Command

The basic mesh forms, known as mesh primitives, are the equivalent of the primitive forms for 3D solids. You can reshape mesh objects by smoothing, creasing, refining, and splitting faces. You can also drag edges, faces, and vertices to mold the overall form. Basic Mesh commands can be found out through Ribbon drop down Menu

6.2.5.1 MESH BOX

Creates a rectangular or cubical mesh box. The base of the mesh box is drawn parallel to the XY plane of the current UCS (work plane). Mesh Box command of 3D Surface can be found out through the following ways Through Short Cut Key: MESH enter B enter



Application

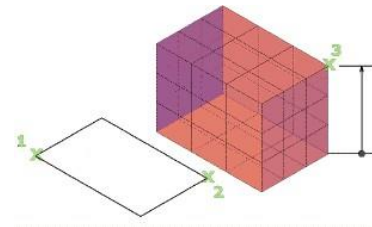
Type MESH at the Command Prompt

[Box/Cone/Cylinder/Pyramid/Sphere/Wedge/Torus/Settings] <Box>: ☐ B enter (for Box) ☐ Specify Start point ☐ Put the Value of @ X and Y Coordinate ☐ Put the Value of height ☐ enter

Mesh Box Options

The Box option of the MESH command provides several methods for determining the size and rotation of the mesh boxes you create.

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



Cube.

Use the Cube option to create a mesh box with sides of equal length

Length.

Use the Cube or Length option if you want to set the rotation of the box in the XY plane.

Center Point.

Use the Center option to create a box using a specified center point.

6.2.5.2 Mesh Cone

Create a 3D surface with a circular or elliptical base that tapers symmetrically to a point or to a circular or elliptical planar face. You can control the smoothness of 3D curved surface, such as a cone, in a shaded or hidden visual. Use the Top Radius option to create a cone frustum.

Through Short Cut Key MESH enter ☐ C enter

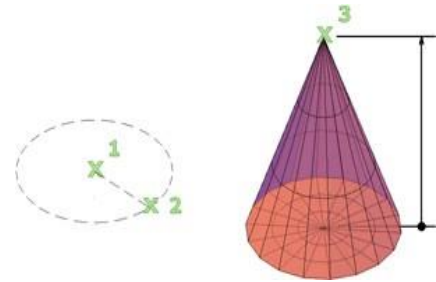
Application

Type MESH at the Command Line ☐ [Box/Cone/Cylinder/Pyramid/Sphere/Wedge/Torus/Settings] <Box>: ☐ C enter (for Cone) ☐ Specify center point of base ☐ Put the base radius value ☐ Put the Value of Height ☐ enter

Mesh Cone Option

The Cone option of the MESH command provides several methods for determining the size and rotation of the mesh cones you create.

- i. Center Point
- ii. Axis Endpoint
- iii. Frustum
- iv. 3P
- v. Elliptical
- vi. TTR (Tangent, Tangent, Radius)



Center Point

Specifies the center point of the Cone. When you specify the center point, the Cone is positioned so that its central axis is parallel to the Z axis of the current user coordinate system (UCS). Latitudinal lines are parallel to the XY plane.

- **Radius** Defines the radius of the Cone.
- **Diameter** Defines the diameter of the Cone.

Axis Endpoint

Use the Axis End point option when you want to reorient the cone by placing the tip or axis endpoint anywhere in 3D space.

Frustum

Use the Top Radius option to create a frustum of a cone, which tapers to an elliptical or planar face.

3P (Three Points)

The 3P (Three Points) option defines the size and plane of the base of the cone anywhere in 3D space

Elliptical

Use the Elliptical option to create a cone base whose axes are of different lengths.

TTR (Tangent, Tangent, Radius)

Use the TTR (Tangent, Tangent, and Radius) option to define points on two objects. Depending on the radius distance, the new cone is located as near as possible to the tangent points you specify. You can set up tangency with circles, arcs, lines, and some 3D objects. The tangency points are projected into the current UCS. The appearance of tangency is affected by the current level of smoothness.

6.2.5.3 Mesh Cylinder: -

Creates a 3D surface with a circular or elliptical base that extends to the other circular or elliptical planar face. 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: MESH enter ☐ CY enter

Application:

Type MESH at the Command Prompt
 [Box/Cone/Cylinder/Pyramid/Sphere/Wedge/ Torus/Settings] <Box>:☐CY
 enter (for Cylinder) ☐ Specify center point of base ☐Put the base radius
 value ☐Put the Value of Height ☐enter

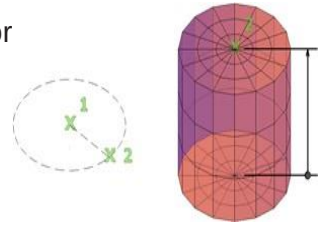
Remember

During a drawing session, the default value for the base radius is always as the previously entered base radius.

Mesh Cylinder Options:

The Cylinder option of the MESH command provides several methods for determining the size and rotation of the mesh cylinders you create

- i. Axis Endpoint
- ii. 3P (Three Point)

**Axis Endpoint**

Use the Axis Endpoint option to set the height and rotation of the cylinder. The center point of the top plane of the cylinder is the axis endpoint, which can be located anywhere in 3D space.

2P (Two Points)

Use the 3P (Three Points) option to define the base of the cylinder. You can set three points anywhere in 3D space.

6.2.5.4 Mesh 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. Initially, the default base radius is not set to any value. During a drawing session, the default value for the base radius is always the previously entered base radius value for any solid primitive.

Use the Top Radius option to create a pyramid frustum Through Short cut Key MESH enter ☐ P enter

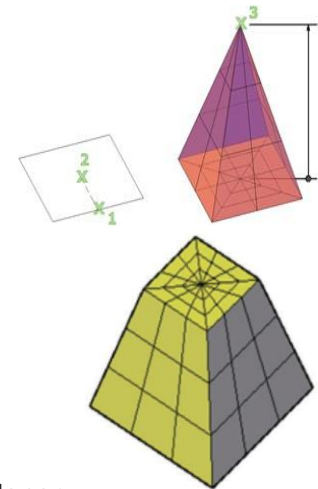
Application

Type MESH at the Command Line ☐ [Box/Cone/Cylinder/Pyramid/Sphere/Wedge/Torus/Settings] <Box>: ☐ P enter (for Pyramid) ☐ Specify center point of base ☐ Put the base radius value ☐ Put the Value of Height ☐ enter

Mesh Pyramid Option

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

- i. Side
- ii. Edges
- iii. Axis Endpoint
- iv. Inscribed or circumscribed perimeter

**Sides.**

Use the Sides option to set the number of sides for the mesh pyramid.

Edges.

Use the Edges option to specify the dimension of the sides at the base.

Frustum (Top Radius)

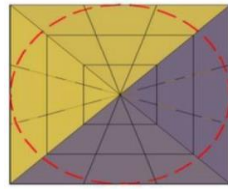
Use the Top Radius option to create a frustum, which tapers to a planar face. The frustum face is parallel to and has the same number of sides as, the base.

Axis Endpoint

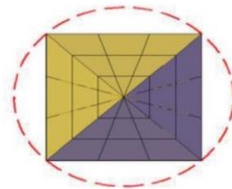
Use the Axis Endpoint option to specify the height and rotation of the pyramid. This endpoint is the top of the pyramid. The axis endpoint can be located anywhere in 3D space.

Inscribed or Circumscribed Perimeter.

Specify whether the pyramid base is drawn inside or outside of the radius.



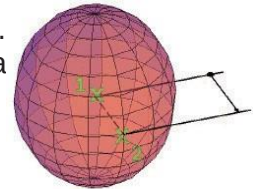
Circumscribed



Inscribed

6.2.5.5 Mesh Sphere

You can create a sphere by specifying a center point and a point on the radius. You can control the smoothness of curved 3D solids, such as a sphere, in a Shaded or hidden visual style with the FACETRES system variable.



Through Short Cut Key MESH enter ☐ S enter

Application

Type MESH at the Command Line [Box/Cone/Cylinder/ Pyramid/ Sphere/Wedge/Torus/ Settings] <Box>: ☐ S enter (for Sphere) ☐ Specify center point Put the radius value enter

Mesh Sphere Option

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

Center Point

Specifies the center point of the sphere. When you specify the center point, the sphere is positioned so that its central axis is parallel to the Z axis of the current user coordinate system (UCS). Latitudinal lines are parallel to the XY plane.

- **Radius** Defines the radius of the sphere.
- **Diameter** Defines the diameter of the sphere.

3P (Three Points)

Defines the circumference of the sphere by specifying three points anywhere in 3D space. The three specified points also define the plane of the circumference.

2P (Two Points)

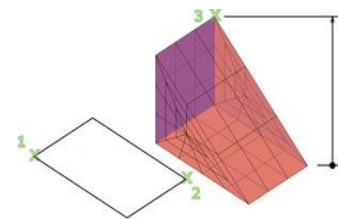
Defines the circumference of the sphere by specifying two points anywhere in 3D space. The plane of the circumference is defined by the Z value of the first point.

TTR (Tangent, Tangent, Radius)

Defines the sphere with a specified radius tangent to two objects. The specified tangency points are projected onto the current UCS.

6.2.5.6 Mesh Wedge

Creates a mesh wedge with rectangular or cubical faces. The base of the wedge is drawn parallel to the XY plane of the current UCS with the sloped face opposite the first corner. The height of the wedge is parallel to the Z axis.



Through Short cut Key MESH enter ☐ W enter

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Application

Type MESH at the Command Prompt ☐ [Box/Cone/Cylinder/ Pyramid/Sphere/Wedge/Torus/ Settings] <Box>: ☐ W enter (for Wedge) ☐ Specify Start point ☐ Put the Value of @ X and Y Co-ordinate ☐ Put the Value of Height ☐ enter

Mesh Wedge Option

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

- i. Center
- ii. Cube
- iii. Length
- iv. 2 Point (With Height)

Center

Create the wedge by using a specified center point

Cube

Set all edges of the mesh wedge base to be of equal length.

Length

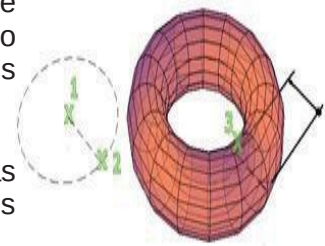
Creates a wedge with length, width, and height values you specify. The length corresponds to the X axis, the width to the Y axis, and the height to the Z axis. If you pick a point to specify the length, you also specify the rotation in the XY plane.

2 point (with Height)

Specifies that the height of the wedge is the distance between the two specified points.

6.2.5.7 Mesh Torus

Creates a ring-shaped surface that resembles the inner tube of a tire. A mesh torus has two radius values. One value defines the tube. The other value defines the path, which is equivalent to the distance from the center of the torus to the center of the tube. By default, a torus is drawn parallel to and is bisected by the XY plane of the current UCS.



A mesh torus can be self-intersecting. A self-intersecting mesh torus has no center hole because the radius of the tube is greater than the radius of the torus.

Through Short cut Key: MESH enter ☐ T enter

Application

Type MESH at the Command Prompt [Box/Cone/Cylinder/ Pyramid/Sphere/Wedge/Torus/ Settings] <Box>: T enter (for Torus) ☐ Specify center point Put the radius value Put the Tube radius Value enter Mesh Torus Option

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

- i. 3P
- ii. 2p
- iii. TTR
- iv. Radius

3P (Three Points)

Use the 3P (Three Points) option to define the size of the mesh torus anywhere in 3D space. The three points also define the plane of the circumference. Use this option to rotate the mesh torus as you create it.

2P (Two Points)

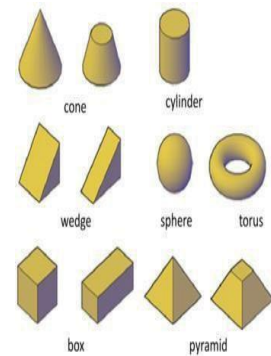
Use the 2P (Two Points) option to define the size of the mesh torus anywhere in 3D space. The plane of the circumference matches the Z value of the first point.

TTR (Tangent, Tangent, Radius)

Use the TTR (Tangent, Tangent, and Radius) option to define points on two objects. Depending on the specified radius distance, the path of the torus is located as near as possible to the tangent points you specify. You can set up tangency with circles, arcs, lines, and some 3D objects. The tangency points are projected into the current UCS. The appearance of tangency is affected by the current level of smoothness.

Radius

Defines the radius of the torus: the distance from the center of the torus to the center of the tube. A negative radius creates a solid shaped like an American football.

**6.2.5.8 Revolved Surfaces**

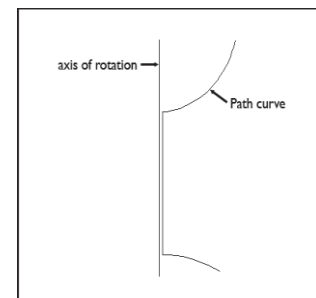
Regenerates a three-dimensional model with hidden lines

Type REVSURF at the command prompt.

Command: **REVSURF** Current wire frame density: SURFTAB1=6 SURFTAB2=6

Select object to revolve: **pick path curve** Select object that defines the axis of revolution: pick line

Specify start angle <0>: **enter** Specify included angle (+=ccw, -=cw) <360>: **enter**

**Surf tab Variables**

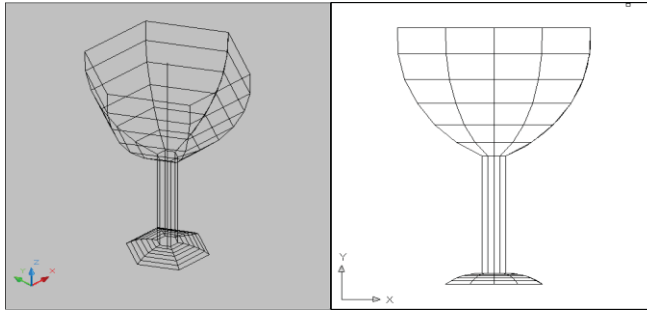
Sets the number of tabulations for both directions to be generated for RULESURF and TABSURF. Also sets the mesh density in ROTATE3D the M direction for REVSURF and EDGESURF commands.

Type Surftab1 at the command prompt. Command: **SURFTAB1**

Enter new value for SURFTAB1 <6>: **30 Type**

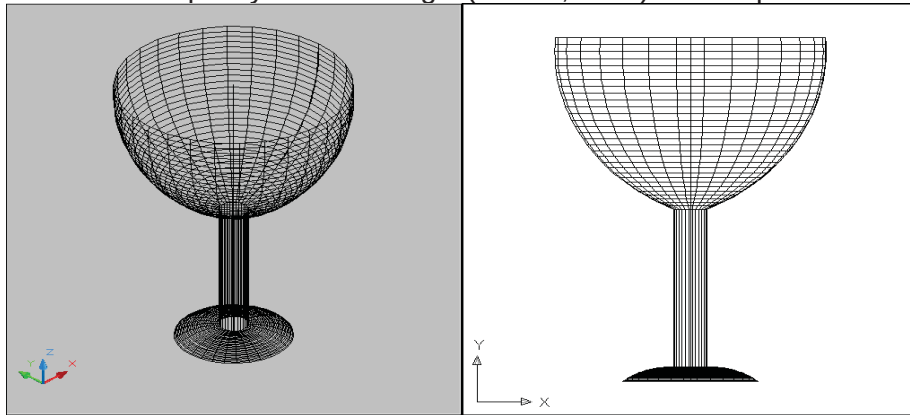
Surftab2 at the command prompt. Command: **SURFTAB2**

Enter new value for SURFTAB2 <6>: **30**



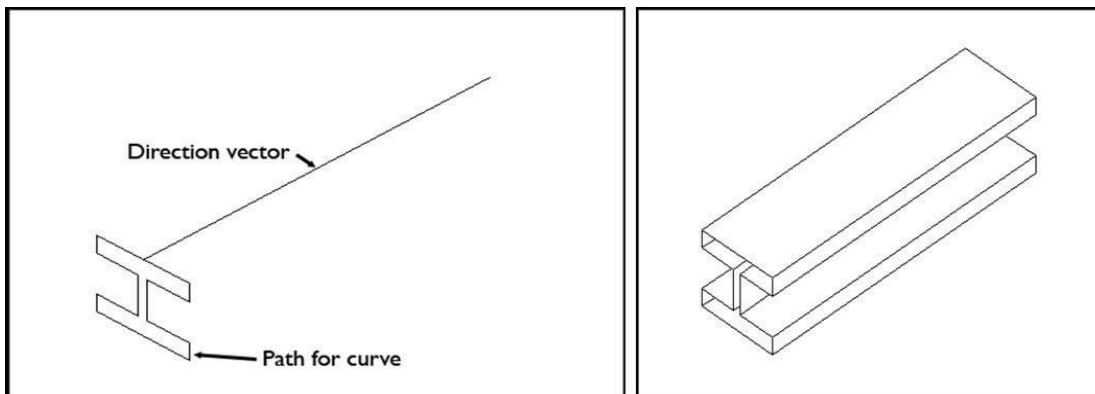
Type **Rev surf** at the command prompt.

Command: **REVSURF** Current wire frame density: SURFTAB1=30 SURFTAB2=30 Select object to revolve **pick path curve** Select object that defines the axis of revolution: pick line Specify start angle <0>: **enter** Specify included angle (+=ccw, -=cw) <360>: press enter



6.2.5.9 Tabulated Surfaces

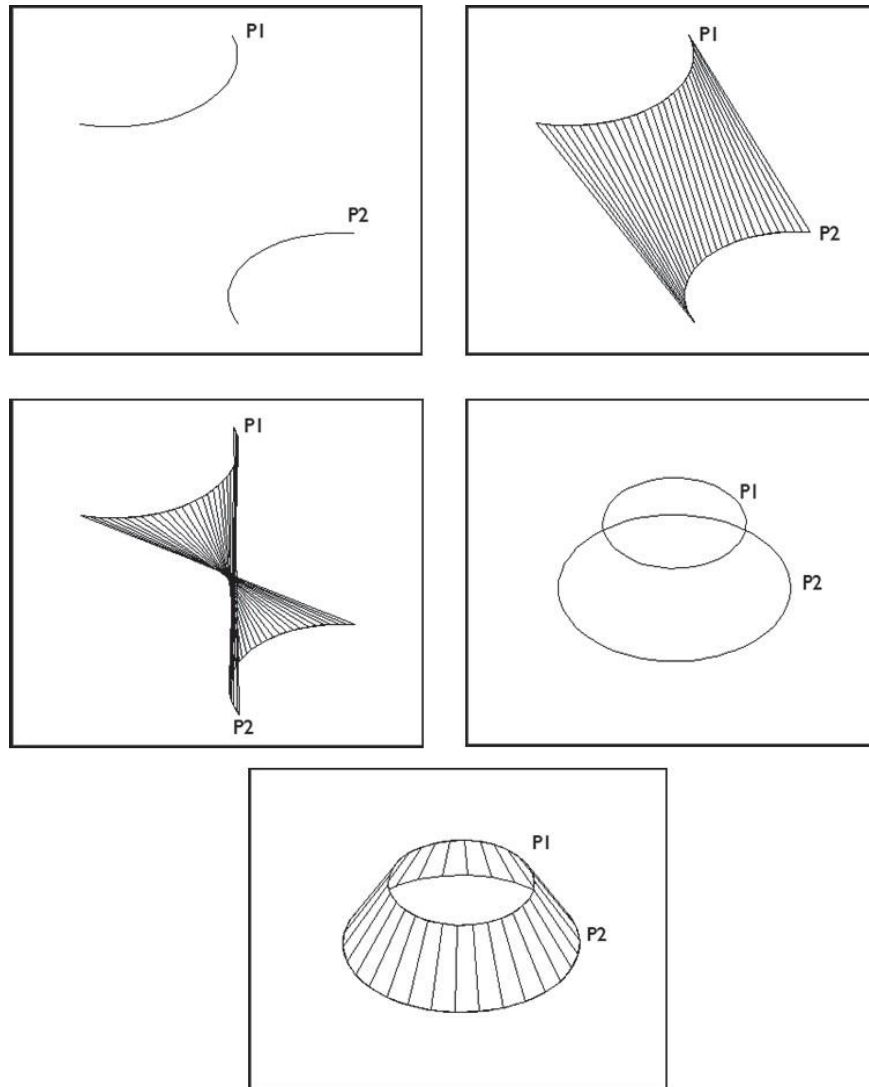
Type **TABSURF** at the command prompt. Command: **TABSURF** Select object for path curve: Select object for direction vector:



6.2.5.10 Ruled Surfaces

Type **RULESURF** at the command prompt. Command: **rule surf** Current wire frame density: SURFTAB1=6 Select first defining curve: **P1** Select second defining curve: **P2**

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6.2.5.11 Surf tab Variables

Set the number of tabulations for both directions to be generated for RULESURF and TABSURF. Also sets the mesh density in ROTATE3D the M direction for REVSURF and EDGESURF commands.

