WEEK 1 - Topic: Freehand Sketching and Drawing

Lesson Objectives

At the end of the lesson, students should be able to:

1. Define freehand sketching and drawing.
2. State the importance of freehand sketching.
3. Identify the materials used for freehand sketching.
4. Explain the principles of good freehand sketching.
5. Draw simple geometric shapes freehand.
6. Produce neat freehand sketches of common objects

Definition of Freehand Sketching

Freehand sketching is the process of drawing objects **without using drawing instruments** such as rulers, compasses, set squares, or protractors. It is done by hand with the aid of the eye to estimate sizes, proportions, and shapes.

Freehand sketching is usually the **first stage of technical drawing**, where ideas are quickly represented before producing accurate instrument drawings.

Definition of Freehand Drawing

Freehand drawing is the art of making drawings by hand without the aid of drawing instruments while maintaining correct shape, proportion, and appearance.

Importance of Freehand Sketching

Freehand sketching is important because it:

1. Helps to communicate ideas quickly.
2. Develops creativity and imagination.
3. Improves observation skills.
4. Saves time during the design process.
5. Serves as the first step before preparing detailed technical drawings.
6. Helps engineers, architects, builders, and technicians explain their ideas.
7. Improves hand and eye coordination.
8. Develops confidence in drawing.

Materials Used for Freehand Sketching

The common materials include:

- Plain drawing paper
- Sketchbook
- HB pencil
- 2H pencil
- B pencil
- Eraser

- Sharpener
- Drawing board (optional)

- Masking tape (optional)

Characteristics of a Good Freehand Sketch

A good freehand sketch should:

- Be neat.
- Have correct proportion.
- Be clear and easy to understand.
- Contain smooth lines.
- Show accurate shape.
- Be properly labelled where necessary.
- Be simple and free from unnecessary details.

Principles of Freehand Sketching

1. Observe the object carefully before drawing.
2. Start with light sketch lines.
3. Draw large shapes before small details.
4. Maintain correct proportions.
5. Keep the hand relaxed.
6. Draw with smooth continuous strokes.
7. Darken the final outline after completing the sketch.
8. Erase unnecessary construction lines.

Techniques of Freehand Sketching

1. Blocking-in Technique: The object is first enclosed within simple geometric shapes before adding details.

2. Observation Method: The object is carefully observed and its shape copied directly.

3. Centre-Line Method: A centre line is drawn first to maintain symmetry.

4. Outline Method: The outer shape is drawn first before adding internal features.

Steps in Freehand Sketching

1. Observe the object carefully.
2. Decide the position of the object on the paper.
3. Draw light construction lines.
4. Sketch the overall shape.
5. Add important details.
6. Darken visible outlines.
7. Erase unwanted lines.
8. Add labels if necessary.

Types of Freehand Sketches

1. **Pictorial Sketch** – Shows the object in three dimensions.
2. **Orthographic Sketch** – Shows front, top, and side views.
3. **Isometric Sketch** – Drawn along three axes at equal angles.
4. **Oblique Sketch** – Front face is drawn in true shape while depth is represented at an angle.

Advantages of Freehand Sketching

- Quick and easy.
- Requires few materials.
- Encourages creativity.
- Helps during brainstorming.
- Useful during site work.
- Easy to modify.
- Does not require drawing instruments.

Limitations of Freehand Sketching

- Less accurate than instrument drawing.
- Measurements are estimated.
- Difficult for complex objects.
- May contain proportion errors.
- Cannot be used for final working drawings.

Guidelines for Sketching Hand Tools

1. Observe the tool carefully.
2. Sketch lightly with an HB pencil.
3. Draw the overall shape first.
4. Add important features such as handles, blades, heads, or jaws.
5. Maintain the correct proportion between parts.
6. Darken the final outline.
7. Label the main parts where necessary.

Importance of Sketching Hand Tools

Sketching hand tools helps students to:

- Identify different tools easily.
- Understand the shape and parts of tools.
- Develop observation and drawing skills.
- Communicate engineering ideas effectively.
- Prepare for technical drawing and engineering design.

Assignment

1. Draw freehand sketches of the following:
    - A cube
    - A cylinder
    - A cone

- A sphere
- A chair

2. State:
   - Five advantages of freehand sketching.
   - Five limitations of freehand sketching.
   - Five rules for producing a good freehand sketch.