Method of change the Surftab1&2 values

Application

i. SURFTAB 1

Type **SURFTAB 1** at the Command Line ☐ Enter new value for SURFTAB1 <6>: ☐ Put the new value of Surftab ☐ enter

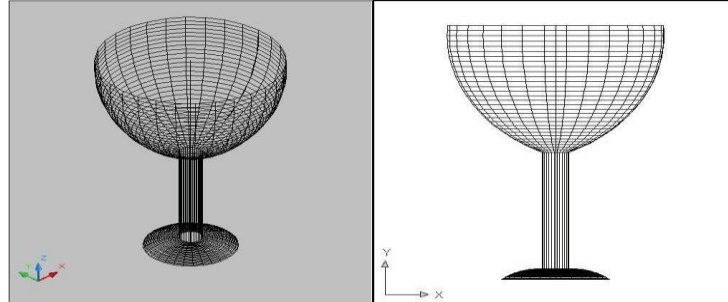
ii. SURFTAB 2

Type **SURFTAB 2** at the Command Line ☐ Enter new value for SURFTAB2 <6>: ☐ Put the new value of Surftab ☐ enter

Reaction of Surftab Value on object

Application

Type REVSURF at the Command Line ☐ Select object to revolve ☐ Select object that defines the axis of revolution ☐ Specify start angle ☐ Specify included angle ☐ enter

**6.2.5.12 Mesh smooth object**

By default, new mesh primitives are created with no smoothness. To change the default smoothness, enter mesh at the Command prompt. Specify the Settings option before you specify the type of mesh primitive you want to create.

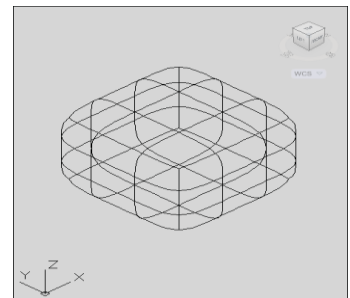
Type MESH at the command prompt. Command: **MESH**

Enter an option [Box/Cone/Cylinder/Pyramid/Sphere/Wedge/ Torus/ Settings] <Box>: **SE**

Specify level of smoothness or [Tessellation] <0>: **3**

Enter an option [Box/Cone/ Cylinder/Pyramid/Sphere/Wedge/ Torus/ Settings] <Box>: **BOX**

Specify first corner or [Center]: **pick point** Specify other corner or [Cube/Length]: **@5,5** Specify height or [2Point] <**3.0000**>:

**6.2.5.13 Mesh Smooth**

Converts 3D faces (3DFACE) and legacy polygonal and poly face meshes (from AutoCAD 2009 and earlier). You can also convert 2D objects such as regions and closed polylines. The default mesh settings are defined in the Mesh Tessellation Options dialog box. The level of smoothness upon conversion depends on the mesh type setting in this dialog box. If the mesh type is not set to be optimized, the converted object is not smoothed

Type MESHSMOOTH at the command prompt. Command:

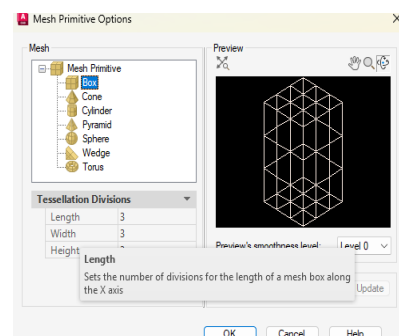
MESHSMOOTH

Select objects to convert: **pick object** Select objects to convert: **press enter** Click Create mesh.

Polyline before MESHSMOOTH 2D Polyline after MESHSMOOTH

i. Smooth and Refine Meshes

The following commands control the smoothness of mesh objects.

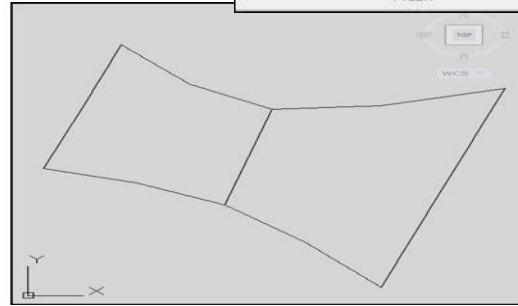
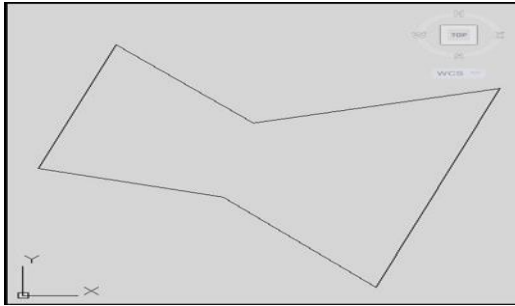
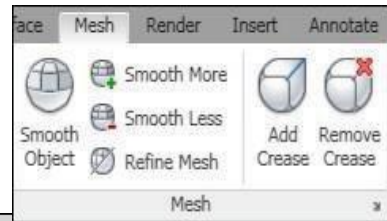
ii. Mesh smooth more

Increases the level of smoothness for mesh objects by one level.
Type **MESHSMOOTHMORE** at the command prompt.

Command: **MESHSMOOTHMORE**

Select mesh objects to increase the smoothness level: **pick object**.

Mesh before smooth increase Mesh after smooth increase



i. Mesh smooth less

Decreases the level of smoothness for mesh objects by one level.

Type **MESHSMOOTHLESS** at the command prompt. Command: **MESHSMOOTHLESS**

Select mesh objects to increase the smoothness level: **pick object**.

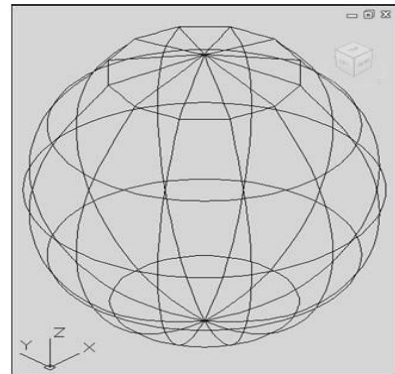
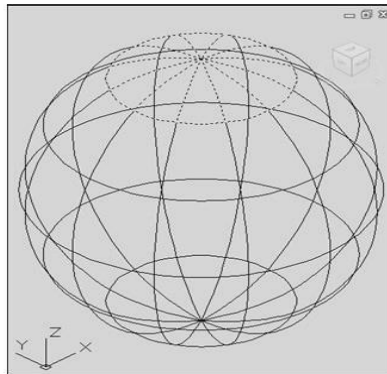
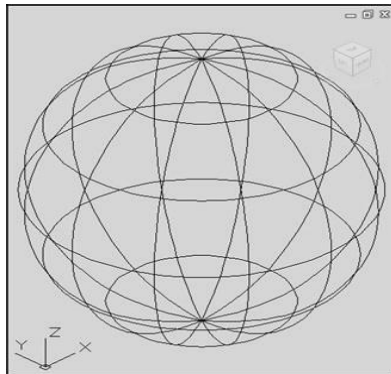
6.2.5.14 Add and Remove Mesh Creases

Mesh crease Sharpens the edges of selected mesh sub objects.

Type **MESHCREASE** at the command prompt. Command: **MESHCREASE**

Select mesh sub objects to crease: **select objects**

Specify crease value [Always] <Always>: enter



Before crease

Selected objects

After crease

TIPS:

Sets highest smoothing level at which the crease is retained. If the smoothing level exceeds this value, the crease is also smoothed. Enter a value of 0 to remove an existing crease.

Specifies that the crease is always retained, even if the object or sub object is smoothed or refined. A crease value of -1 is the same as Always

Editing Meshes

Mesh extrudes

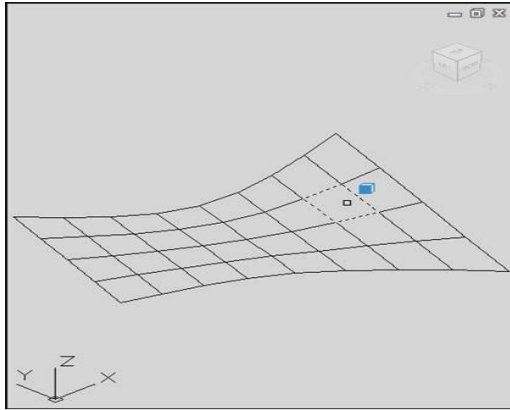
Extends a mesh face into 3D space.

Type MESH EXTRUDE at the command prompt.

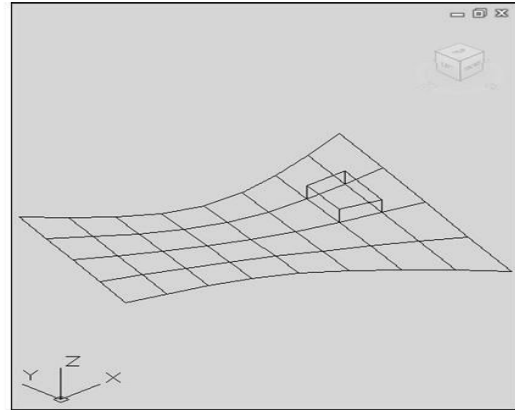
Command: **_MESH EXTRUDE** Adjacent extruded faces set to: Join

Select mesh face(s) to extrude or [Setting]:pick object(s)

Select mesh face(s) to extrude or [Setting]: Specify height of extrusion or [Direction/Path/ Taper angle] <0.5000>: **1**



Selected mesh face



Extruded mesh faces

Mesh split

Splits a mesh face into 2 faces.

Type MESH SPLIT at the command prompt. Command: **MESH SPLIT**

Select a mesh face to split: **(pick object)**

Specify first split point on face edge or [Vertex]:**MID** of Specify second split point on face edge or [Vertex]:

Merge face

Merges adjacent faces into a single face.

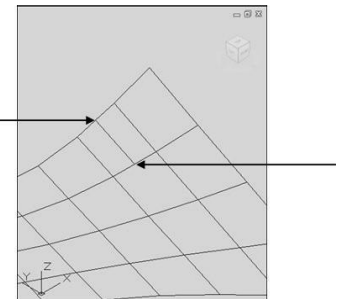
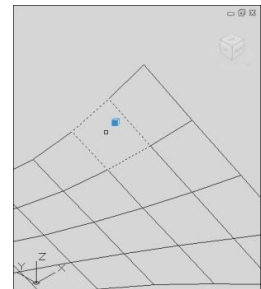
Type MESH MERGE at the command prompt.

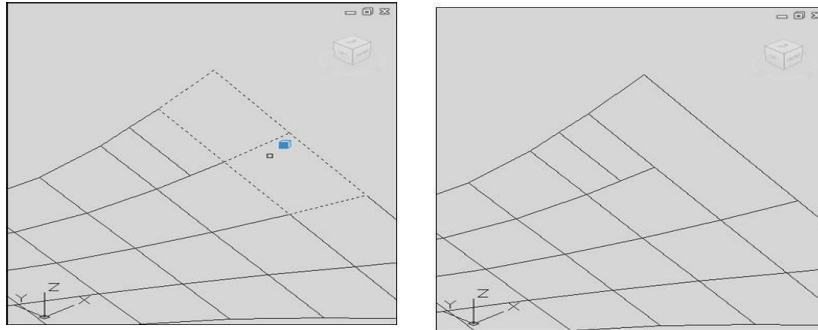
Selected mesh faces Resultant merge

MESHMERGE

Command: **_MESHMERGE**

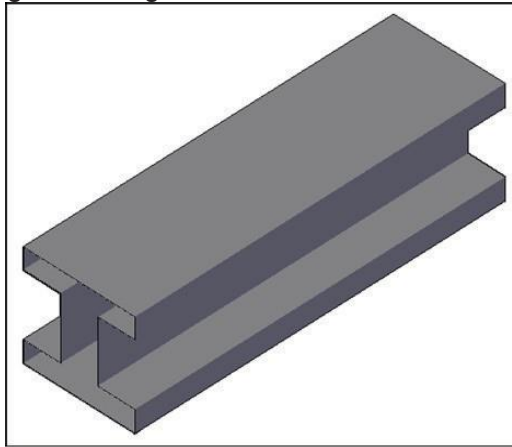
Select adjacent mesh faces to merge: (pick object) Select adjacent mesh faces to merge: (pick object) Select adjacent mesh faces to merge: press enter



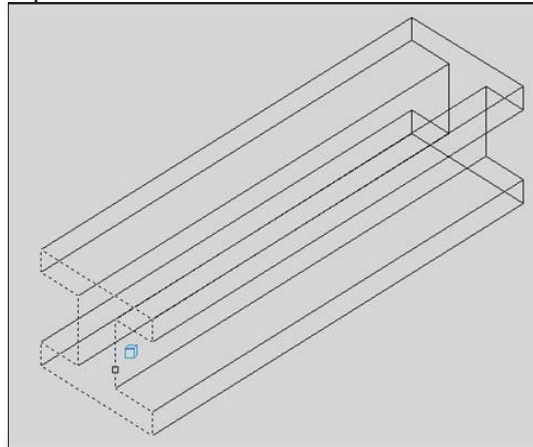
Mesh cap (Close Hole)

Creates a mesh face that connects open edges.

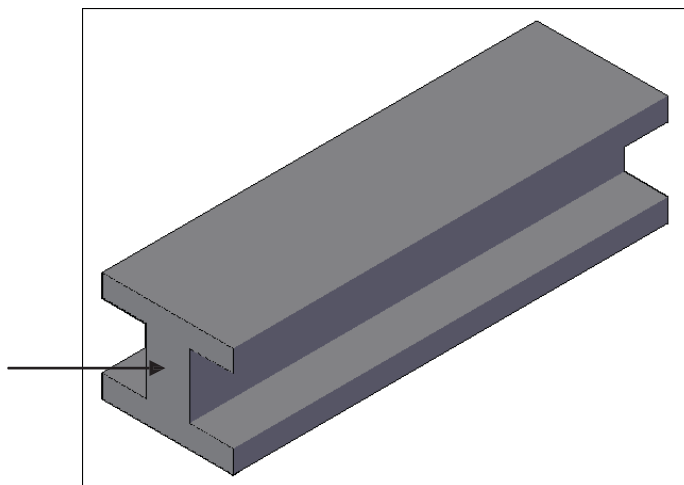
Type MESHCAP at the command prompt. Command: _MESHCAP
 Select connecting mesh edges to create a new mesh face: (pick objects) Select connecting mesh edges to create a new mesh face: press enter



Mesh object before



Selected mesh edges



Closed “hole”

6.2.5.15 Converting Meshes

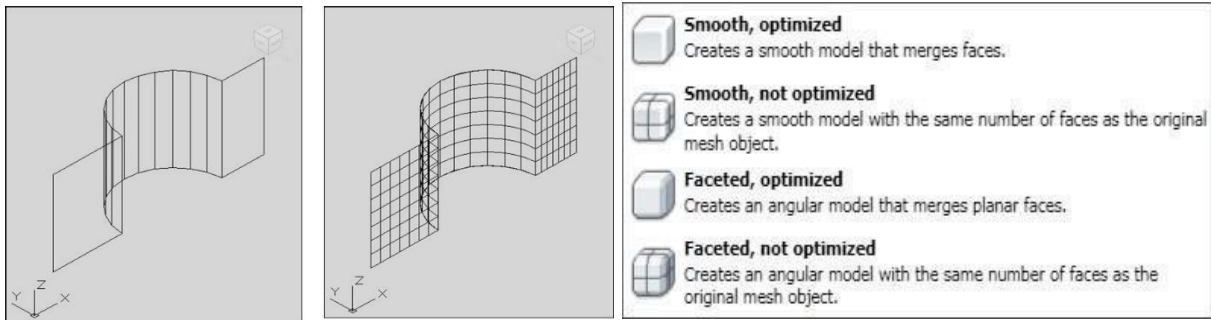
Converts objects to surfaces. Objects that can be converted to surfaces include the following: surface, 3D solids, Regions, open, zero-width polylines with thickness, lines with thickness, arcs with thickness, mesh objects, planar 3D faces

Type CONVOTOSURFACE at the command prompt.

Command: **CONVOTOSURFACE**

Mesh conversion set to: Smooth and optimized. Select objects: **pick object**

Select objects: **press enter**

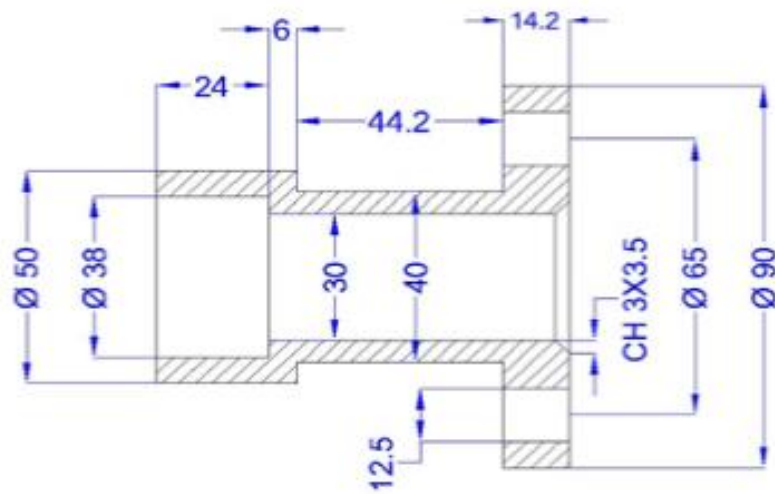
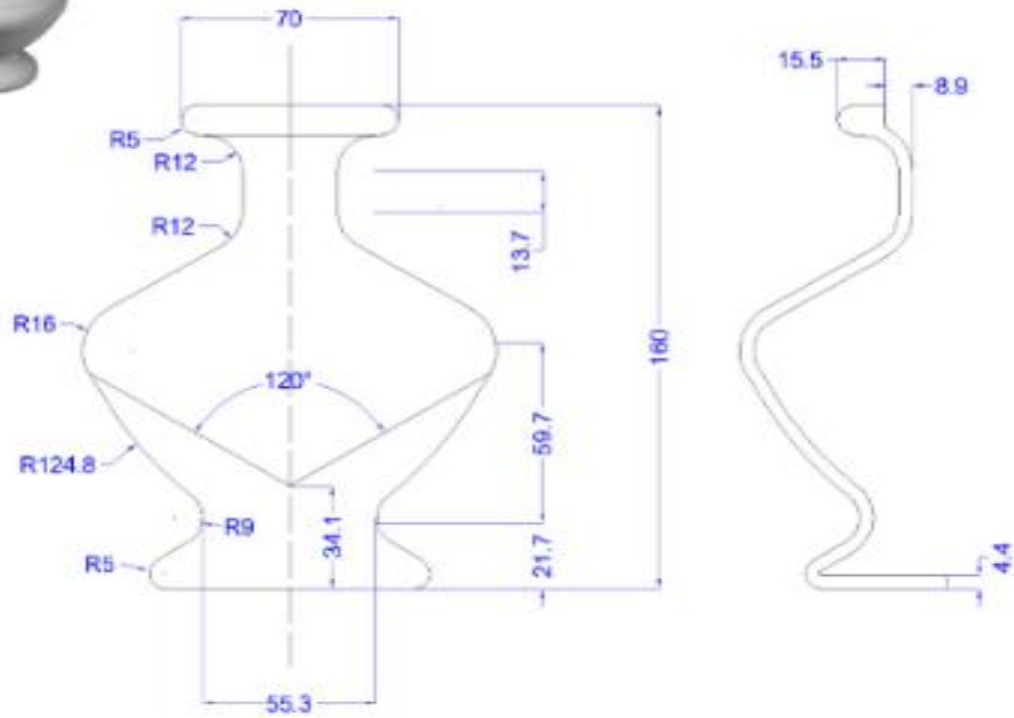


PLine with thickness New converted mesh

Activity 1: Practice to create cylindrical shape object with Radius of 6” and Height 12” by using cylinder command.

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

Activity 3: Practice to generate surface by transitioning between multiple cross-sectional profile



Learning Unit 6.3**Develop 3D Model****Learning Outcomes:**

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

- 3D modeling basics and CAD software
- Manipulation of simple 3D shapes (cubes, spheres, etc.) in a digital workspace.
- Boolean operation on 3D model of civil and mechanical as per design requirements.

6.3.1 Manipulation of simple 3D shapes (cubes, spheres, etc.) in a digital workspace**6.3.1.1 Solid Primitive Commands**

You can create several basic 3D shapes, known as solid primitives: boxes, cones, cylinders, spheres, wedges, pyramids, and torus (donuts).

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.

- | | |
|-------------|-----------|
| a) Box | e) Sphere |
| b) Cone | f) Wedge |
| c) Cylinder | g) Tours |
| d) Pyramid | |

- **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

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

- **Cube**

Use the Cube option of the BOX command to create a box with sides of equal length.

Length

Create a box with length, width, and height values you specify. If you enter values, the length corresponds to the X axis, the width to the Y axis, and the height to the Z axis. If you pick a point to specify the length, you also specify the rotation in the XY plane.

Center point.

Use the Center option to create a box using a specified center point.

- **Cone**

Create a 3D solid with a circular or elliptical base that tapers symmetrically to a point or to a 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.

Initially, the default base radius is not set to any value. During a drawing session, the default value for the base radius is always the previously entered base radius value for any solid primitive.

Through Short Cut Key ☐ Cone enter

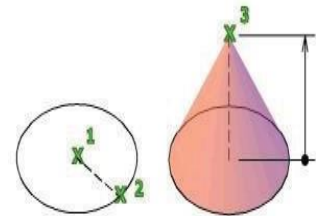
Application

Type **Cone** at the Command Prompt ☐ Specify center point of base☐put the base radius value☐Put the Value of Height☐enter

Cone Option

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)



Center Point

When you specify the center point, the Cone is positioned so that its central axis is parallel to the Z axis of the current user coordinate system (UCS). Latitudinal lines are parallel to the XY plane.

Axis Endpoint

Use the Axis Endpoint option when you want to reorient the cone by placing the tip or axis endpoint anywhere in 3D space.

Frustum

Use the Top Radius option to create a frustum of a cone, which tapers to an elliptical or planar face.

3P (Three Points)

The 3P (Three Points) option defines the size and plane of the base of the cone anywhere in 3D space.

Elliptical

Use the Elliptical option to create a cone base whose axes are of different lengths.

TTR (Tangent, Tangent, Radius)

Use the TTR (Tangent, Tangent, and Radius) option to define points on two objects.

Depending on the radius distance, the new cone is located as near as possible to the tangent points you specify. You can set up tangency with circles, arcs, lines, and some 3D objects. The tangency points are projected into the current UCS. The appearance of tangency is affected by the current level of smoothness.

• 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

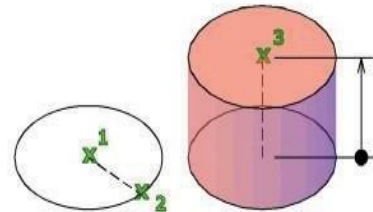
☐ Cylinder enter

Application

Type Cyl at the Command Prompt ☐ Specify center point of base ☐ put the base radius value ☐ Put the Value of Height ☐ enter

Cylinder Options

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



Axis End point

Use the Axis Endpoint option to set the height and rotation of the cylinder. The center point of the top plane of the cylinder is the axis endpoint, which can be located anywhere in 3D space.

3P (Three Points)

Use the 3P (Three Points) option to define the base of the cylinder. You can set three points anywhere in 3D space.

• Elliptical

Use the Elliptical option to create a cylinder base whose axes are of different lengths.

TTR (Tangent, Tangent, Radius)

Use the TTR (Tangent, Tangent, and Radius) option to define points on two objects. Depending on the radius distance, the new cylinder is located as near as possible to the tangent points you specify. You can set up tangency with circles, arcs, lines, and some 3D objects. The tangency points are projected onto the current UCS.

• 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. Initially, the default base radius is not set to any value. During a drawing session, the default value for the base radius is always the previously entered base radius value for any solid primitive.

Use the Top Radius option to create a pyramid frustum.

Through Short Cut Key ☐ Pyr enter

Application

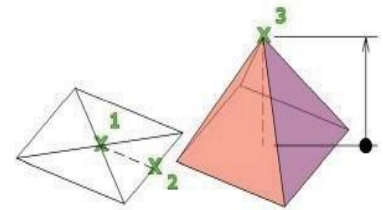
Type Pyr at the Command Prompt ☐ Specify center point of base ☐ put the base radius value ☐ Put the Value of Height ☐ enter

Pyramid Option

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

Sides

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

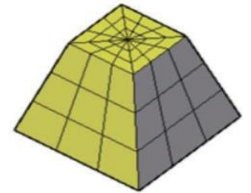


Sides

Use the Sides option to set the number of sides for the pyramid.

Edges.

Use the Edges option to specify the dimension of the sides at the base.



Frustum

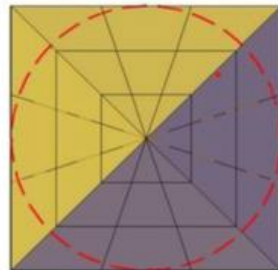
Use the Top Radius option to create a frustum, which tapers to a planar face. The frustum face is parallel to and has the same number of sides as, the base.

Axis Endpoint

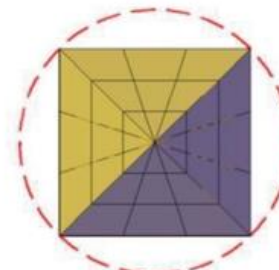
Use the Axis Endpoint option to specify the height and rotation of the pyramid. This endpoint is the top of the pyramid. The axis endpoint can be located anywhere in 3D space.

Inscribed or circumscribed perimeter.

Specify whether the pyramid base is drawn inside or outside of the radius



Circumscribed



Inscribed

• 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. You can control the smoothness of curved 3D solids, such as a torus, in a shaded or hidden visual style with the FACETRES system variable.

Through Short Cut Key ☐

Sphere enter

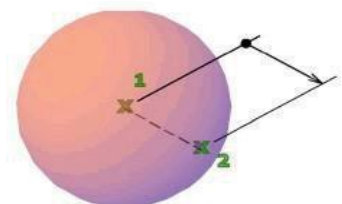
Application

Type Sphere at the Command Prompt ☐ 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)

Center Point

Specify the center point of the sphere. When you specify the center point, the sphere is positioned so that its central axis is parallel to the Z axis of the current user coordinate system (UCS). Latitudinal lines are parallel to the XY plane.

Radius	Defines the radius of the sphere.
Diameter	Defines the diameter of the sphere.

2P (Two Points)

Define the circumference of the sphere by specifying two points anywhere in 3D space. The plane of the circumference is defined by the Z value of the first point.

3P (Three Points)

Define the circumference of the sphere by specifying three points anywhere in 3D space. The three specified points also define the plane of the circumference.

TTR (Tangent, Tangent, Radius)

Define the sphere with a specified radius tangent to two objects. The specified tangency points are projected onto the current UCS.

- 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

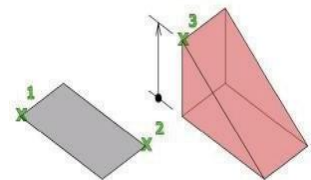
Application

Type Wedge at the Command Prompt ☐ Specify Start point ☐ Put the Value of @ X and Y Coordinate ☐ Put the Value of Height ☐ enter

Wedge Option

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

- i. Center
- ii. Cube
- iii. Length
- iv. 2 points with weight)

**Center**

Create the wedge by using a specified center point.

- Cube**

Set all edges of the mesh wedge base to be of equal length.

Length

Create a wedge with length, width, and height values you specify. The length corresponds to the X axis, the width to the Y axis, and the height to the Z axis. If you pick a point to specify the length, you also specify the rotation in the XY plane.

2 points (with Height)

Specify that the height of the wedge is the distance between the two specified points.

- **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. You can control the smoothness of curved 3D solids, such as a torus, in a shaded or hidden visual style with the FACETRES system variable.

Through Short Cut Key ☐ Tor enter

Application

Type Tor at the Command Prompt ☐ Specify center point of Torus ☐ Put the radius value of Torus ☐ Put the Tube radius Value ☐ enter

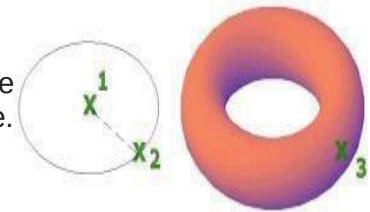
Torus Option

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

- i. 3P
- ii. 2p
- iii. TTR
- iv. Radius

3P (Three Points)

Use the 3P (Three Points) option to define the size of the torus anywhere in 3D space. The three points also define the plane of the circumference. Use this option to rotate the torus as you create it.

**2P (Two Points)**

Use the 2P (Two Points) option to define the size of the torus anywhere in 3D space. The plane of the circumference matches the Z value of the first point.

TTR (Tangent, Tangent, Radius)

Use the TTR (Tangent, Tangent, and Radius) option to define points on two objects. Depending on the specified radius distance, the path of the torus is located as near as possible to the tangent points you specify. You can set up tangency with circles, arcs, lines, and some 3D objects. The tangency points are projected into the current UCS.

Radius

Define the radius of the torus: the distance from the center of the torus to the center of the tube. A negative radius creates a solid shaped like an American football.

- **Poly Solid Command**

You can create walls with straight and curved segments of constant height and width. With the POLYSOLID command, you can convert an existing line, 2D polyline, arc, or circle to a solid with a rectangular profile. A poly-solid can have curved segments, but the profile is always rectangular by default. You can draw a solid with POLYSOLID just as you would a polyline. The PSOLWIDTH system variable sets the default width for the solid. The PSOLHEIGHT system variable sets the default height for the solid.

Through Short Cut Key ☐ Ploy soid enter

Application

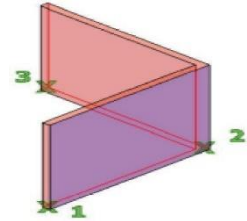
Teaching and Learning Guide: Information Technology (CAD) **AutoCAD**

Type poly solid at the Command Prompt ☐ Specify start point or [Object/Height/Width/Justify]
 <Object>☐Specify next point or [Arc/Undo]☐ Specify next point or [Arc/Undo]
☐enter

Poly Solid Options

Use the following options to control the size and shape of the polysolid you create.

- i. Object
- ii. Height
- iii. Width
- iv. Justify



Object

Specify an object to convert to a solid. You can convert:

- a. Line
- b. Arc
- c. 2D polyline
- d. Circle

Height

Specify the height of the solid

Width

Specify the width of the solid.

Justify

Set the width and height as the solid to be left, right, or center justified when defining the profile with the command. The justification is based on the starting direction of the first segment of the profile.

6.3.2 Boolean operation on 3D model of civil and mechanical as per design requirements.

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

- i. Union
- ii. Subtract
- iii. Intersect
- iv. slice

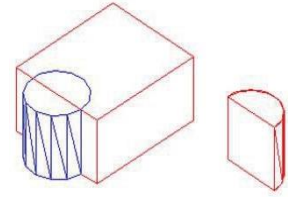
6.3.2.1 Union:

You can combine two or more 3D solids, surfaces, or 2D regions into a single, composite 3D solid, surface, or region. You must select the same type of objects to combine.

Through Short Cut Key ☐ UNI enter

Application

Type **UNI** at the Command Line ☐ Select objects ☐ enter

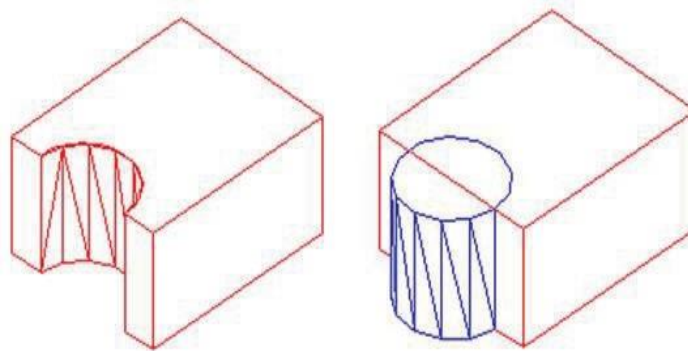
**6.3.2.2 Subtract**

With SUBTRACT, you can create a 3D solid by subtracting one set of existing 3D solids from another, overlapping set. You can create a 2D region object by subtracting one set of existing region objects from another, overlapping set. You can select only regions for use with this command.

Through Short Cut Key ☐ **su** enter

Application

Type **SU** at the Command Line ☐ SUBTRACT Select solids and regions to subtract from ☐ enter ☐ Select solids and regions to subtract ☐ enter

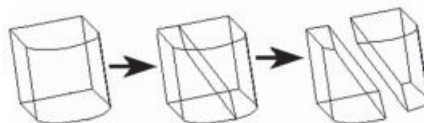
**6.3.2.3 Intersect**

Create a 3D solid, surface, or 2D region from overlapping solids, surfaces, or regions. With INTERSECT, you can create a 3D solid from the common volume of two or more existing 3D solids, surfaces, or regions. If you select a mesh, you can convert it to a solid or surface before completing the operation. **Through Short Cut Key** ☐ enter Application

Type **IN** at the Command Line ☐ Select objects ☐ **enter**

6.3.2.4 Slice

Creates new 3D solids and surfaces by slicing, or dividing, existing objects.



The cutting plane is defined with 2 or 3 points, by specifying a major plane of the UCS, or by selecting a surface object (but not a mesh). Either one or both sides of the sliced 3D solids can be retained.

The sliced objects retain the layer and color properties of the original solids. However, the

resulting solid or surface objects do not retain a history of the original objects.

- **Objects that Can Be Used in a Slice Operation**

Objects that can be sliced	Objects that can be used as cutting planes
3D solids	Surfaces
Surfaces	Circles
	Ellipses
	Circular or elliptical arcs
	2D splines
	3D polyline segments

Objects to slice

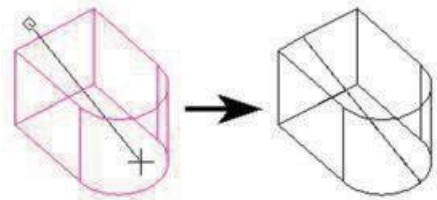
Specifies the 3D solid or surface object that you want to slice. If you select a mesh object, you can choose to convert it to a 3D solid or surface before completing the slice operation.

- i. Start point of slicing plane
- ii. Planar object
- iii. Surface
- iv. Z axis
- v. View
- vi. XY
- vii. YZ
- viii. ZX

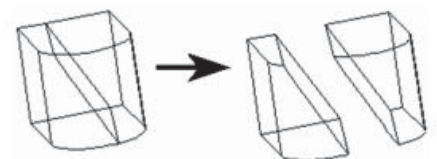


Slice by Line

- i. Slices objects by a plane perpendicular to the current view, defined by two points. This is the default option.
- ii. Select Slice by Line (2 Points) from the local menu or Inspector Bar.
- iii. Select the objects to slice. You can use Shift to select more than one object.
- iv. Select two points the slicing plane will pass through the line defined by these points, in the direction normal to the current view (into the screen).
- v. The slice is created, though in the current view the dividing plane appears as a line.



You can rotate the view and move one of the new objects to see how the original object was sliced.



Slice by Plane

Slices objects by defining the slicing plane. The plane is defined

by three points.

Select Slice by Plane (3 Points) from the local menu or Inspector Bar.

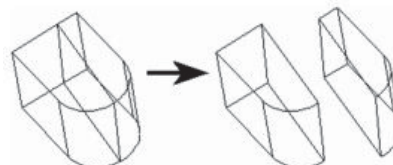
- i. Select the object to section. You can use Shift to select more than one object.
- ii. Select three points to define the slicing plane.
- iii. The slice is created. You can move one of the new objects to see how the original object was sliced.



Slice by Work plane

Slices objects by using the current work plane as the slicing plane.

- i. Select Slice by Work plane from the local menu or Inspector Bar.
- ii. Select the object to slice.
- iii.



Note: To slice multiple objects, start out using a different option - Slice by Line or Slice by Plane. Use Shift to select the objects to slice, then click the Slice by Work plane icon. The object is sliced.

You can move one of the new objects to see how the original object was sliced.



Manipulate 3D object by using Modify Commands- Extrude, Rotate, Rotate3D, Revolve, Revolve Surface, Shell, Sweep, Loft, etc.

6.3.2.5 Thicken Command: -

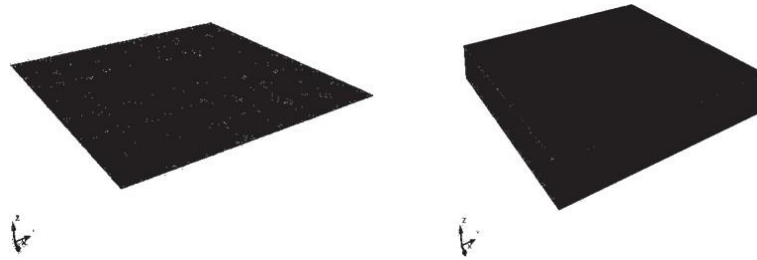
Convert a surface into a 3D solid with a specified thickness. A useful technique for modeling a complex 3D curved solid is to first create a surface and then convert it to 3D solid by thickening it. Initially, the default thickness value is zero. During a drawing session, the default value for the thickness is the previously entered thickness value.

Through Short Cut Key ☐ thicken enter Application

Type **THICKEN** at the Command Prompt ☐

Select surfaces to thicken ☐

Specify thickness <0.0000> ☐ put the thicken value ☐ enter



6.3.2.6 3D Rotate

3D Rotate command helps to constrain or in rotation of 3D objects and sub-objects along any axis up to a specified angle

Application

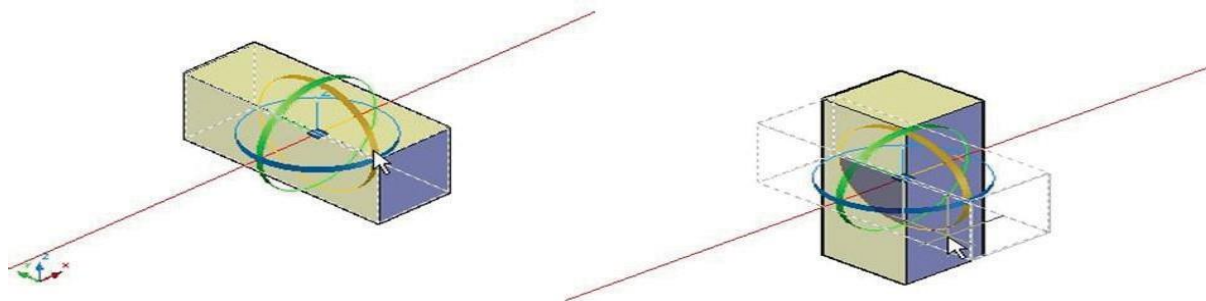
Pick Tool ☐ Select the objects OR hold Ctrl key to select sub-objects (faces, edges, and vertices)

☐ Release Ctrl key and press Enter ☐

The rotate gizmo is displayed attached to the cursor ☐ Click to place the rotating gizmo, specifying the base point for the move ☐ However the cursor over an axis path on the gizmo until it turns yellow and the vector that represents the axis of rotation is displayed. ☐

Specify angle of the rotation.