3. Draw neat freehand sketches of the following tools and label their major parts:

   - Claw hammer
   - Adjustable spanner
   - Spirit level
   - Trowel
   - Hand saw

Topic: Converting Orthographic Projection to Isometric Drawing

Learning Objectives
At the end of this lesson, students should be able to:
1. Define orthographic projection and isometric drawing.
2. Explain the differences between orthographic and isometric drawings.
3. Identify the views used in orthographic projection.
4. Convert orthographic views into an isometric drawing.
5. Apply the rules of isometric drawing correctly.

Definition of Orthographic Projection
Orthographic projection is a method of representing a three-dimensional (3D) object using two-dimensional (2D) views. These views usually include:

- Front View (Elevation)
- Top View (Plan)
- Side View (End View)

Each view shows only two dimensions of the object.

Definition of Isometric Drawing
An isometric drawing is a pictorial representation of a three-dimensional object in which the three principal dimensions (length, width, and height) are drawn along three axes that are equally inclined at **120°** to one another.
The two side axes are drawn at **30°** to the horizontal while the vertical axis remains upright.

Difference Between Orthographic and Isometric Drawing

Orthographic Drawing	Isometric Drawing
Shows different views separately.	Shows the object in one pictorial view.
Two-dimensional (2D).	Three-dimensional (3D).
Used for manufacturing details.	Used for visual presentation.
Consists of front, top and side views.	Combines all visible faces in one drawing.

Rules for Converting Orthographic to Isometric Drawing

1. Study all the orthographic views carefully.
2. Identify the length, width, and height of the object.
3. Draw the isometric axes:
   - One vertical line.
   - Two lines at 30° to the horizontal.
4. Draw an isometric box using the overall dimensions.
5. Sketch the object's features inside the box.
6. Draw only visible edges.
7. Erase unnecessary construction lines.
8. Darken the final object outline.

Steps in Converting Orthographic to Isometric Drawing

Step 1: Examine the front, top, and side views.

Step 2: Determine: Length**,** Width **and** Height

Step 3: Draw the three isometric axes.

Step 4: Construct an isometric box using the overall dimensions.

Step 5: Transfer measurements from the orthographic views onto the isometric box.

Step 6: Draw all edges and surfaces.

Step 7: Add holes, slots, or inclined surfaces where necessary.

Step 8: Erase construction lines and darken visible outlines.

Procedure for Conversion

1. Read all dimensions from the orthographic views.
2. Draw the isometric axes.
3. Mark the overall dimensions.
4. Construct the enclosing box.
5. Draw the object progressively from the largest features to the smallest.
6. Complete details such as steps, grooves, or holes.
7. Check accuracy with the orthographic views.

Precautions

- Use correct isometric axes (30°, 30°, and vertical).
- Transfer dimensions accurately.
- Do not use perspective shortening.
- Keep lines neat and uniform.
- Ensure all visible edges are complete.
- Draw circles as isometric ellipses where necessary.

Assignment

1. Convert the following orthographic views into an isometric drawing:
   - A rectangular block measuring **60 mm × 40 mm × 30 mm**.
2. Draw the isometric view of a stepped block using its given front, top, and side views.
3. State **five advantages** and **three limitations** of isometric drawing.
4. Explain the procedure for converting orthographic projections to isometric drawings.

5. Sketch the isometric axes and label the **length, width, and height** directions.

WEEK 2 - Topic: Engineering Design

Learning Objectives

At the end of this lesson, students should be able to:

1. Define engineering design.
2. Explain the importance of engineering design.
3. State the steps involved in the engineering design process.
4. Identify the factors considered in engineering design.
5. Explain the qualities of a good engineering design.
6. Describe the applications of engineering design.

1. Definition of Engineering Design

Engineering design is the systematic process of applying scientific knowledge, mathematics, engineering principles, and creativity to develop products, machines, structures, or systems that solve specific problems and satisfy human needs.

It involves planning, designing, testing, improving, and producing a product that is safe, functional, economical, and reliable.

2. Objectives of Engineering Design: Engineering design aims to:

- Solve engineering and technological problems.
- Meet the needs of users.
- Improve existing products and systems.
- Ensure safety and reliability.
- Reduce production costs.
- Increase efficiency and productivity.
- Promote innovation and creativity.