When you drag the cursor, the selected objects and sub-objects rotate about the base point along the specified axis. The gizmo displays the degree of rotation from the original position of the object as the object moves. You can click or enter a value to specify the angle of the rotation



6.3.2.7 Interfere Command

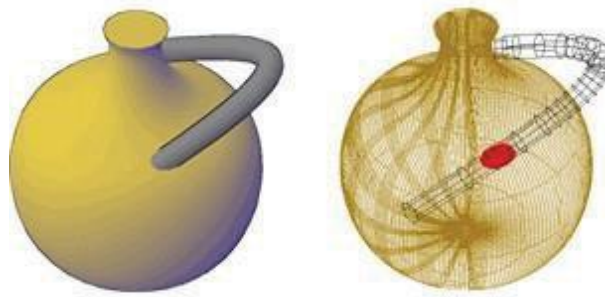
Create a temporary 3D solid from the interferences between two sets of selected 3D solids. Interferences are highlighted with a temporary 3D solid that represents the intersecting volume. You can also choose to retain the overlapping volumes

Through Short Cut Key ☐ inf enter

Application

Type INF at the Command Line ☐ Select first set of objects or [Nested selection/Settings]

Select solids ☐ enter.



6.3.2.8 Extrude Command

Extrusions can extend in the Z direction or be set to taper or follow a path. You can extrude an open or closed object to create 3D surface or solid

Through Short Cut Key Ext enter

Application

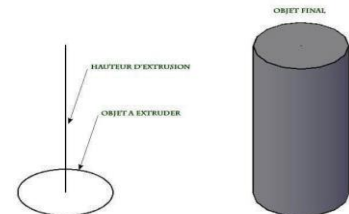
Type Ext at the Command Line Select Object enter Specify height of extrusion or [Direction/Path/Taper angle] enter

Extrude Command Options

- i. Height of extrusion
- ii. Direction
- iii. Path
- iv. Taper angle

Height of extrusion

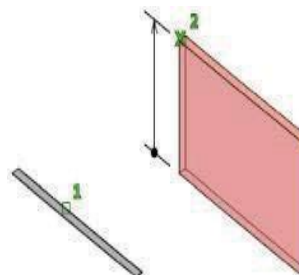
Note: Select face and edge sub objects by pressing Ctrl while you select them Extrudes objects along the positive Z axis of the object's coordinate system if you enter a positive value. If you enter a negative value, the objects are extruded along the negative Z axis. Objects do not have to be parallel to the same plane. If all the objects are on a common plane, the objects are extruded in the direction of the normal of the plane.



Direction

Specifies the length and direction of the extrusion with two points you specify. (The direction cannot be parallel to the plane of the sweep curve created by the extrusion.)

- i. Start point of direction. Specifies the first point in the direction vector.
- ii. End point of direction. Specifies the second point in the direction vector

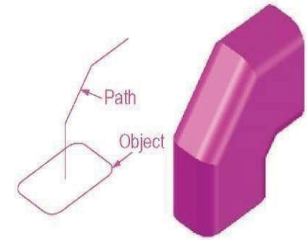


Remember

By default, planar objects are extruded in the direction of the object's normal.

Path:

Specifies the extrusion path based on an object that you select. The path is moved to the center of the profile. Then the profile of the selected object is extruded along the chosen path to create solids or surfaces.

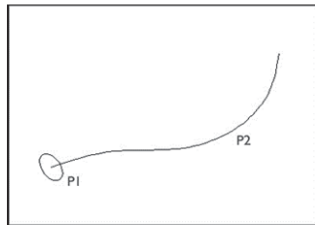


The path should not lie on the same plane as the object, nor should the path have areas of high curvature.

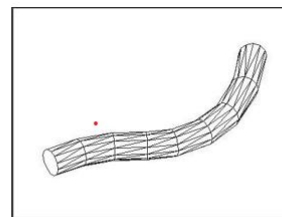
The extrusion starts from the plane of the object and maintains its orientation relative to the path. If the path contains segments that are not tangent, the program extrudes the object along each segment and then miter the joint along the plane bisecting the angle formed by the segments. If the path is closed, the object should lie on the miter plane. This allows the start and end sections of the solid to match up. If the object is not on the miter plane, the object is rotated until it is on the miter plane. Objects with multiple loops are extruded so that all the loops appear on the same plane at the end section of the extruded solid.

Application

Type **Ext** at the Command Line Select Object enter Specify height of extrusion or [Direction/Path/Taper angle] **P** enter (For Path) Select Path enter



Circle Extruded Along a Path

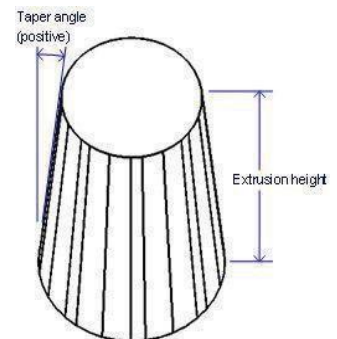


Hidden Line Removal of Extruded Circle

Taper Angle

Positive angles taper in from the base object. Negative angles taper out. The default angle, 0, extrudes a 2D object perpendicular to its 2D plane. All selected objects and loops are tapered to the same value. Specifying a large taper angle or a long extrusion height can cause the object or portions of the object to taper to a point before reaching the extrusion height. Individual loops of a region are always extruded to the same height. When an arc is part of a tapered extrusion, the angle of the arc remains constant, and the radius of the arc changes.

- i. Angle of taper. Sets an angle between -90 and +90 degrees.
- ii. Specify two points. Sets the taper angle based on two points you specify in the drawing area. The taper angle applied to the extrusion is the distance between the two specified point

**Application**

Teaching and Learning Guide: Information Technology (CAD) **AutoCAD**

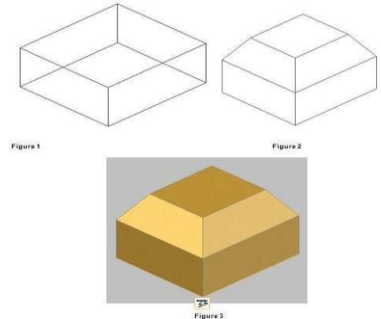
Type **Ext** at the Command Line Select Object enter Specify height of extrusion or [Direction/Path/Taper angle] **T** enter (For Taper Angle) Put the Value of Taper Angle Specify height of extrusion or [Direction/Path/Taper angle] put the Value of Height enter

6.3.2.9 Extrude Faces

You can extrude one or more faces of 3D solid at the specified height and path. Extrude faces command of 3D

There are two options of Extrude faces command

- i. Height
- ii. Path



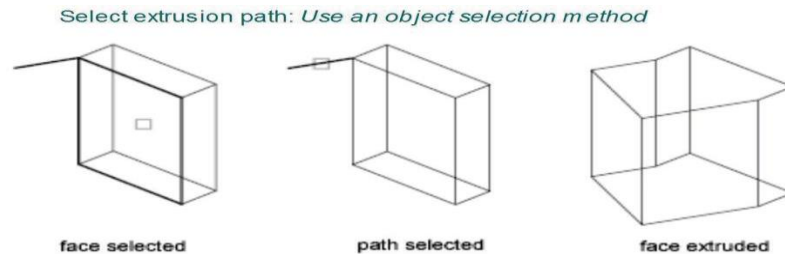
Application (Extrude faces with Height)

Pick tool select faces put the Height of extrusion put the taper angle of extrusion

Application (Extrude faces with Path)

In the first step we draw the path in polyline.

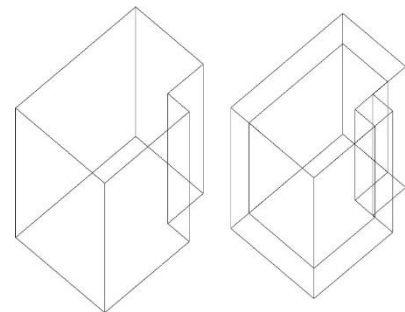
Pick tool select faces put the “P” for path option Select the path



6.3.2.10 Shell

You can create a shell or a hollow thin wall with a specified thickness from your 3D solid object. AutoCAD creates new faces by offsetting existing ones inside or outside their original positions. AutoCAD treats continuously tangent faces as single faces when offsetting.

Choose Modify, Solid Editing, Shell. Select a 3D solid: pick solid Remove faces or [Undo/Add/ALL]: enter Enter the shell offset distance: .5



How to Apply “Imprint” Facility on 3D Solid Object

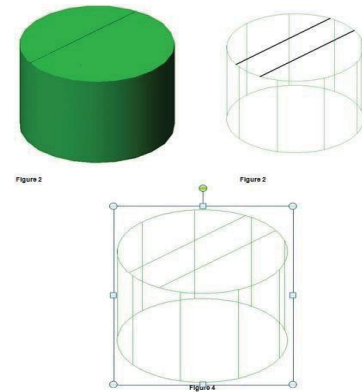
This command is used to imprint an object on the selected solid face. The object to be imprinted must intersect one or more faces on the selected solid in order for imprinting to be successful. Imprinting is limited to the following objects: arcs, circles, lines, 2D and 3D polylines, ellipses, SP lines, regions, bodies, and 3D solids.

Application

Draw the shape in 2D polylines for imprinting on 3D solid face Pick tool. Select 3D object

Enter

Select imprint object delete the source object (Yes/No)

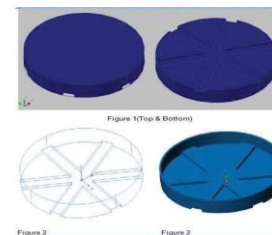


How to Apply “Shell” command on 3D solid object:

Shell command is used to create a hollow, thin wall structure of a specified thickness. You can specify a constant wall thickness for all the faces. Also, the desired faces can be removed as well.

Application

Pick tool Select 3D Solid Select faces to remove Enter put the wall thickness Enter

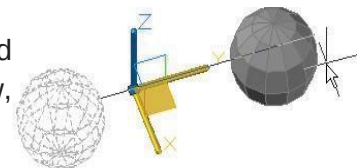


6.3.2.11 3D MOVE

3D move command is used to move a selection set of objects or sub-objects to a specified distance in a specified direction or freely constrain the movement along any axis or plane.

To move selected objects along a plane:

Move the cursor over the planar rectangle that intersects the plan and use to control the plane of constraint. When the rectangle turns yellow, click it.

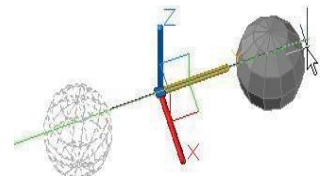


Application

Pick Tool Select the objects OR hold Ctrl key to select sub- objects (faces, edges, and vertices). Release Ctrl key and press Enter. □The Move gizmo is displayed attached to the cursor □Click to place the Move gizmo, specifying the base point for the move. □Move the cursor over the plane □ put the specify distance of the move.

To move selected objects along an axis:

Move the cursor over an axis to control the gizmo until it turns yellow and the vector is displayed. Then click the axis handle



Application

Pick Tool Select the objects OR hold Ctrl key to select sub-objects (faces, edges, and vertices). Release Ctrl key and press Enter. The Move gizmo is displayed attached to the cursor Click to

place the Move gizmo, specifying the base point for the move. Handle on the gizmo until it turns yellow and the vector is displayed. Then click the axis handle. Put the specified distance of the move.

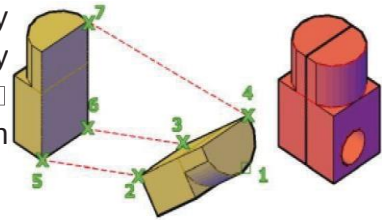
6.3.2.12 3D Align Command

You can specify one, two, or three points for the source object. Then, you can specify one, two, or three points for the destination.

Through Short Cut Key 3Dalign enter

Application

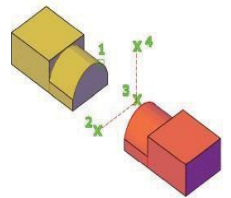
Type 3Dalign at the Command Line Select object enter Specify source plane and orientation ☐ Specify base point or [Copy]: ☐ Specify second point or [Continue] ☐ Specify third point or [Continue] ☐ Specify destination plane and orientation ☐ Specify first destination point Specify second destination point ☐ Specify third destination point



6.3.2.13 3D Mirror Command

Create a mirrored copy of selected 3D objects across a mirroring plane. You can specify the mirroring plane by aligning the objects with a specified plane or by specifying three points.

Through Short Cut Key ☐ 3Dmirror enter



Application

Type 3Dmirror at the Command Line ☐ Select object ☐ enter ☐ Specify first point of mirror plane (3 points) or [Object/Last/Zaxis/View/XY/YZ/ZX/3points] ☐ Specify second point on mirror plane ☐ Specify third point on mirror plane ☐ Delete source objects? [Yes/No] <N> ☐ enter.

6.3.2.14 Sweep Command

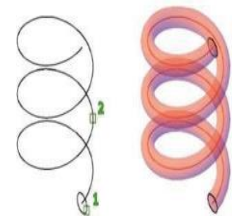
Creates a solid or surface by sweeping an open or closed, planar or non-planar curve (profile) along an open or closed path. Open curves create surfaces and closed curves create solids or surfaces, depending on the specified mode. You can use the following objects and paths when creating a swept solid or surface:

Through Short Cut Key ☐ Sweep enter

Application

Type Sweep at the Command Line ☐ Select Object to sweep ☐ enter ☐ Select sweep path ☐ enter
Sweep Options

- i. Alignment
- ii. Base point
- iii. Scale
- iv. Twist



Alignment

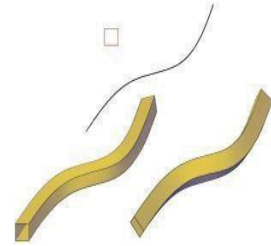
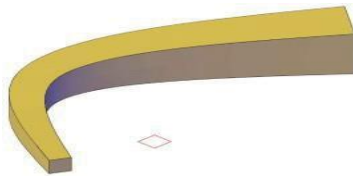
Specify whether the profile is aligned to be normal to the tangent direction of the sweep path. If the profile is not perpendicular (normal) to the tangent of the start point of the path, then the profile automatically aligns. Enter No at the alignment prompt to prevent this.

Base point

Specify a base point for the objects to be swept.

Scale

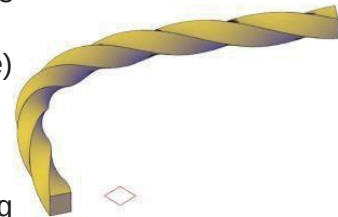
Specify a scale factor for a sweep operation. The scale factor is uniformly applied to the objects that are swept from the start to the end of the sweep path.

**Remember**

Scale the selected objects based on the length you reference by picking points or entering values.

Twist

Set a twist angle for the objects being swept. The twist angle specifies the amount of rotation along the entire length of the sweep path. Specify whether the curve(s) being swept will naturally bank (rotate) along a 3D sweep path (3D polyline, spline, or helix).

**6.3.2.15 Loft Command**

LOFT command creates a solid by joining several cross sections lying on different planes. The cross sections define the profile (Shape) of the resulting solid. Cross sections (generally, curves or circle). Loft draws a solid in the space among the different cross sections. You must specify at least two cross sections when you use the LOFT command.

Through Short Cut Key



Loft enter

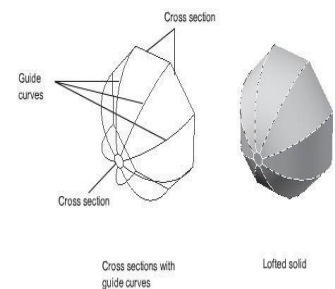
Application

Type Loft at the Command Line ☐ Select cross-sections in lofting order

☐ Select Cross sections ☐ enter

Loft Command Options

- i. Guides
- ii. Path
- iii. Cross sections only
- iv. Settings

**Guides**

Specifies guide curves that control the shape of the lofted solid or surface. You can use guide curves to control how points are matched up on corresponding cross sections to prevent undesired results, such as wrinkles in the resulting solid or surface.

- Intersects each cross section
- Starts on the first cross section
- Ends on the last cross section

Select any number of guide curves for the lofted surface or solid and press Enter

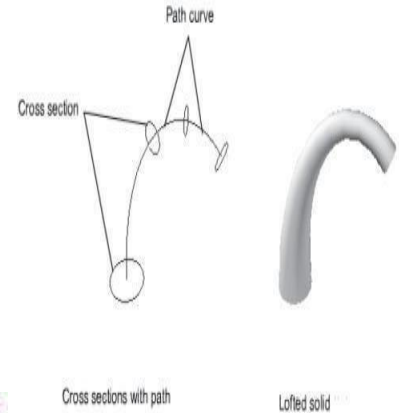
Path

Specify a path for the loft operation to obtain more control over the shape of the lofted object.

For best results, start the path curve on the plane of the first cross section and end it on the plane of the last cross section.

Cross-section

Select a series of cross-section profiles to define the shape of the new 3D object. Lofted objects with different cross-section settings as you create a lofted object; you can adjust its shape by specifying how the profile passes through the cross sections (for example, a sharp or smooth curve). You can also modify the settings later in the Properties Inspector.

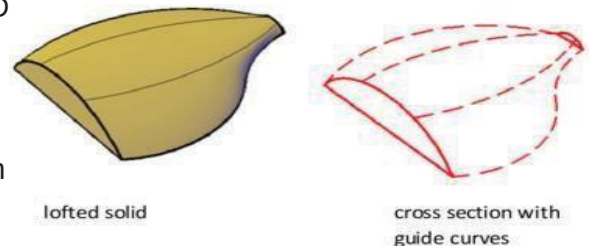


Guide Curves.

Specify guide curves to match points on corresponding cross sections. This method prevents undesired results, such as wrinkles in the resulting 3D object.

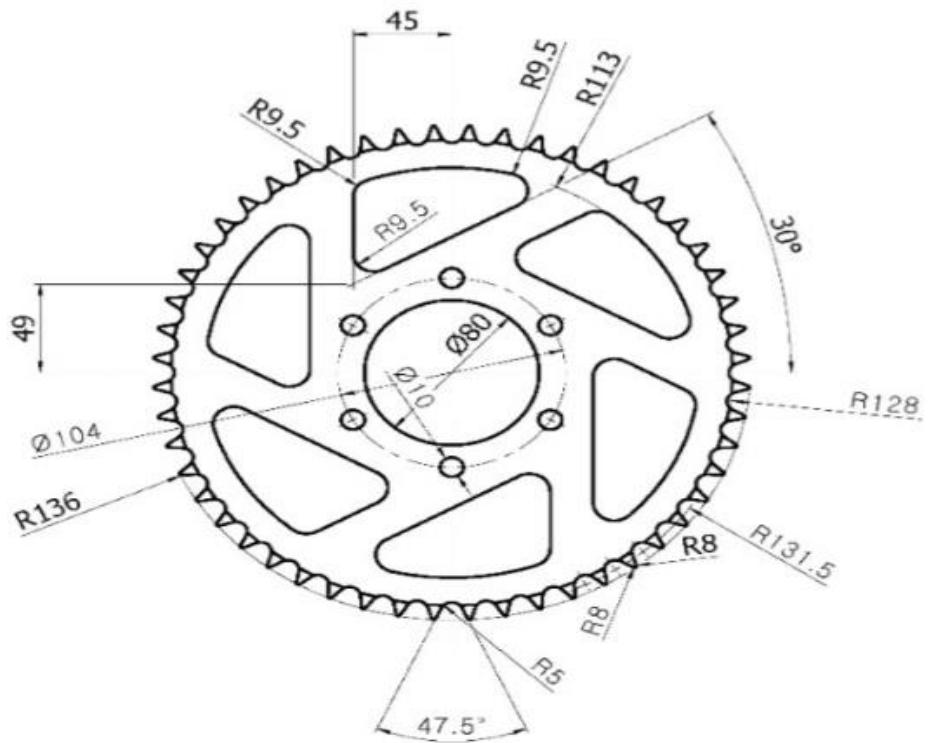
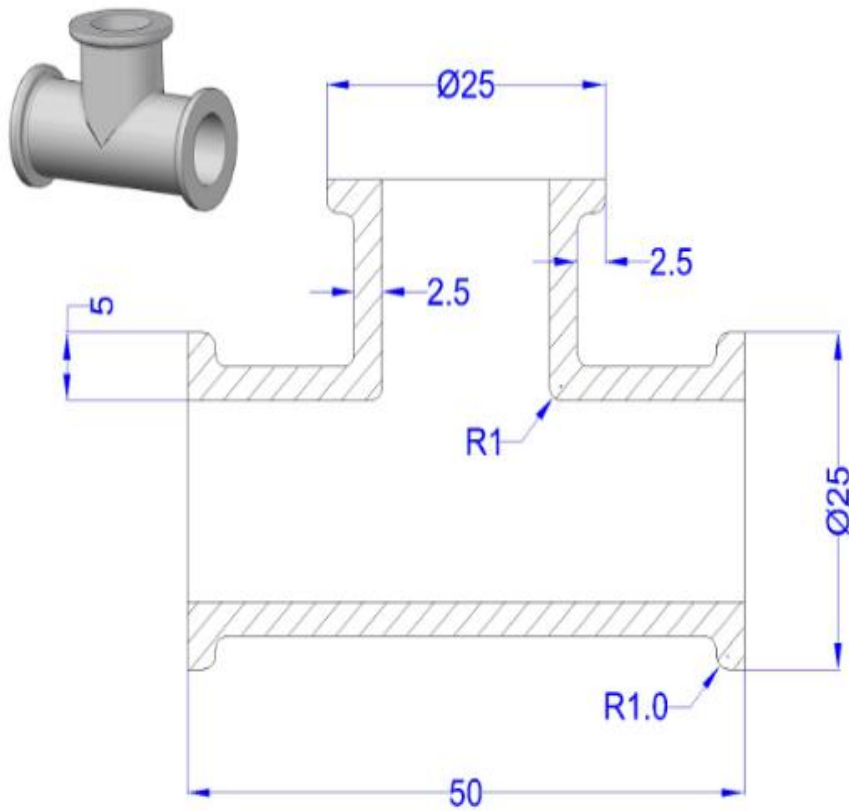
Each guide curve must meet the following criteria