3. Importance of Engineering Design: Engineering design is important because it:

1. Provides solutions to engineering problems.
2. Improves the quality of products.
3. Reduces manufacturing errors.

4. Saves production time and cost.
5. Enhances safety during use.
6. Encourages innovation and technological advancement.
7. Ensures products meet required standards.
8. Supports industrial and economic development.

4. Engineering Design Process: The engineering design process follows a series of logical steps:
Step 1: Identify the Problem: Define the problem or need and understand the design requirements.
Step 2: Research and Gather Information: Collect relevant information and study similar products and available materials.
Step 3: Generate Possible Solutions: Brainstorm different ideas and produce freehand sketches and concept drawings.
Step 4: Select the Best Solution: Compare alternatives and Choose the most suitable design based on cost, safety, and performance.
Step 5: Prepare Detailed Drawings: Produce working drawings and Include dimensions, specifications, tolerances, and materials.
Step 6: Construct or Manufacture the Product: Fabricate or build the design using appropriate tools and materials.
Step 7: Test and Evaluate: Test the product to determine whether it meets the design requirements and Identify defects or weaknesses.
Step 8: Improve and Modify: Make necessary improvements based on test results and produce the final design.
5. Factors Considered in Engineering Design: When designing a product, the following factors should be considered:
Functional Requirements: The product should perform its intended purpose effectively.
Safety: The design must protect users from injury and hazards.
Strength and Durability: Materials should withstand expected loads and operating conditions.
Cost: The design should be economical to produce and maintain.
Materials: Suitable materials should be selected based on strength, weight, availability, and cost.
Appearance (Aesthetics): The product should be attractive and pleasing in appearance.
Ergonomics: The design should be comfortable, convenient, and easy to use.
Manufacturability: The product should be easy to manufacture using available equipment.
Maintenance: The product should be easy to inspect, repair, and maintain.
Environmental Impact: The design should minimize waste, pollution, and energy consumption.

6. Principles of Good Engineering Design
A good engineering design should be:

- Functional
- Safe
- Simple
- Strong
- Durable
- Economical
- Reliable
- Attractive
- Easy to manufacture
- Easy to maintain
- Environmentally friendly

8. Types of Engineering Design Drawings

1. Freehand Sketches
2. Orthographic Drawings
3. Isometric Drawings
4. Oblique Drawings
5. Perspective Drawings
6. Sectional Drawings
7. Detail Drawings
8. Assembly Drawings
9. Working Drawings

10. Advantages of Engineering Design

- Improves product quality.
- Reduces production costs.
- Increases efficiency.
- Enhances safety.
- Encourages innovation.
- Improves communication through technical drawings.
- Simplifies manufacturing and assembly.
- Supports quality control.

11. Limitations of Engineering Design

- Can be time-consuming.
- Requires skilled personnel.
- May involve high development costs.
- Some designs require expensive equipment.
- Design changes may increase production costs

Assignment

1. Define engineering design and explain its importance.
2. Draw a flowchart showing the engineering design process.
3. Describe the factors that should be considered when designing a simple wooden stool.
4. Explain the differences between a prototype and a final product.
5. State five applications of engineering design in everyday life.

WORKING DRAWINGS, DETAIL DRAWINGS, AND ASSEMBLY DRAWING

Learning Objectives

At the end of this lesson, students should be able to:

1. Define working drawings, detail drawings, and assembly drawings.
2. State the features of each type of drawing.
3. Explain the importance and uses of working drawings.
4. Differentiate between detail drawings and assembly drawings.
5. Identify the components of a complete set of working drawings.

1. Working Drawings

A **working drawing** is a complete set of technical drawings that provides all the information required to manufacture, fabricate, assemble, construct, inspect, or maintain a product or structure. It is prepared according to standard engineering drawing practices and includes dimensions, materials, specifications, tolerances, and notes.

Working drawings serve as the official guide for engineers, technicians, builders, and manufacturers during production.

Characteristics of Working Drawings

- Drawn accurately and to scale.
- Fully dimensioned.
- Use standard drawing symbols and conventions.
- Include notes and specifications.
- Easy to read and interpret.
- Suitable for manufacturing and construction.

Components of Working Drawings

- Title block
- Orthographic views (front, top, side)
- Sectional views
- Detail drawings
- Assembly drawing
- Dimensions
- Notes and specifications
- Bill of Materials (BOM)
- Symbols and conventions
- Tolerances

Uses of Working Drawings

- Manufacturing machine parts.
- Constructing buildings and engineering structures.
- Assembling products.
- Inspection and quality control.
- Maintenance and repair work.
- Production planning.
- Cost estimation.
- Communication among engineers and technicians.

Advantages of Working Drawings

- Improve accuracy.
- Reduce production errors.
- Save time and cost.
- Ensure standardization.
- Facilitate maintenance and repairs

2. Detail Drawings

A **detail drawing** is a technical drawing of a single component or part of a machine or structure. It contains all the information required to manufacture or fabricate that individual part. Each component of an assembly has its own detail drawing.

Information Contained in a Detail Drawing

- Shape of the part
- Dimensions
- Material specification
- Surface finish
- Tolerances
- Thread details (if any)
- Machining instructions
- Scale
- Part number

Characteristics of Detail Drawings

- Represents only one component.
- Fully dimensioned.
- Contains manufacturing information.
- Includes material specifications.
- Prepared before production begins.

Uses of Detail Drawings

- Manufacturing individual components.

- Inspection of finished parts.
- Machining operations.
- Fabrication processes.
- Replacement of damaged parts.

Example: A detail drawing of a bolt will show: Length**,** Diameter**,** Thread size**,** Head dimensions**,** Material **and** Tolerance

3. Assembly Drawings: An **assembly drawing** is a technical drawing that shows how two or more individual parts fit and work together to form a complete machine, product, or structure. It illustrates the arrangement, position, and relationship of all components.

Information Shown in an Assembly Drawing

- Position of each part
- Method of joining components
- Overall dimensions
- Part numbers
- Bill of Materials (BOM)
- Exploded or assembled views (where necessary)

Characteristics of Assembly Drawings

- Shows the complete product.
- Indicates the relationship between parts.
- Usually contains item numbers.
- May include sectional views.
- Normally accompanied by a parts list.

Uses of Assembly Drawings

- Guide workers during assembly.
- Show how components fit together.
- Assist maintenance and repair.
- Aid installation.
- Help identify replacement parts.
- Support quality inspection.

Types of Assembly Drawings

1. General Assembly Drawing
2. Exploded Assembly Drawing
3. Installation Assembly Drawing
4. Sub-Assembly Drawing

Example: An assembly drawing of a bench vice shows: Body**,** Movable jaw**,** Fixed jaw, Screw spindle**,** Handle **and** Nut**,** assembled in their correct positions.

Difference Between Working Drawing, Detail Drawing, and Assembly Drawing

Feature	Working Drawing	Detail Drawing	Assembly Drawing
Definition	Complete drawing package for manufacturing or construction	Drawing of one individual part	Drawing showing all parts assembled
Purpose	Guide production and construction	Manufacture one component	Assemble the complete product
Number of Parts	May contain many parts	One part only	All parts together
Dimensions	Complete dimensions	Complete dimensions for one part	Mainly overall dimensions
Material Specification	Included	Included	Usually referenced through BOM
Bill of Materials	May include BOM	Not required	Usually included
Users	Engineers, builders, technicians	Machinists and fabricators	Assemblers and maintenance personnel

Relationship Between the Three Drawings

1. A product is first designed.
2. Detail drawings are prepared for every individual component.
3. The components are manufactured using the detail drawings.
4. An assembly drawing is used to assemble all the manufactured components.
5. Together, the detail drawings and assembly drawing form the complete set of working drawings.

Importance of Working Drawings

- Provide complete production information.
- Improve communication among technical personnel.
- Ensure uniformity and accuracy.
- Reduce manufacturing errors.
- Save production time.
- Facilitate maintenance and repairs.
- Assist quality control.
- Enable mass production.

Assignment

1. Draw a simple **detail drawing** of a bolt, showing all important dimensions.
2. Draw an **assembly drawing** of a nut and bolt with a washer in the assembled position.
3. Explain the relationship between working drawings, detail drawings, and assembly drawings.
4. State **five** differences between detail drawings and assembly drawings.
5. List **seven** industries where working drawings are commonly used.