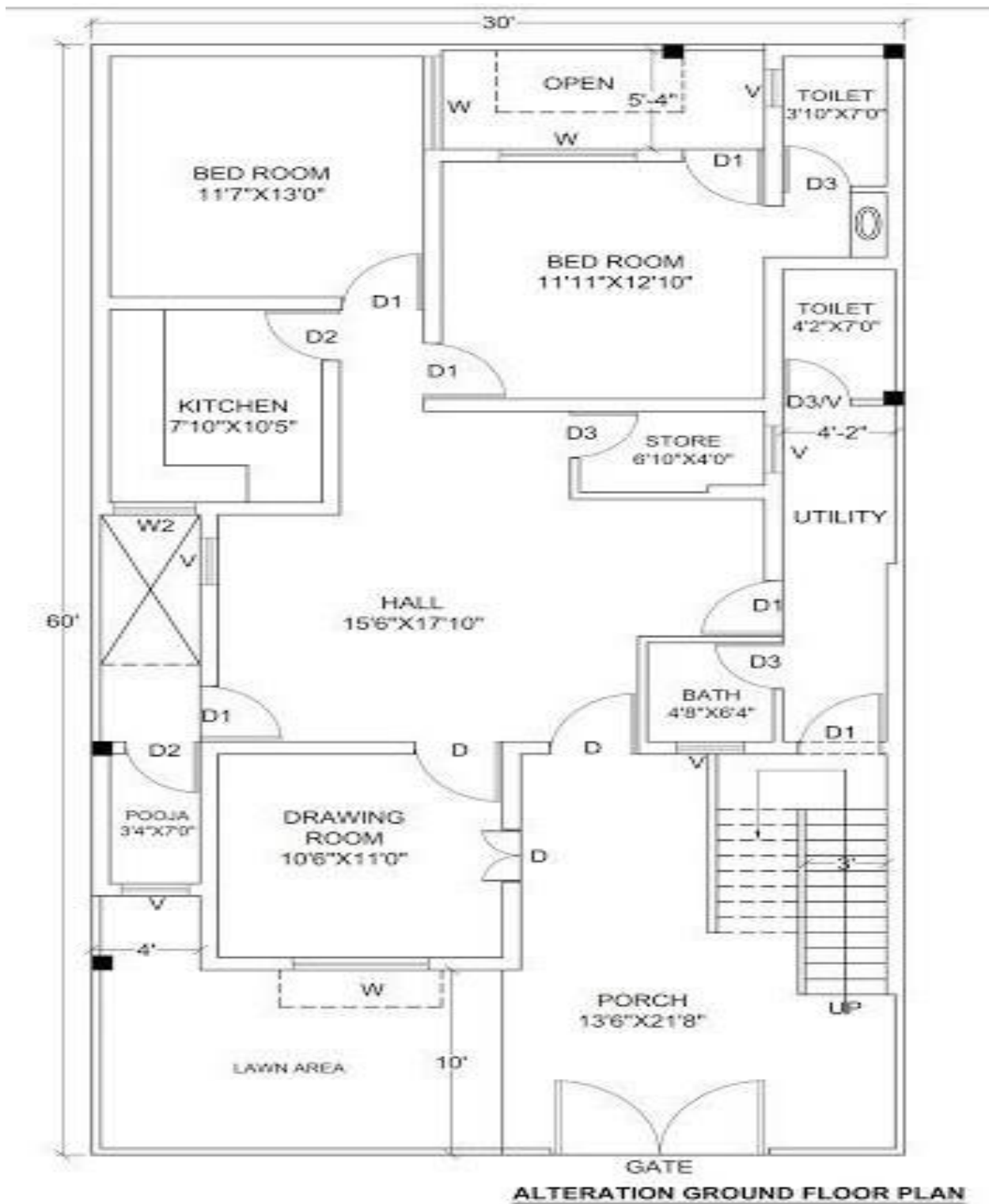
- Intersects each cross section
- Starts on the first cross section
- Ends on the last cross section

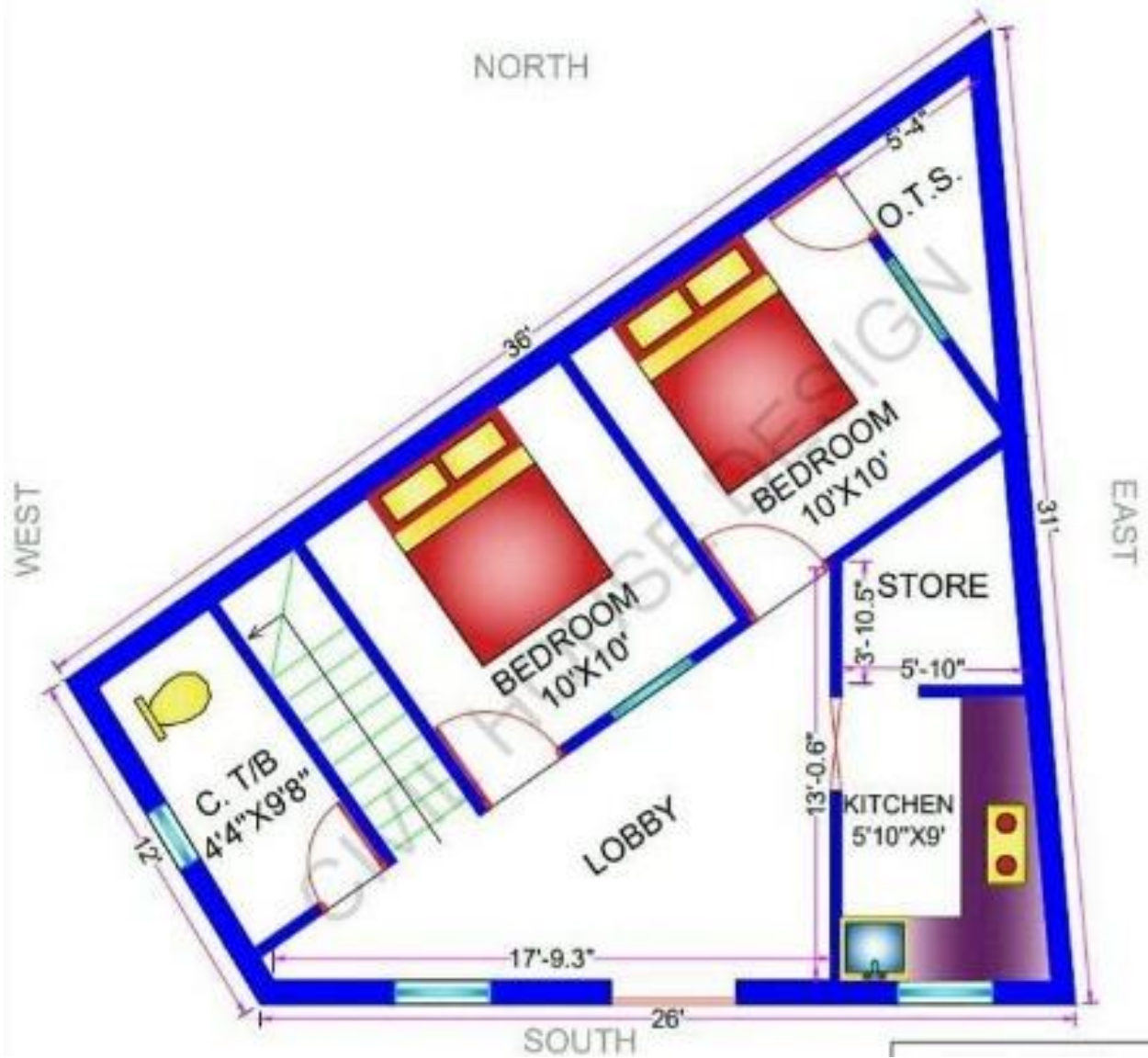


Activity

Practice to Draw 2D Drawing and extrude into 3D Views (civil & mechanical)







Learning Unit 6.4**Render 3D Model**

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

- Rendering tools and commands
- Position and installation of cameras
- Types of material/texture and light

6.4.1 Rendering tools and commands

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

6.4.1.2 Rendering Tools**i. 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.

ii. 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.

iii. Cameras and Views

- **Camera (CAMERA)** – Creates a camera to define the view for rendering.
- **Perspective View (PERSPECTIVE)** – Enables perspective projection for realistic views.

iv. Rendering Settings

- **Render Presets (RPREF)** – Opens the rendering settings to adjust quality and output format.
- **Render Environment (RENDERENVIRONMENT)** – Controls background and sky settings.

6.4.1.3 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.

Command	Description
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.

6.4.1.4 Rendering Process in AutoCAD

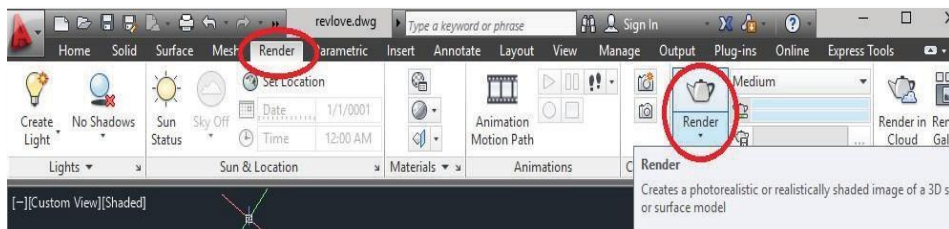
- i. **Set Up the Model**
 - Ensure your 3D model is complete.
- ii. **Apply Materials (MATERIALS)**
 - Assign materials to different surfaces.
- iii. **Set Up Lighting (LIGHT or SUNPROPERTIES)**
 - Use artificial lights or sun settings for better effects.
- iv. **Create a Camera View (CAMERA)**
 - Define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

6.4.2 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.

6.4.2.1 Render Tab

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



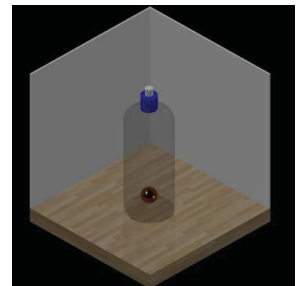
Remember

If the Render Option is not displayed on the Visualize tab, right-click the Visualize tab and click Panels → Render.

6.4.2.2 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:

- i. BMP, RLE, or DIB
- ii. GIF
- iii. JFIF, JPG, or JPEG
- iv. PCX
- v. PNG
- vi. TGA



vii. 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.

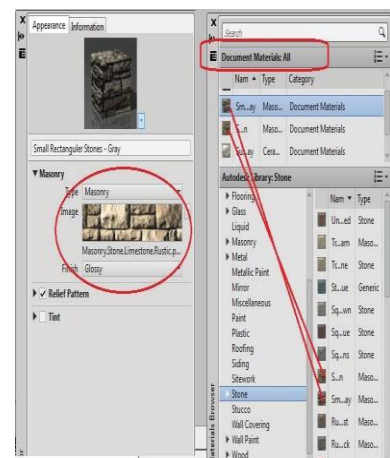
To Browse Material

Step -1 View ☐ Render ☐ Materials Brower

Step-2: Double Click or drag any of the material from material library into the document material list as shown in the figure below

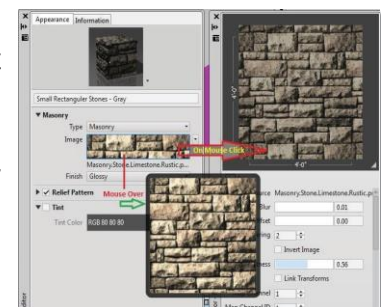
Step-3: Go to the Material list and apply material as shown in the figure

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



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

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.

6.4.2.3 Control Sampling

Control how the renderer performs sampling.

Sampling provides a "best guess" color for each rendered pixel.

The renderer first samples 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

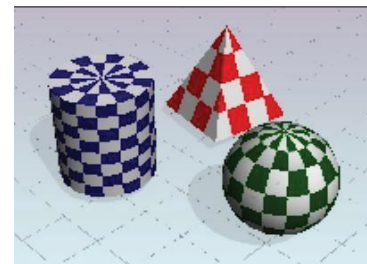
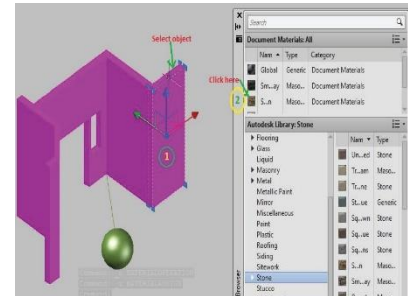
Min. Samples = 1/64;

Max. Samples = 1/4.

In the following example, increased sampling smooth's edges

Min. Samples = 1;

Max. Samples = 16.

**6.4.2.4 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.

6.4.2.5 Ray Tracing

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

i. Max Depth

Limit the combination of reflection and refraction.

ii. Max Reflections

Set the number of times a ray can be reflected.

iii. Max Refractions

Set the number of times a ray can be refracted

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

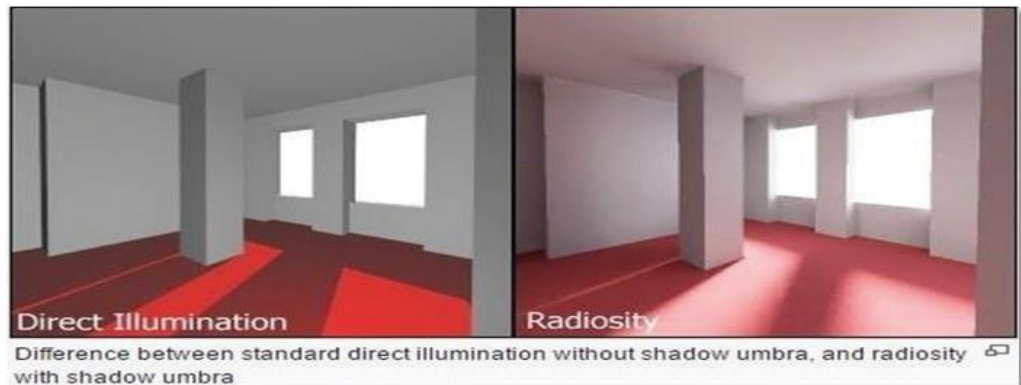
Specifies the area within which photons will be used when luminance is computed.

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.

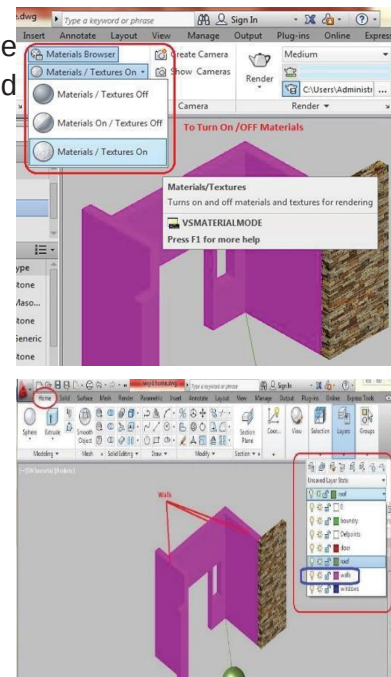
6.4.2.6 Material by Layers

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



6.4.2.7 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

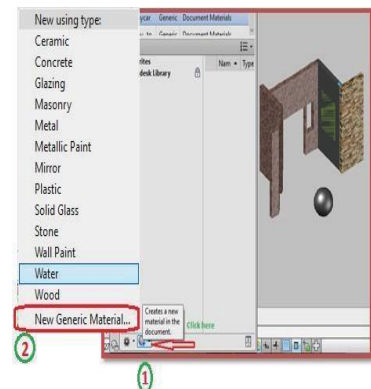
Step-2: Click Create **New Material** Option as shown in the figure

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

Step-5: Apply material to the selected object.

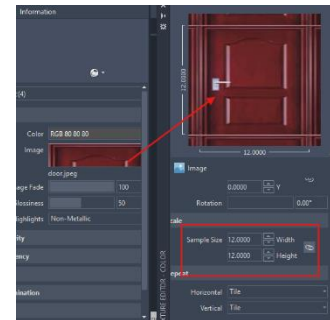
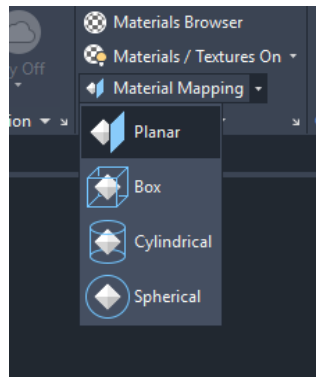
Step-6: Apply render command to display render



6.4.2.7 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>
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.
 or direct apply from material ribbon



6.4.2.8 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

6.4.2.9 Rendering

Method-1:

Type **RPERF** in command bar.

Method-2:

Procedure Apply Advanced Render Settings
 STEP BY STEP Operation on AutoCAD

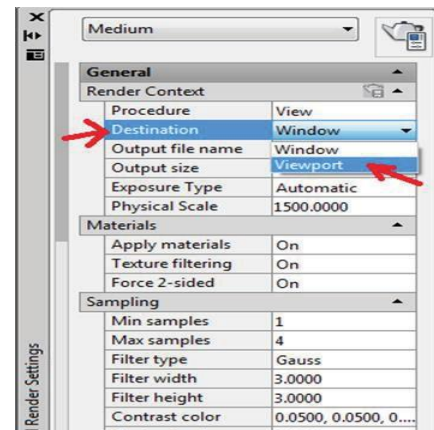
GET READY. Before you begin these steps, be sure to set unit and you must have an object in your drawing to apply rendering.

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

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

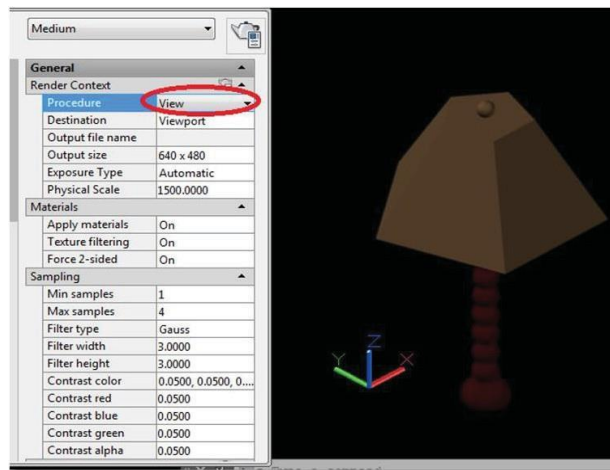
Step-3: Type **render** command in command bar.

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.



6.4.2.10 Quality Setting

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

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

Selected Procedure

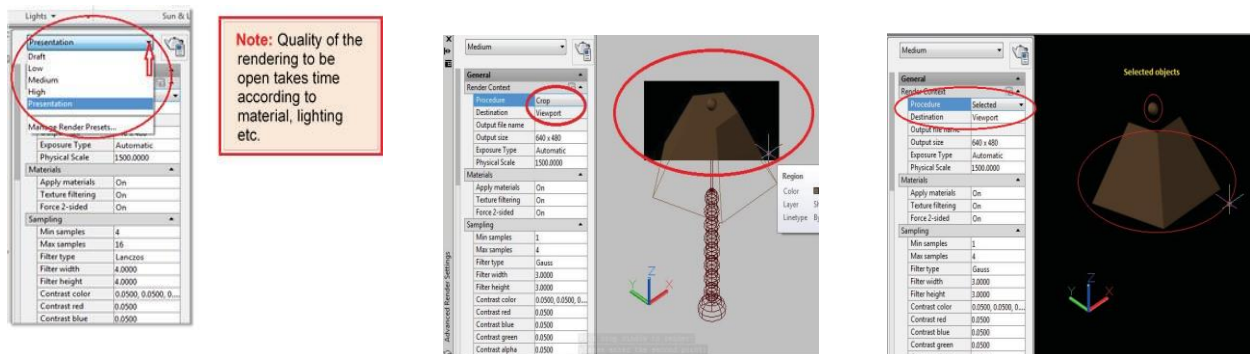
Step-1: Type **RPERF** command in command bar <Enter>.

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.

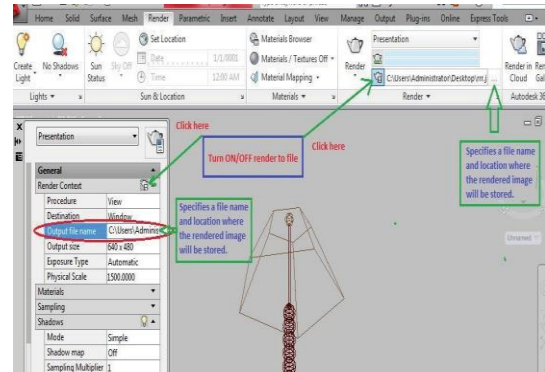
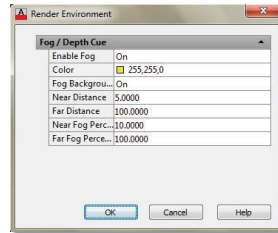


6.4.2.11 Render Environment

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

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

Step-2: Apply render



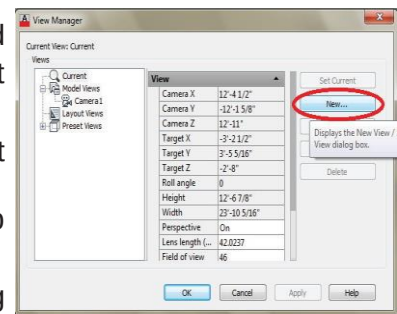
Creating Views and Applying Background

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.

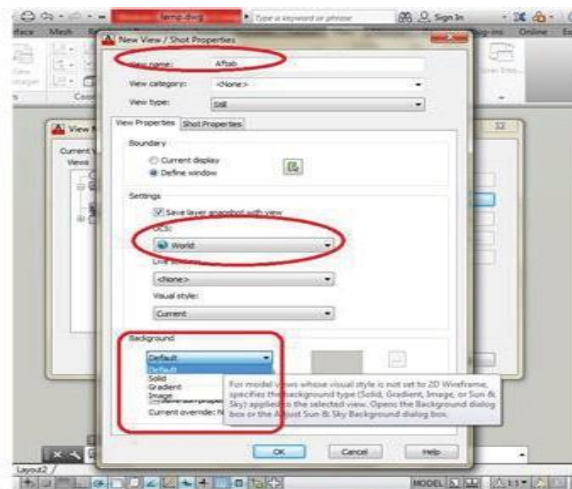
Step-1: Type **view** command in command bar or click View tab ☐ views Manager to get the following.

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

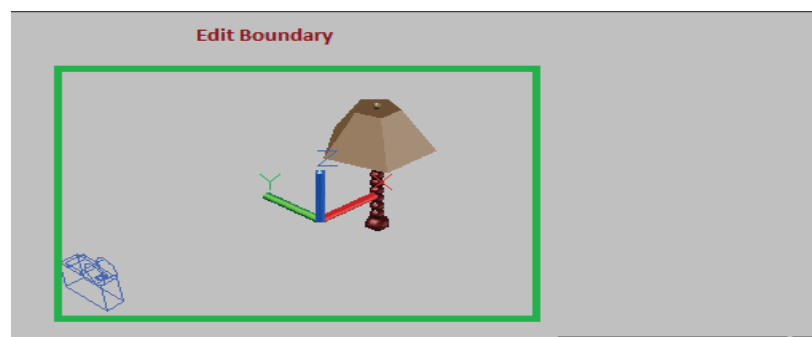
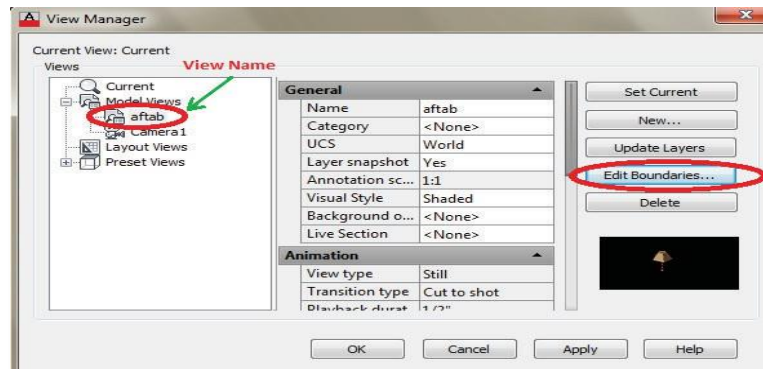


Note:
You can change the setting according to your View.

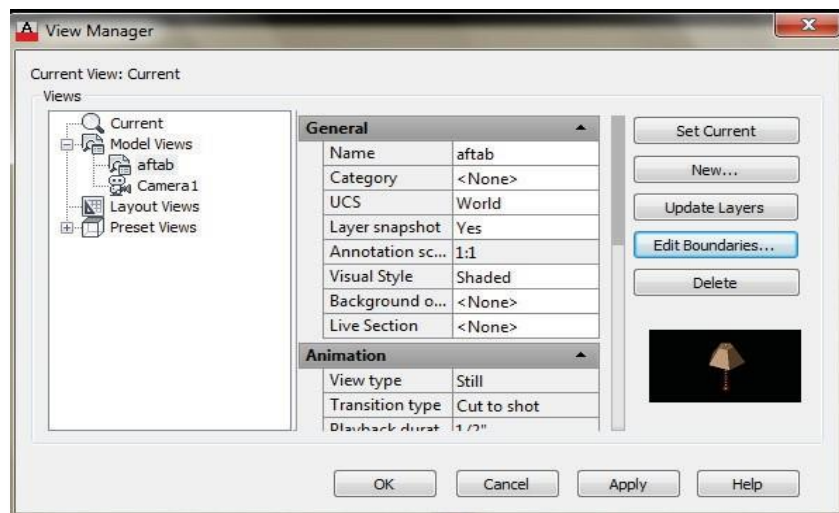
Here we applied:
View Name: Aftab
UCS: World



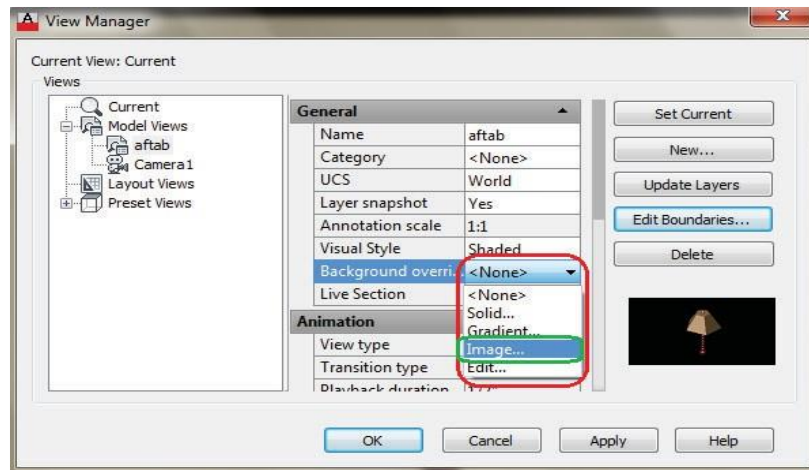
Step-3: Click the Edit Boundary option to define your own boundary for the background as shown in the figure below.



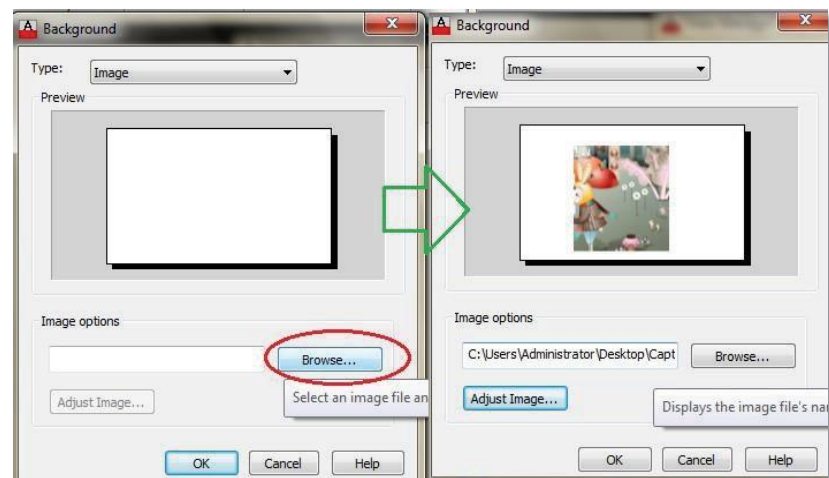
Step-4: After defining the boundary press Enter, you will get back to View Manager Window.



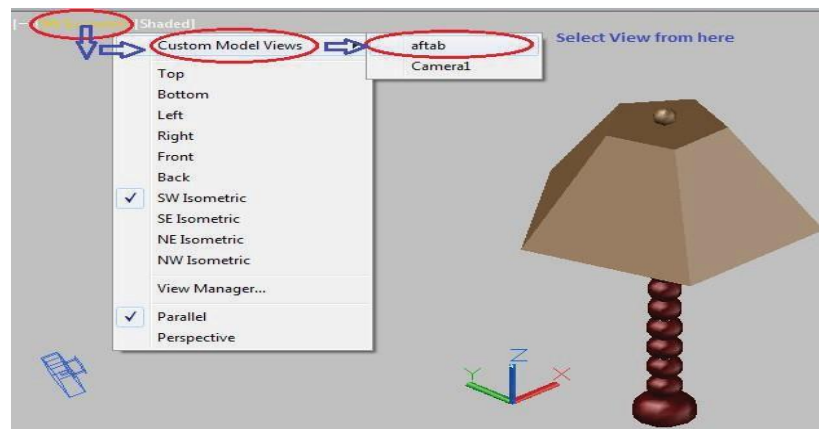
Step-5: Now select background option to apply one of the three option of background as show in figure below.



Step-6: Here we are going 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 following Out Put



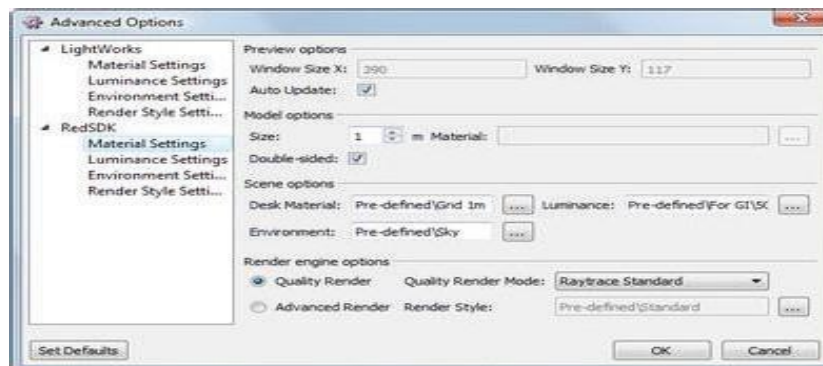
6.4.2.12 Opacity Control

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.

- i. Select a material in the Materials Palette
- ii. Right click and select Edit Materials.
- iii. 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.

6.4.2.13 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 light

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

Web light:

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

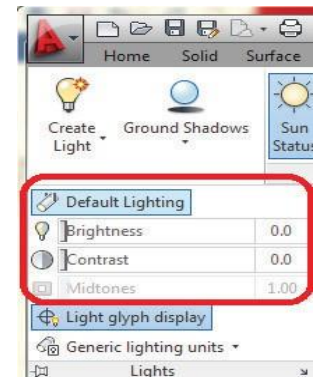
Method-1:

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.



Point Light

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

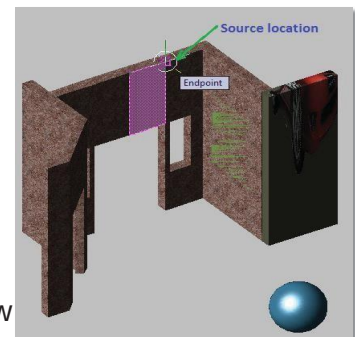
Step-1: type **point light** command in command bar <Enter> Or Click go through 3D Modelling ▢ render tab ▢ Light ▢ PointLight

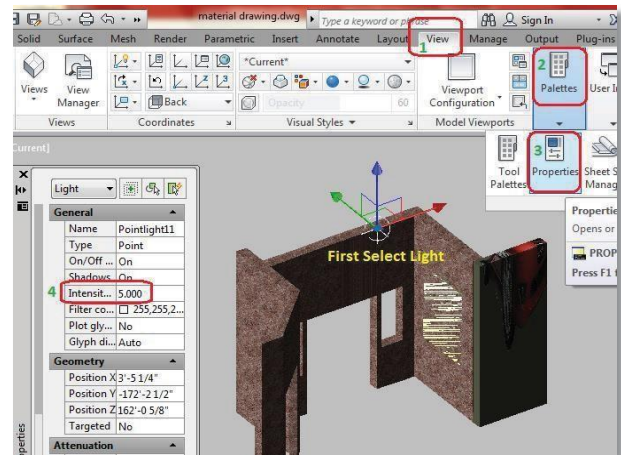
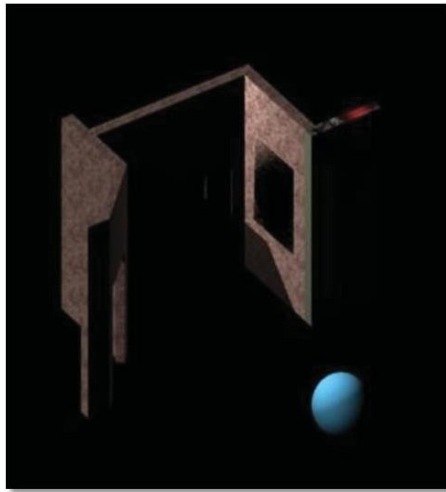
Step-2: Specify source location <0,0,0>: <Click or Define Source Location>

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

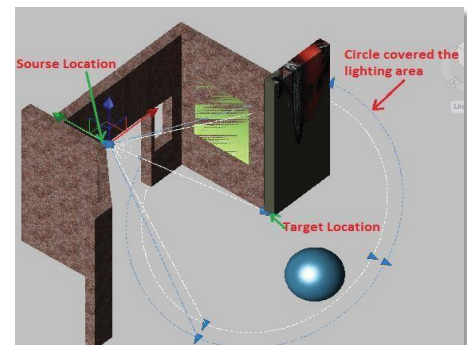
Spotlight

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>

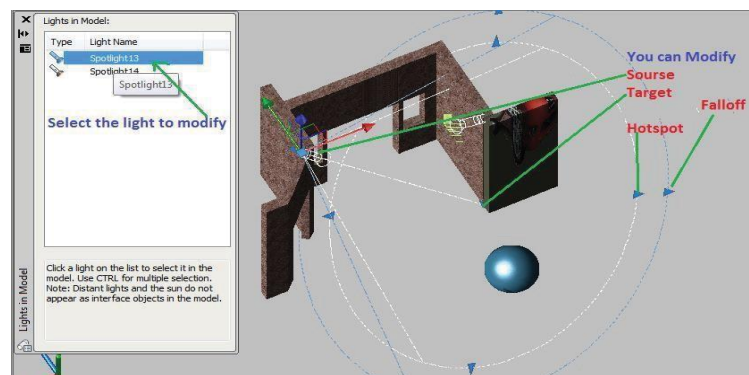
Step-3: Specify target location <0,0,0>: <Click or Define Source Location>



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



6.4.2.14 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

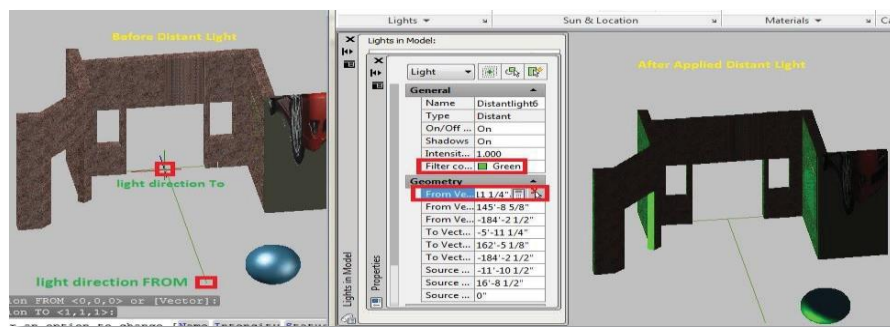
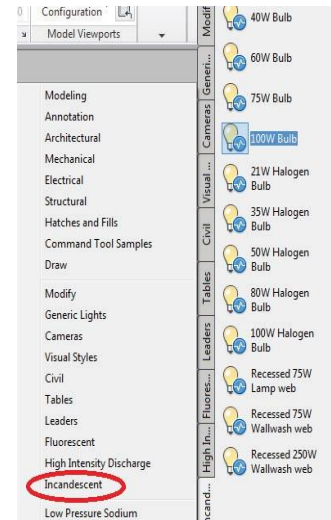
Distance light is used for uniform parallel light rays in one direction and mentioning from and to points.

Step-1: type distant light command in command bar <Enter> Or Click go through 3D Modelling →render tab →Light →Distant Light

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>



6.4.3 Position and installation of cameras

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.)

6.4.3.1 Creating Camera

To Access Camera

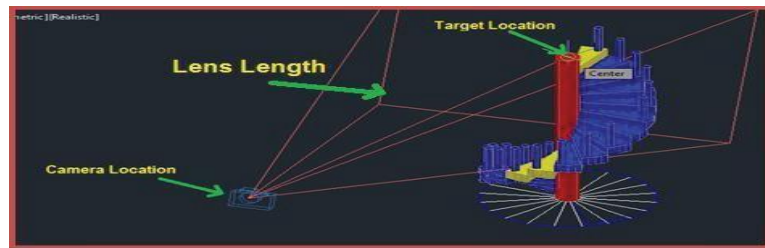
Render Tab	Button	Command Entry
Camera panel ☐ Create Camera		Cam/camera

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

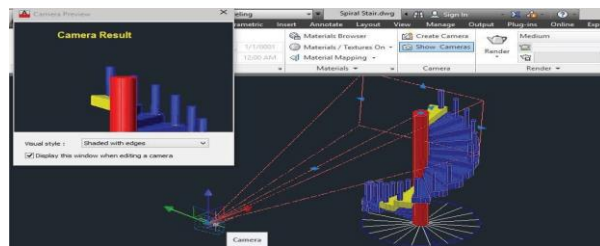
Step-2: Click in the drawing to specify the camera's location.