WEEK 3 - Topic: Types of Screw Threads and Their Uses

Lesson Objectives

At the end of the lesson, students should be able to:

1. Define a screw thread.
2. Explain the importance of screw threads.
3. Identify the different types of screw threads.
4. State the uses of each type of screw thread.
5. Differentiate between internal and external threads.

Definition of a Screw Thread

A **screw thread** is a continuous helical ridge (spiral groove) formed on the outside or inside of a cylindrical or conical surface. It is used to convert rotational motion into linear motion and to fasten or hold parts together.

Importance of Screw Threads

Screw threads are used to:

- Fasten two or more parts together.
- Transmit motion and power.
- Lift or move heavy loads.
- Provide accurate linear movement.
- Allow easy assembly and disassembly of machine parts.
- Ensure secure and adjustable connections.

Types of Screw Threads

1. V-Thread (Triangular Thread): Shape: V-shaped profile (usually 60° or 55°) **Uses:** Bolts and nuts**,** Machine screws **and** General fastening in engineering and construction

2. Square Thread: Shape: Square profile. **Uses:** Screw jacks**,** Bench vices**,** Lifting machines

3. Acme Thread (Trapezoidal Thread): Shape: Trapezoidal profile, Lead screws**,** Lathe machines**,** Milling machines

4. Buttress Thread: Shape: One side nearly vertical, the other side inclined. **Uses:** Car jacks**,** Injection moulding machines**,** Railway couplings

5. Knuckle Thread (Round Thread): Shape: Rounded crest and root. **Uses:** Railway carriage couplings**,** Electric bulb holders**,** Bottle caps

6. Pipe Thread: Shape: Tapered or parallel thread. **Uses:** Water pipes**,** Gas pipes**,** Plumbing fittings**,** Hydraulic systems

7. Worm Thread: Shape: Deep helical thread. **Uses:** Worm gears**,** Conveyor systems**,** Speed reduction mechanisms

Classification of Screw Threads

A. External Thread: Found on the **outside** of a cylinder. Examples: Bolts**,** Screws**,** Threaded rods

B. Internal Thread: Found on the **inside** of a hole. Examples: Nuts**,** Threaded holes**,** Pipe fittings

Common Standard Screw Thread Systems

Thread System	Application
ISO Metric Thread	General engineering and machinery
Unified Thread (UNC/UNF)	American machines and equipment
British Standard Whitworth (BSW)	Older British machinery
British Standard Fine (BSF)	Fine engineering work
British Standard Pipe (BSP)	Plumbing and pipe fittings

Comparison of Common Screw Threads

Thread Type	Shape	Main Use
V-Thread	V-shaped	Fastening
Square Thread	Square	Power transmission
Acme Thread	Trapezoidal	Lead screws
Buttress Thread	One-sided	Heavy loads
Knuckle Thread	Rounded	Pipe and hose fittings
Pipe Thread	Tapered	Plumbing
Worm Thread	Deep helix	Worm gears

Advantages of Screw Threads

- Strong and reliable fastening.
- Easy assembly and disassembly.
- Can transmit motion and force.
- Durable and reusable.
- Available in different sizes and forms.

Assignment

1. Draw neat sketches of the following thread forms:
   - V-thread
   - Square thread
   - Acme thread
   - Buttress thread
   - Knuckle thread
2. Explain the uses of each thread type.
3. Differentiate between external and internal screw threads with suitable examples.

Topic: Types of Fasteners and Their Uses

Lesson Objectives

At the end of the lesson, students should be able to:

1. Define a fastener.
2. Explain the importance of fasteners.
3. Identify the different types of fasteners.
4. State the uses of various fasteners.
5. Differentiate between permanent and temporary fasteners.

Definition of a Fastener

A **fastener** is a mechanical device used to join, connect, or hold two or more parts together. Fasteners are widely used in engineering, construction, automobile manufacturing, furniture making, and machine assembly.

Importance of Fasteners

Fasteners are used to:

- Join two or more components together.
- Hold machine parts securely.
- Allow easy assembly and disassembly (for temporary fasteners).
- Improve the strength and stability of structures.
- Simplify maintenance and repairs.
- Ensure safety and reliability in engineering structures.

Classification of Fasteners: Fasteners are broadly classified into:

1. Temporary Fasteners: These can be removed and reused without damaging the joined parts.
Examples: Bolts, Nuts, Screws, Washers, Studs, Pins

2. Permanent Fasteners: These cannot be removed without damaging the fastener or the joined parts.
Examples: Rivets, Welded joints, Adhesive bonds

Types of Fasteners and Their Uses

1. Bolt: A **bolt** is a threaded fastener used together with a nut.
2. Nut: A **nut** is a metal block with an internal thread that fits onto a bolt.
3. Screw: A **screw** is a threaded fastener that can be inserted directly into a material or into a threaded hole. **Types of Screws:** Machine screw**,** Wood screw**,** Self-tapping screw**,** Sheet metal screw
4. Washer: A **washer** is a thin metal disc placed under the head of a bolt or nut. **Types:** Plain washer**,** Spring washer**,** Lock washer
5. Rivet: A **rivet** is a permanent fastener consisting of a head and a shank.
6. Stud: A **stud** is a threaded rod without a head.
7. Split Pin (Cotter Pin)
A split pin is a bent metal pin inserted through a hole in a bolt or shaft.

8. Dowel Pin: A dowel pin is a cylindrical pin used for accurate positioning of machine parts.
9. Keys: Keys are metal pieces fitted between a shaft and a hub. **Types:** Parallel key**,** Woodruff key**,** Taper key
10. Circlip (Snap Ring): A circlip is a spring steel ring fitted into a groove on a shaft or inside a bore.

Table of Fasteners and Their Uses

Fastener	Main Use
Bolt	Joining machine and structural parts
Nut	Securing bolts
Screw	Joining wood, metal, and plastic parts
Washer	Distributing load and preventing loosening
Rivet	Permanent joining of metal plates
Stud	Heavy-duty machine assembly
Split Pin	Locking nuts in position
Dowel Pin	Aligning machine parts
Key	Connecting shafts to gears or pulleys
Circlip	Retaining bearings and gears

Advantages of Fasteners

- Strong and reliable joints.
- Easy assembly and maintenance (temporary fasteners).
- Available in many sizes and materials.
- Reusable in many cases.
- Suitable for different engineering applications.

Disadvantages of Fasteners

- May loosen due to vibration.
- Some require periodic maintenance.

- Permanent fasteners cannot be reused after removal.
- Incorrect fastener selection may weaken a joint.

Assignment

1. Draw and label the following fasteners:
    - Bolt and nut
    - Rivet
    - Washer
    - Screw
    - Split pin
2. Classify the above fasteners into **temporary** and **permanent** fasteners.
3. State **two uses** of each fastener.

WEEK 4 – TOPIC: LOCKING DEVICES

Learning Objectives

At the end of this lesson, students should be able to:

1. Define locking devices.
2. Explain the concept of locking devices.
3. Identify the different types of locking devices.
4. State the applications and uses of locking devices.
5. Explain the importance of locking devices in engineering.

Definition of Locking Devices

A **locking device** is a mechanical component or mechanism used to prevent nuts, bolts, screws, shafts, and other fasteners from becoming loose during operation due to vibration, shock, rotation, or repeated loading.

Concept of Locking Devices

In engineering and machine construction, fasteners such as nuts and bolts may loosen because of continuous vibration, movement, thermal expansion, or repeated loading. Locking devices are therefore incorporated into assemblies to maintain tightness, prevent accidental loosening, and ensure that machine parts remain securely fastened throughout their service life.

Locking devices are widely used in automobiles, aircraft, construction equipment, industrial machines, railway systems, and structural steelwork where safety and reliability are essential.

Importance of Locking Devices

- Prevent loosening caused by vibration.
- Improve the safety of machines and structures.
- Prevent machine failure and accidents.

- Increase the service life of fasteners.
- Reduce maintenance and repair costs.
- Ensure accurate alignment of machine parts.
- Improve the reliability and efficiency of equipment.

Types of Locking Devices

1. Lock Nut (Jam Nut) A lock nut is an additional nut tightened against the main nut to prevent it from rotating.

2. Spring Washer (Lock Washer) A spring washer is a split circular washer that exerts continuous pressure on the nut or bolt, reducing the chances of loosening.

3. Plain Washer (Used with Locking Arrangements) A plain washer distributes the load of a fastener. When combined with locking devices, it helps improve joint stability.

4. Split Pin (Cotter Pin) A split pin is inserted through a hole in a bolt or shaft and bent to prevent a nut from rotating.