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

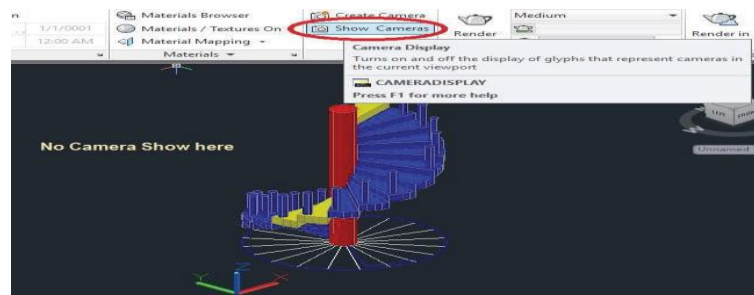
Step-4: Press Enter to Finish, you will get the following as shown in figure below



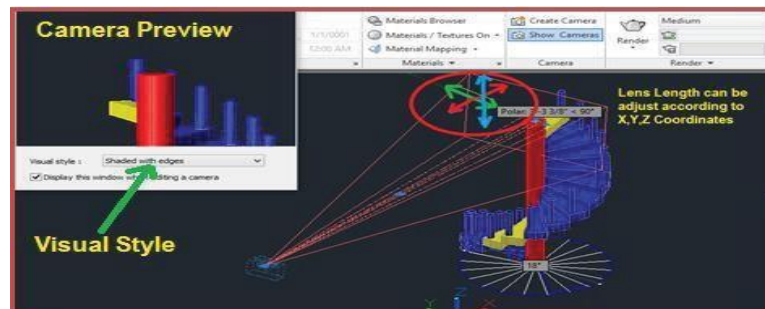
Step-5: To View the Camera, just click the camera location, you will get the following as shown in the figure below



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.

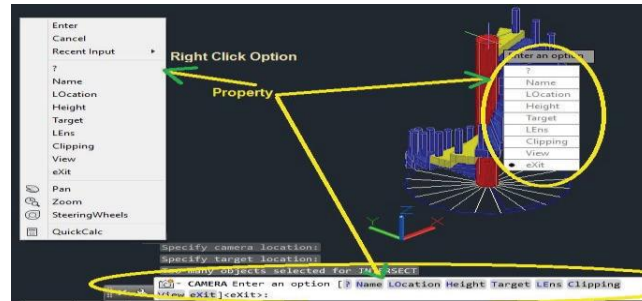


To further define camera properties, you will get properties on the screen while you setting up camera or you can right-click and select from the list of options.

6.4.3.2 Camera Properties

Teaching and Learning Guide: Information Technology (CAD) **AutoCAD**

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.

6.4.3.3 Make Animation file in Auto CAD

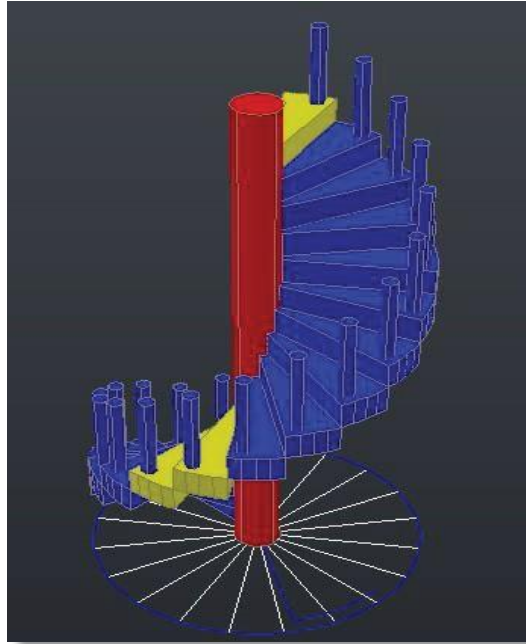
Animation Path is 3D Camera view through which you can view the object/s in as animated motion via a specified path.

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

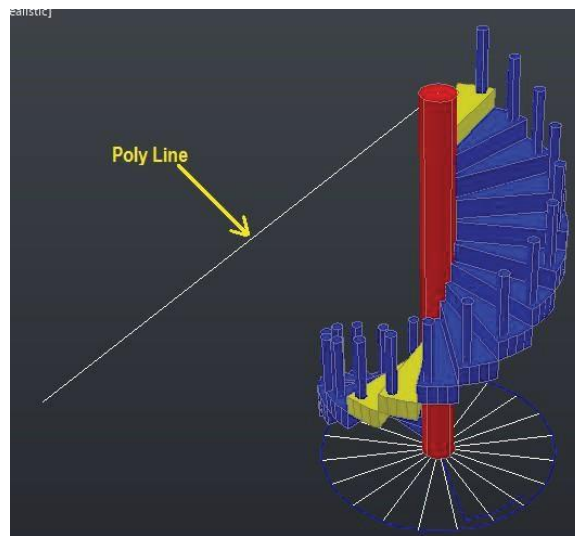
A path can be a line, polyline, 3D polyline, arc, elliptical arc, circle, or spline. To Access Camera

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

We are going to apply animation path on drawing as shown in the figure below.



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



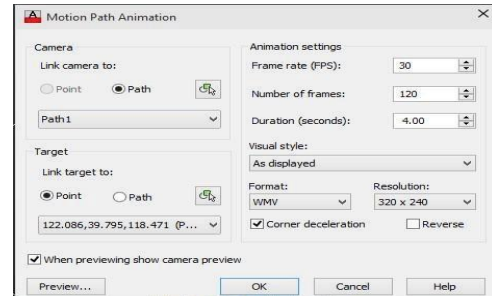
Step-2: In the Motion Path Animations dialog box, do the following:

- i. Specify a point or path for the camera.
- ii. Specify a point or path for the target.
- iii. Modify any animation settings as you want.

Step-3: Type **ANIPATH** command in command bar or Click Render Tab
☐ Animations panel ☐ Animation Motion Path.

For practice we 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.



6.4.3.4 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

6.4.3.5 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

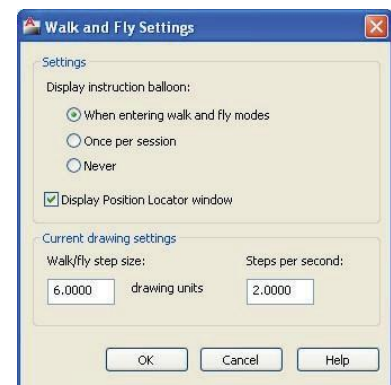
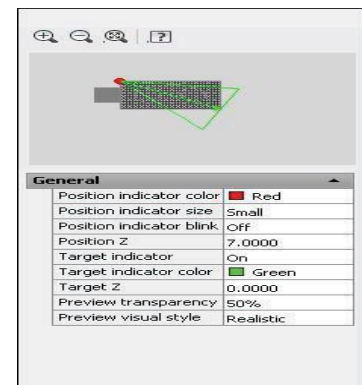
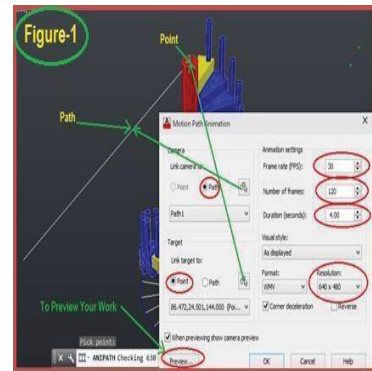
Specifies settings related to the Walk and Fly Navigation Mappings balloon and the Position Locator window.

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).

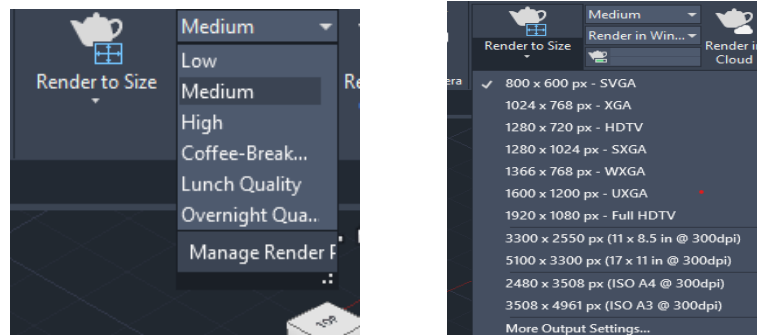
Steps Per Second

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

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



6.4.3.6 Render Quality (preset)

Step 1: Type RPREF at the command prompt

Step 2: Click the dropdown option for the render quality and choose **Presentation** you can change from ribbon as well

6.4.3.7 Render Selection

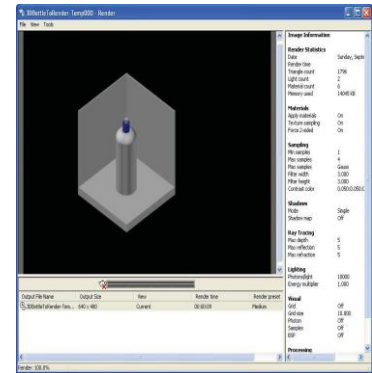
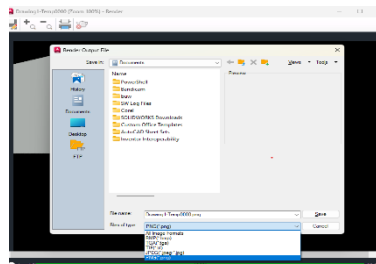
Controls the parts of the model that gets processed during rendering. The render procedure has three settings: View, Crop, and Selected

Step 1: Type RPREF at the command prompt

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

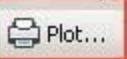
The render preferences and render selected objects

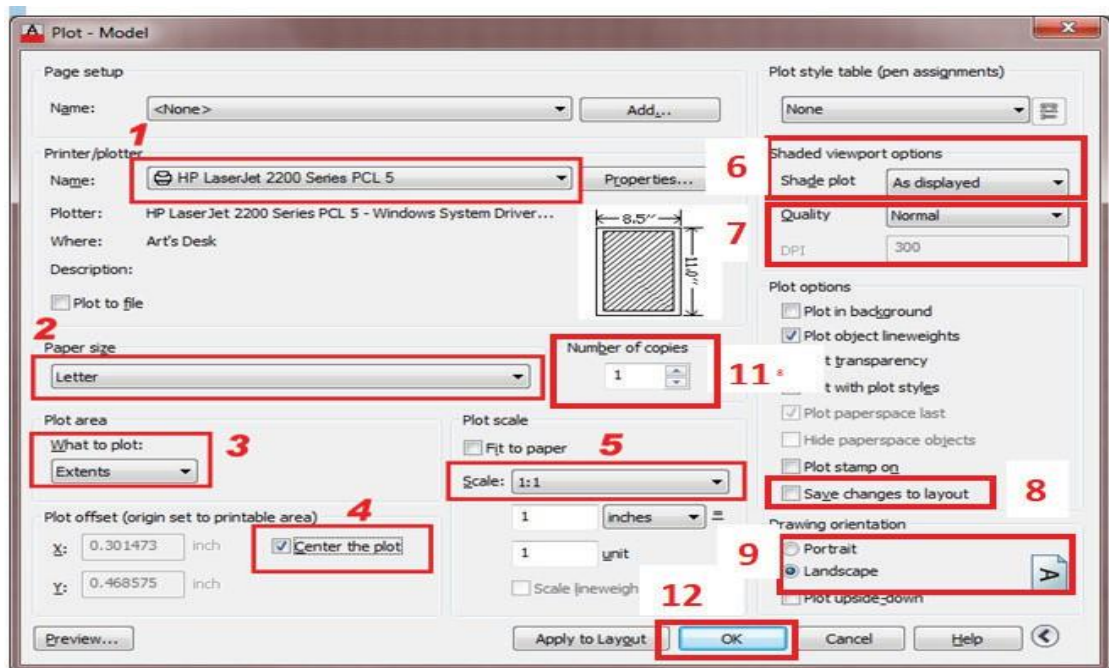
This result is a selected object in the drawing that is rendered. After the completion these step you change also type and dots per inch for best quality of picture.



6.4.3.8 Print The 3D MODEL

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

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

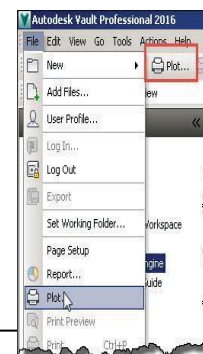


Open the Plot Window

Step 2: Open the Plot window

- Select Plotter/Printer
- Select Page Size
- Select Plot area
- Center the plot
- Set the plot Scale

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- vi. Select shade plot
- vii. Select Print Quality
- viii. Save the layout
- ix. Select drawing Orientation
- x. Preview
- xi. Set number of copy
- xii. Ok

Activity 1:

Practice to import and render 3D prototype Model (civil and mechanical.) including materials, lights and cameras in any 3D view

Activity 2:

Practice to print rendered model as per required scale

Activity 3:

Create portfolio in PDF format

SUMMARY

In summary, this module equipped us with the skills to navigate, visualize, and manipulate 3D models effectively in AutoCAD. We explored advanced tools for creating and editing 3D objects, setting up dynamic views, and generating animations, preparing us to tackle complex 3D design challenges in various professional fields.

FAQs:**1. What is AutoCAD 3D used for?**

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?

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

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

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

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

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

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

2D is for flat drawings (e.g., plans, elevations), while 3D is for creating three-dimensional models with depth and volume.

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

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

7. **What is the Extrude command used for?**
It converts 2D shapes into 3D objects by adding height or depth.
8. **How do I create a 3D solid from a 2D shape?**
Use the **Extrude**, **Revolve**, or **Press/Pull** command on a 2D closed shape.
9. **What is the Press/Pull tool used for?**
It allows you to quickly extrude or cut 3D shapes by clicking on a face or region.
10. **How do I create a hole in a 3D object?**
Use the **Subtract** command to remove a 3D shape (e.g., cylinder) from another 3D object.
11. **How do I move a 3D object in AutoCAD?**
Use the **Move** command and specify the direction and distance.
12. **How do I rotate a 3D object?**
Use the **Rotate** command and select the axis of rotation.
13. **What is the Union command used for?**
It combines two or more 3D objects into a single object.
14. **How do I scale a 3D object?**
Use the **Scale** command and specify the base point and scale factor.
15. **How do I slice a 3D object?**
Use the **Slice** command to cut a 3D object along a plane.
16. **How do I render a 3D model in AutoCAD?**
Go to the **Render** tab and click **Render** to generate a photorealistic image.
17. **How do I add materials to a 3D object?**
Use the **Materials Browser** to apply textures and finishes to your model.
18. **What is the purpose of lighting in 3D rendering?**
Lighting enhances the realism of the model by adding shadows and highlights.
19. **How do I change the background in a 3D view?**
Use the **View Manager** to set a background color or image.
20. **How do I create a walkthrough or animation in AutoCAD?**
Use the **Motion Path Animation** tool to create a camera path and generate a video

MCQs:

Questions	Option A	Option B	Option C	Option D
What is AutoCAD 3D primarily used for?	Creating 2D drawings	Creating three-	Editing images	Writing scripts

		dimensional models		
How do you switch to 3D mode in AutoCAD?	Use the Line command	Go to Workspace Switching and select 3D Modeling	Press Ctrl + 2	Use the Hatch command
Which of the following is NOT a basic 3D modeling tool in AutoCAD?	Extrude	Revolve	Hatch	Loft
What tool is used to view a 3D model from different angles?	View Cube	Line	Trim	Hatch
What is the main difference between 2D and 3D in AutoCAD?	2D has depth, while 3D is flat	2D is flat, while 3D has depth and volume	2D is used for rendering, while 3D is for drafting	There is no difference
Which command is used to create a 3D box in AutoCAD?	Circle	Box	Line	Arc
What does the Extrude command do?	Converts 2D shapes into 3D objects	Deletes 3D objects	Rotates 3D objects	Scales 3D objects
Which command is used to create a 3D solid from a 2D shape?	Extrude	Trim	Hatch	Line
What is the Press/Pull tool used for?	Deleting objects	Extruding or cutting 3D shapes quickly	Rotating objects	Scaling objects
How do you create a hole in a 3D object?	Use the Union command	Use the Subtract command	Use the Hatch command	Use the Line command
Which command is used to move a 3D object?	Rotate	Move	Scale	Trim
How do you rotate a 3D object?	Use the Move command	Use the Rotate command	Use the Scale command	Use the Hatch command
What does the Union command do?	Combines two or more 3D objects into one	Deletes 3D objects	Rotates 3D objects	Scales 3D objects
Which command is used to scale a 3D object?	Move	Rotate	Scale	Trim

What does the Slice command do?	Combines 3D objects	Cuts a 3D object along a plane	Deletes 3D objects	Rotates 3D objects
How do you render a 3D model in AutoCAD?	Use the Line command	Go to the Render tab and click Render	Use the Hatch command	Use the Trim command
Which tool is used to add materials to a 3D object?	Materials Browser	Line	Trim	Hatch
What is the purpose of lighting in 3D rendering?	To delete objects	To add shadows and highlights for realism	To rotate objects	To scale objects
How do you change the background in a 3D view?	Use the View Manager	Use the Line command	Use the Hatch command	Use the Trim command
Which tool is used to create a walkthrough or animation in AutoCAD?	Motion Path Animation	Line	Trim	Hatch

Answers Key

1	2	3	4	5	6	7	8	9	10
B	B	C	A	B	B	A	A	B	B
11	12	13	14	15	16	17	18	19	20
B	B	A	C	B	B	A	B	A	A

Module 07	Develop Entrepreneurial Skills
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Learning Outcomes:

After Completion of this learning module, you will be able to:

- Develop Business Plan
- Collect information Regarding Funding Sources
- Develop Marketing Plan

Learning Unit 7.1	Develop Business Plan
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After completion of this learning unit, you will be able to:

- Set Goals & Objectives
- Create Financial plan
- Conduct market survey to collect information
- Select the best option in terms of cost, service, quality, sales, profit margin, overall expenses
- Compile information collected through market survey, in business plan format

7.1.1 Main Elements of a Business Plan

A business plan is a written document that outlines the goals of a business, the strategy to achieve them, and the financial details. The main elements of a business plan are:

- Executive Summary:**
A brief overview of the business, including the business concept, mission, vision, and key objectives.
- Business Description:**
Describes the nature of the business, its offerings, the market needs it will address, and the industry in which it operates.
- Market Research and Analysis:**
Analyzing the market and identifying target customers, competitors, and industry trends.
- Organization and Management:**
Information about the business structure (e.g., LLC, sole proprietorship), the team, and their roles.
- Products or Services:**
Details about the products or services offered, including features, benefits, and how they solve customers' problems.
- Marketing and Sales Strategy:**
How the business plans to attract and retain customers, including pricing, advertising, promotions, and sales strategies.
- Financial Plan:**
Financial projections, including income statements, balance sheets, cash flow

Remember

Entrepreneurship is the activity of setting up a business or businesses, taking on financial risks in the hope of profit.

statements, and break-even analysis.

- viii. **Appendix:**
Additional information like resumes, permits, legal documents, and other supplementary materials.

7.1.2 Business Plan Format

The format of a business plan typically includes the following sections:

- i. **Title Page** – Includes the name of the business, logo, contact information, and date.
- ii. **Table of Contents** – Lists all the sections of the business plan.
- iii. **Executive Summary** – An overview of the business.
- iv. **Business Description** – Provides in-depth details about the business and industry.
- v. **Market Research and Analysis** – Information about the target market, competitors, and trends.
- vi. **Products or Services** – Description of the products/services.
- vii. **Marketing & Sales Strategy** – How the business will sell and market.
- viii. **Operational Plan** – Describes the daily operations of the business.
- ix. **Management and Organization** – Information on the business structure.
- x. **Financial Plan** – Projected financial statements and funding requirements.
- xi. **Appendices** – Additional supporting documents.

7.1.3 Business Terms Used in the Industry

- i. **Revenue:** The total income generated from selling goods or services.
- ii. **Profit:** The amount of money remaining after all expenses are subtracted from revenue.
- iii. **Assets:** Resources owned by a business, like property, equipment, and inventory.
- iv. **Liabilities:** Debts or obligations that the business owes to others.
- v. **Cash Flow:** The movement of money into and out of the business.
- vi. **Capital:** The funds invested in a business to fund operations and growth.
- vii. **Market Share:** The percentage of an industry's total sales that a business controls.
- viii. **Brand:** A name, term, or design that distinguishes one business from another.
- ix. **B2B (Business to Business):** Selling products or services from one business to another.
- x. **B2C (Business to Consumer):** Selling products or services directly to consumers.

7.1.4 7 Cs of Business Communication

The 7 Cs are a set of principles to ensure effective communication in business:

- i. **Clarity:** Be clear about the message you are communicating. Avoid jargon and confusion.
- ii. **Conciseness:** Keep the message brief and to the point. Avoid unnecessary details.
- iii. **Concreteness:** Provide specific facts and figures to support your message.
- iv. **Correctness:** Use proper grammar, punctuation, and spelling.
- v. **Consideration:** Think about the audience's perspective and adjust your message accordingly.

Remember

Short and precise messages have a 30% higher chance of being understood and acted upon compared to long, verbose communications.

- vi. **Completeness:** Ensure the message contains all necessary information for the receiver to understand and take action.
- vii. **Courtesy:** Be polite and respectful, considering the feelings and viewpoints of others.

7.1.5 Data Collection Techniques

Data collection is essential for gathering information that helps businesses make decisions. Some common techniques include:

- i. **Surveys and Questionnaires:**
A method where participants respond to a set of questions to collect data on various topics.
- ii. **Interviews:**
One-on-one discussions with individuals to gain in-depth insights.
- iii. **Observation:**
Collecting data by observing the behavior of people or processes in their natural environment.
- iv. **Focus Groups:**
A small group of people discussing a topic to gather opinions and ideas.
- v. **Experiments:**
Controlled studies designed to test hypotheses and observe results.
- vi. **Secondary Data:**
Using data that has already been collected for other purposes, such as government reports or industry research.
- vii. **Case Studies:**
In-depth examinations of a particular case or situation to gather detailed information.
- viii. **Documents and Records:**
Collecting data from existing business documents, reports, or databases.

Remember

The average survey completion time for online surveys is around 5-10 minutes, with a response rate of about 30-50% depending on the subject and incentive.

Activity 1:

Select and Visit a Target Market to Find a Gap and Trends in the Market

Steps to Follow:

Select a Target Market:

- i. Choose an industry or niche where you want to launch your product or service. This could be related to architecture, engineering, interior design, or any other field where AutoCAD plays a role.
- ii. Example industries:
 - Residential and Commercial Construction
 - Interior Design
 - Urban Planning

- Engineering Firms
- Furniture Design

Research the Market:

- i. Use secondary data (industry reports, online surveys, articles) and primary data (observations, interviews with professionals, surveys) to gather insights.
- ii. Identify key players in the market and analyze their strengths and weaknesses.
- iii. Study customer needs, preferences, and existing solutions.

Visit the Market:

- i. Go to local businesses, construction sites, architecture firms, or design studios. Interact with potential customers and industry professionals.
- ii. Observe existing products, services, and designs. Identify what is working well and what isn't.
- iii. Take note of any gaps in products or services that could be improved, innovated, or introduced.

Analyze Market Trends:

- i. Look for trends in technology, consumer behavior, and emerging demands. For example, are customers moving towards eco-friendly or sustainable designs? Is there a shift towards automation or smart buildings?
- ii. Keep an eye on new tools, techniques, and design approaches being used in AutoCAD and related industries.

Identify the Gap:

- i. After your research and visits, pinpoint a specific gap in the market where you could introduce something new or improve existing solutions.
- ii. Example: If AutoCAD designs are not being optimized for mobile platforms, this could be a potential gap in the market.

Compile Findings:

Present your findings in a structured format. This could be a report or presentation that includes:

- The market overview
- Identified trends
- Market gap
- Opportunities for innovation

Activity 2:

Develop a Business Plan

Steps to Follow:

Executive Summary:

- i. Write a brief overview of your business idea, the gap you are addressing in the market, and your vision for the business.
- ii. Example: "We aim to provide innovative AutoCAD design solutions for small architecture firms, focusing on user-friendly interfaces and cost-effective services for emerging architects."

Business Description:

- i. Describe your business in detail, including the product/service you are offering, the target market, and the mission statement.
- ii. Example: "Our business will offer AutoCAD design services that cater to small and medium-sized architecture firms that require precise, scalable, and customized building designs."

Market Research:

- i. Summarize the findings from Activity 1, including the target market, trends, and gaps you identified.
- ii. Example: "Through market research, we identified a gap in the small architecture firms where many are struggling with the high cost of AutoCAD software and are seeking more affordable and efficient alternatives."

Marketing and Sales Strategy:

- i. Outline your marketing and sales approach. How will you reach your target audience? What tools or methods will you use to promote your product/service?
- ii. Example: "We will use social media platforms, industry-specific webinars, and partnerships with architectural firms to promote our services. Our sales strategy includes offering discounted trial periods and referrals to build a client base."

Operations Plan:

- i. Describe how your business will run on a day-to-day basis. What are the key operations, tasks, and responsibilities?
- ii. Example: "Our team will consist of AutoCAD specialists, designers, and project managers who will ensure that designs are delivered on time, with high precision and according to client needs. We will also invest in the latest AutoCAD software and hardware for optimal performance."

Financial Plan:

- i. Provide projections for revenue, expenses, and profit. What funding will be required to start the business, and what are your expected costs and income?
- ii. Example: "We estimate an initial investment of \$20,000 to cover software licenses, marketing expenses, and hiring skilled employees. We expect to break even within the first year of operations and anticipate a steady increase in profits as we scale."

Management Team:

- i. List the key members of your team, their roles, and responsibilities.
- ii. Example: "The team will consist of a CEO, marketing director, chief designer, and two AutoCAD technicians. Each team member will bring industry-specific knowledge and expertise to ensure the success of the business."

Learning Unit 7.2	Collect information regarding Funding Sources
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After completion of this Learning Unit, you will be able to:

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- Identify available funding sources based on their terms and conditions, maximum loan limit, payback time, interest rate
- Choose best available option according to investment requirement
- Prepare documents according to the loan agreement requirement
- Include information of funding sources in the business plan

7.2.1 Knowledge of Funding Sources

Funding sources help you finance your business. Common sources include:

- **Personal Savings:** Use your own money.
- **Family and Friends:** Ask for financial support.
- **Bank Loans:** Borrow from banks with interest.
- **Government Grants:** Get financial help from the government.
- **Angel Investors:** Wealthy individuals invest in exchange for a share of your business.
- **Venture Capitalists (VC):** Investment firms that help growing businesses.
- **Crowdfunding:** Raise money from many people online.
- **Microfinance:** Small loans for entrepreneurs.
- **Business Competitions:** Win money through contests.

7.2.2 How to Get a Loan to Start a New Business

Steps to get a loan for your business:

- **Research Loan Types:** Find the best loan for your needs.
- **Prepare a Business Plan:** Explain your business idea and how you'll repay the loan.
- **Check Your Credit:** Good credit helps you get approved.
- **Decide Loan Amount:** Be clear on how much money you need.
- **Provide Collateral:** Offer assets as security if required.
- **Apply for the Loan:** Fill out the application and submit documents.
- **Wait for Approval:** Lenders will review and decide.
- **Repay the Loan:** Stick to the repayment terms.

7.2.3. Market Survey and Its Tools

A **market survey** helps understand customer needs and market trends. Key tools include:

- **Interviews:** One-on-one conversations to gather detailed opinions.
- **Questionnaires:** Written surveys to collect data from many people.
- **Observation:** Watching customers' behavior in real-life situations.
- **Focus Groups:** Group discussions to understand customer views.
- **Secondary Data:** Using existing reports and data to analyze the market.

Activity 1:

Collect Information Regarding Funding Sources for business/niche.

Instructions:

Identify the Business Idea:

Choose a business idea, like offering AutoCAD design services or creating templates.

Research Funding Sources:

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Look for different funding options for your AutoCAD business:

- i. Personal Savings
- ii. Bank Loans
- iii. Grants/Subsidies
- iv. Crowdfunding
- v. Angel Investors
- vi. Venture Capital
- vii. Microfinance

Create a Report:

Write a brief report with:

- i. Description of each funding source
- ii. Advantages and disadvantages
- iii. How to apply for each

Share Findings:

Present your findings to the class or submit your report.

Learning Unit 7.3	Develop Marketing Plan
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After completion of this Learning Unit, you will be able to:

- Collect information required to devise marketing plan
- Develop a marketing & sales strategy
- Prepare marketing plan for new business

7.3.1: 7Ps of Marketing

The 7Ps of marketing are key factors to consider when promoting a product or service:

- i. **Product:** What you're selling; it must meet customer needs.
- ii. **Price:** The cost of the product; it should reflect its value.
- iii. **Placement:** Where the product is sold and how it gets to customers.
- iv. **Promotion:** How you advertise and raise awareness about the product.
- v. **People:** The staff or individuals involved in providing the product or service.
- vi. **Packaging:** The design and appearance of the product's packaging.
- vii. **Physical Evidence:** It includes tangible elements, like store layout and employee appearance, that help customers assess a product or service.

Remember

A 10% reduction in price can lead to a 20-30% increase in sales for certain products. However, the effect varies greatly by industry.

Activity:

Plan and Develop a Marketing Plan

Steps to Create a Marketing Plan:

Define Your Product or Service:

- i. Decide what AutoCAD services you will offer (e.g., design services, 3D modeling, AutoCAD training).

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- ii. Identify the unique selling point (USP) – what makes your service different?

Identify Your Target Market:

- i. Who will use your services? (e.g., architects, construction companies, interior designers).
- ii. Define their needs and preferences.

Set Goals and Objectives:

- i. What do you want to achieve with your marketing? (e.g., increase brand awareness, get more clients).
- ii. Make sure your goals are SMART (Specific, Measurable, Achievable, Relevant, Time-bound).

Choose Your Marketing Strategies:

- i. **Social media:** Promote your services on platforms like Instagram, Facebook, and LinkedIn.
- ii. **Website:** Create a simple website to showcase your portfolio and services.
- iii.
- iv. **Networking:** Attend industry events or join online groups to connect with potential clients.

Budget Planning:

Decide how much you can spend on marketing (e.g., ads, website hosting, or printing materials).

Timeline and Implementation:

- i. Set a timeline for when and how you'll implement your marketing strategies.
- ii. Monitor progress regularly.

Evaluate and Adjust:

- i. After some time, review your results to see if your marketing plan is working.
- ii. Make necessary adjustments if you are not reaching your goals.

SUMMARY

A business plan outlines the key elements for starting and running a successful business, including its format, business terms, and communication strategies. The 7Cs of business communication emphasize clarity, conciseness, and correct communication practices. Effective data collection techniques like interviews, questionnaires, and observations help gather essential market information. Understanding funding sources, including personal savings, loans, and investors, is crucial for financing a business. Market surveys using tools like interviews and questionnaires provide insights into customer preferences and trends. The 7Ps of marketing—Product, Price, Placement, Promotion, People, Packaging, and Positioning—are fundamental strategies to ensure a product's success in the market, helping businesses meet customer needs and stay competitive.

FAQs:

1. What is a business plan?

A document outlining business goals, strategy, and financial details.

2. What are the main elements of a business plan?

Executive summary, business description, market research, products/services, marketing strategy, financial plan, and appendix.

3. How do I conduct market research?

Use surveys, interviews, and focus groups to gather customer insights.

4. What are common funding sources for a business?

Personal savings, family/friends, bank loans, grants, investors, crowdfunding, and microfinance.

5. How do I get a loan to start my business?

Research loan types, prepare a business plan, and apply for approval.

6. What are the 7Ps of marketing?

Product, Price, Placement, Promotion, People, Packaging, Positioning.

7. How do I create a marketing plan?

Define your product, target market, set goals, and choose marketing strategies.

8. How do I measure the success of my marketing plan?

Monitor progress and adjust strategies based on goal achievement.

MCQs:

Questions	Option A	Option B	Option C	Option D
1. What is a business plan?	A document outlining business goals	A product list	A marketing strategy	A team directory
2. Which section appears first in a business plan?	Executive Summary	Marketing Plan	Financial Plan	Products
3. What does market research help with?	Understanding competitors	Identifying customer needs	Setting employee roles	Creating products
4. Which is a funding source?	Personal Savings	Product sales	Marketing Strategy	Customer feedback
5. What does a financial plan include?	Employee list	Income and expenses	Market analysis	Product features
6. Which of the following is part of the 7Ps?	Price	Staff size	Competitors	Industry trends

7. How do you gather market data?	By guessing	Through surveys	From financial reports	From competitors
8. What does the executive summary provide?	A detailed market survey	A business overview	A product description	A financial projection
9. Which is a marketing strategy?	Ignoring competitors	Social media promotion	Raising prices	Focusing on one product
10. How do you measure marketing success?	By number of products sold	By meeting marketing goals	By product cost	By customer feedback

Answer Key:

1	2	3	4	5	6	7	8	9	10
A	A	B	A	B	A	B	B	B	B

Module 08	Plan Market and Site Visit
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Learning Outcomes:

After Completion of this learning module, you will be able to:

- Visit Site and Market
- Prepare Visit Report

Learning Unit 8.1	Visit Site and Market
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After completion of this Learning Unit you will be able to:

- Visit the site
- Observe designing and construction
- Visit the market
- Observe the different types of materials for construction and finishing

8.1.1 Types of Materials for Civil, Electrical, and Mechanical Works**i. Civil Works:**

- **Concrete:** Made of cement, sand, and aggregates; used for foundations, roads, and buildings. Strong in compression.
- **Steel:** Strong metal, used in reinforcement and structural components. High tensile strength.
- **Wood:** Natural material, used for framing and finishes. Light but vulnerable to moisture.
- **Brick:** Fired clay used for walls and pavements. Fire-resistant and durable.
- **Glass:** Transparent, used for windows and facades. Fragile but strong in tension.
- **Asphalt:** Bitumen and aggregate mix; used for roads and roofs. Flexible and waterproof.
- **Aluminum:** Lightweight, corrosion-resistant metal; used in windows and roofing.

Do you Know

Concrete is the most widely used construction material in the world. Around 10 billion tons of concrete are produced every year, accounting for more than 6% of global carbon dioxide emissions.



ii. Electrical Works:

- **Copper:** Excellent conductor, used for wiring and electrical components.
- **Aluminum:** Lightweight alternative to copper, used in power lines.
- **Insulated Cables:** Coated wires for safety in electrical circuits.
- **Circuit Breakers & Switches:** Devices to control and protect electrical circuits.
- **Transformers:** Change voltage in power transmission.
- **Conductive Materials:** Materials like graphite or silver used in circuits.



iii. Mechanical Works:

- **Steel:** Strong alloy used for machine parts, gears, and structures.
- **Cast Iron:** Brittle but strong in compression, used for engine blocks and pipes.
- **Aluminum:** Lightweight and corrosion-resistant, used in machinery and vehicles.
- **Copper:** Good for heat exchangers and electrical components.



- **Brass:** Copper and zinc alloy, used in valves and fittings.
- **Plastic Materials:** Lightweight and moldable, used for bearings and insulation.
- **Rubber:** Elastic, used in seals and shock absorbers.
- **Composite Materials:** Combination of materials, lightweight and strong, used in advanced machinery

Activity 1:

Enlist Different Markets for Civil Works and Finishing Materials Available in Town

Remember

Market is an area or arena in which commercial dealings are conducted.

Common Markets for Civil Works and Finishing Materials:

Construction Material Markets:

- **Location:** Usually located near industrial zones or major construction areas.
- **Materials Available:** Cement, sand, aggregates, bricks, steel, pipes, and concrete blocks etc.

Hardware Stores:

- **Location:** Widely available in urban and suburban areas.
- **Materials Available:** nails, screws, adhesives, plumbing fittings, and power tools etc.

Tile and Flooring Markets:

- **Location:** Often in specialized areas of towns dedicated to flooring and finishing.
- **Materials Available:** Tiles (ceramic, porcelain, vinyl), marble, granite, and flooring adhesives etc.

Wood and Timber Markets:

- **Location:** Typically, in industrial districts.
- **Materials Available:** Plywood, hardwood, softwood, timber beams, and timber boards etc.

Plumbing and Electrical Markets:

- **Location:** Commonly near hardware and appliance stores.
- **Materials Available:** Pipes, faucets, electrical wires, fittings, switches, and circuit breakers etc.

Paint and Finishing Material Markets:

- **Location:** Found in both independent stores and large shopping complexes.
- **Materials Available:** Paints, varnishes, wallpapers, sealants, and coatings etc.

Glass and Window Markets:

- **Location:** Usually in specialized commercial areas.
- **Materials Available:** Glass panes, window frames, and curtain rods etc.

Stone and Marble Suppliers:

- **Location:** Typically, near quarries or major construction zones.
- **Materials Available:** Marble, granite, stones, countertops, and decorative stones etc.

Activity 2:

Visit a Market and Interact with Vendors to Learn About Different Construction and Finishing Materials

Choose a Market:

- Select a construction materials market or hardware store in your town to visit.

Preparation before the Visit:

- List the types of materials you're interested in learning about (e.g., tiles, paint, plumbing materials, etc.).
- Prepare questions regarding the use, advantages, cost, and availability of materials.

Interaction with Vendors:

- Ask about Types of Materials:
- Understand Material Properties:
- Discuss Cost:
- Learn About Trends:
- Inquire About Quality:

Observe Material Handling and Usage:

- Take note of how materials are stored and handled.
- Observe the different packaging and product labels that indicate quality, safety, and origin.

Record Information:

- Take notes or photographs (if allowed) of materials, their specifications, and any important details shared by vendors.
- Make sketches or drawings for future reference if you're learning about materials for AutoCAD projects.

Post-Visit Reflection:

- After the visit, summarize the key findings and materials learned about, focusing on how they might be used in AutoCAD design and drafting.
- Reflect on how these materials will be represented in your AutoCAD models (e.g., material types, textures, finishes).

Learning Unit 8.2	Prepare Visit Report
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After completion of this Learning Unit, you will be able to:

- Collect information
- Compile all information with pictures in E- report
- Submit report

8.2.1. Markets for Architectural Material in the Town

i. Key Materials:

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- **Basic Materials:** Cement, bricks, steel, wood.
- **Finishing Materials:** Tiles, paint, glass.
- **Exterior Materials:** Roofing, siding, insulation.
- **Decorative Materials:** Wallpaper, marble.

ii. **Market Factors:**

- Local suppliers vs. larger brands.
- Trends: Eco-friendly materials.
- Demand: Driven by construction growth and urbanization.

8.2.2. Types of Report

- **Informational Report:** Provides data without analysis. Example: Monthly sales report.
- **Analytical Report:** Analyzes data and offers recommendations. Example: Market analysis.
- **Progress Report:** Updates on project progress. Example: Weekly project update.
- **Research Report:** Presents research findings. Example: Academic paper.
- **Business Report:** Reviews business performance. Example: Annual report.
- **Feasibility Report:** Assesses the viability of a project. Example: Business startup evaluation.
- **Technical Report:** Provides technical details. Example: Product testing.

Activity:

Prepare visit report with pictures

SUMMARY

The types of materials for civil, electrical, and mechanical works. The market for architectural materials in town consists of local suppliers providing basic construction materials, finishing items, and decorative materials with trends shifting toward sustainable options due to urbanization and growing construction needs. Lastly, types of reports include informational reports.

FAQs:

1. What is the objective of this module?

It teaches how to visit sites and markets and prepare a visit report.

2. What are the materials used in civil works?

Concrete, steel, wood, brick, glass, asphalt, and aluminum.

3. What materials are used in electrical works?

Copper, aluminum, insulated cables, circuit breakers, and transformers.

4. What materials are used in mechanical works?

Steel, cast iron, aluminum, copper, brass, plastic, rubber, and composite materials.

5. Where can I find construction materials in my town?

Construction material markets, hardware stores, tile markets, and plumbing markets.

6. What should I ask vendors when visiting a market?

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Inquire about the types, properties, cost, and quality of materials.

7. What should be included in a visit report?

Information, pictures, and notes on materials observed during the visit.

8. What are the common types of reports?

Informational, analytical, progress, research, business, feasibility, and technical reports.

9. What are finishing materials for construction?

Tiles, paint, glass, marble, and wallpaper.

10. Why is it important to understand construction materials?

To make informed decisions for building projects and AutoCAD design.

MCQs:

Questions	Option A	Option B	Option C	Option D
1. Which material is known for being flexible and waterproof?	Asphalt	Concrete	Aluminum	Steel
2. What is a key feature of cast iron in mechanical works?	High tensile strength	Strong in compression	Lightweight	Corrosion resistance
3. Which type of report analyzes data and offers recommendations?	Informational report	Analytical report	Feasibility report	Progress report
4. Which of these materials is often used for flooring?	Copper	Concrete	Tiles	Steel
5. What should be included in a visit report?	Sketches of design	Observations and materials	Supplier contact details	Cost analysis

Answer Key

1	2	3	4	5
A	B	B	C	B

Module 09	Adopt Soft Skills
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Annexure is attached