5. Castle Nut (Slotted Nut) A castle nut has slots cut into its top surface and is used together with a split pin.

6. Tab Washer: A tab washer has one or more tabs that are bent against the nut or bolt after tightening to prevent rotation.

7. Locking Plate: A locking plate is a specially shaped metal plate used to secure one or more bolts by preventing their rotation.

8. Safety Wire (Lock Wire): Safety wire is threaded through holes in bolts or nuts and twisted tightly to prevent them from turning.

9. Nyloc Nut (Nylon Insert Lock Nut) A Nyloc nut contains a nylon insert that grips the bolt threads and resists loosening due to vibration.

10. Thread-Locking Adhesive: This is a chemical adhesive applied to screw threads before assembly to prevent fasteners from loosening.

Summary Table

Locking Device	Main Application/Use
Lock Nut	Prevents nuts from loosening in machinery
Spring Washer	Resists loosening caused by vibration
Plain Washer	Distributes load and supports locking arrangements
Split Pin	Locks castle nuts on shafts and axles
Castle Nut	Used with split pins on rotating parts
Tab Washer	Prevents nut or bolt rotation
Locking Plate	Secures multiple bolts in machinery
Safety Wire	Prevents fastener rotation in aircraft and racing vehicles
Nyloc Nut	Provides vibration-resistant fastening
Thread-Locking Adhesive	Permanently or semi-permanently secures threaded fasteners

Advantages of Locking Devices

- Increase operational safety.
- Prevent accidental loosening of fasteners.
- Reduce maintenance requirements.
- Improve machine reliability.
- Extend the lifespan of mechanical components.
- Reduce vibration-related failures.
- Help maintain correct alignment of machine parts.

Assignment

1. Define a locking device with suitable examples.
2. Draw and label any **five** locking devices.
3. Compare **six** locking devices, stating their construction, functions, and applications.
4. Explain the consequences of not using locking devices in mechanical assemblies.
5. State **ten** engineering applications where locking devices are commonly used.

WEEK 6 – TOPIC: STAIRS AND STAIRCASES

Learning Objectives
At the end of this lesson, students should be able to:
1. Define stairs and staircases.
2. Explain the purpose of stairs and staircases.
3. Identify the main parts of a staircase.
4. Describe the different types of stairs and staircases.
5. State the uses, advantages, and disadvantages of each type.
6. Draw and label the parts of a staircase.

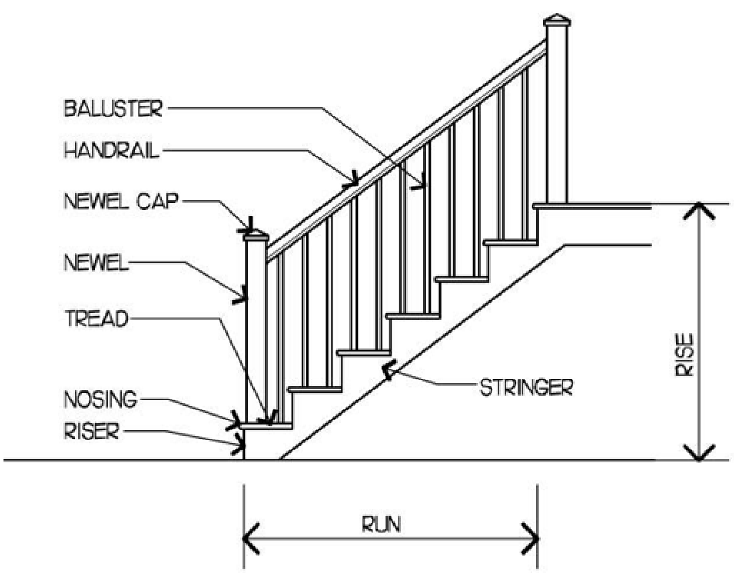
Definition of Stairs
Stairs are a series of steps arranged one above another to provide safe and convenient movement between different levels or floors of a building.

A stair is the basic unit used for vertical circulation within a building.

Definition of Staircase
A **staircase** is the complete structure that consists of one or more flights of stairs, landings, handrails, balustrades, stringers, and other supporting members used to connect different floors of a building.

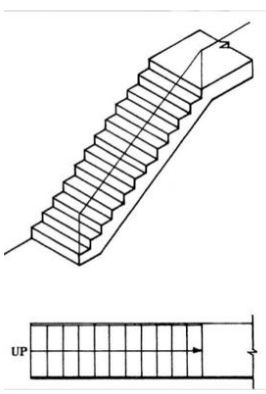
Purpose (Functions) of Stairs and Staircases
Stairs and staircases are provided to:
1. Connect different floors of a building.
2. Provide safe movement between levels.
3. Serve as emergency escape routes during fire or disasters.
4. Improve access to upper floors, basements, and rooftops.
5. Add beauty and architectural value to buildings.
6. Increase convenience where lifts are unavailable.
7. Provide access for maintenance work.

Main Parts of Stairs and Staircases

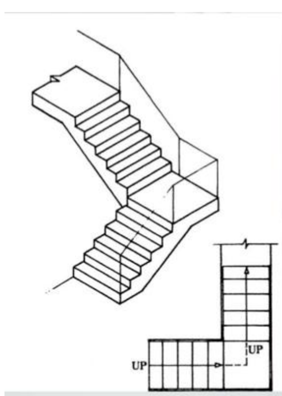


1. Tread: The horizontal surface on which the foot is placed. It determines the comfort of walking.
2. Riser: The vertical portion between two consecutive treads. It determines the height of each step.
3. Nosing: The projecting edge of a tread beyond the riser. It provides additional foot space and improves safety.
4. Flight: A continuous series of steps between two landings.
5. Landing: A flat platform between flights. It provides resting space and changes the direction of movement.
6. Stringer (String): The inclined member supporting the treads and risers.
7. Handrail: A rail fixed along the staircase for support while climbing or descending.
8. Baluster: Vertical members supporting the handrail.
9. Balustrade: The complete assembly of handrail and balusters.
10. Newel Post: A strong vertical post placed at the beginning, end, or turning point of a staircase.
11. Waist Slab: The sloping reinforced concrete slab supporting concrete stairs.
12. Headroom: The vertical clearance between the staircase and the ceiling above.
13. Pitch Line: An imaginary line joining the nosings of all the steps.
14. Going: The horizontal distance between two consecutive risers.
15. Rise: The vertical height between two consecutive treads.

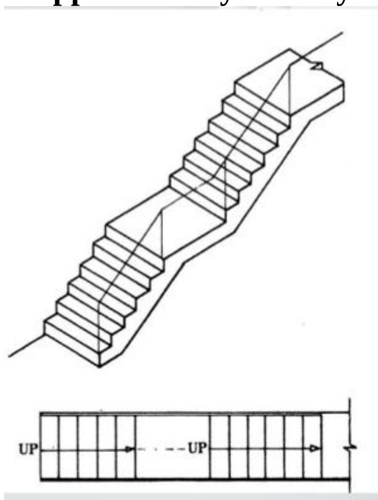
Types of Stairs and Staircases
1. Straight Stair: Consists of one straight flight without changing direction.



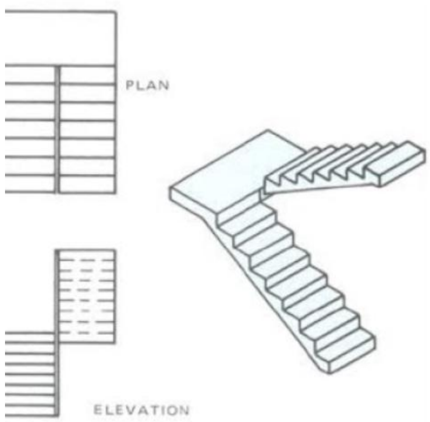
2. Quarter-Turn (L-Shaped) Stair: Changes direction by **90°** using a landing.



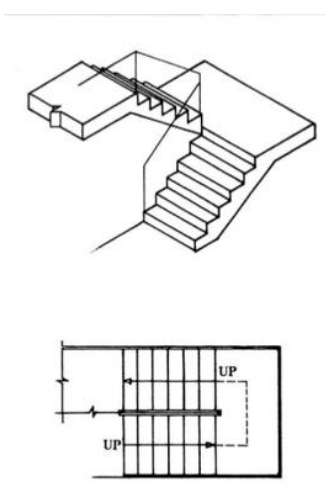
3. A **straight two-flight stair with half landing** is a stair consisting of **two flights** connected by a **landing located approximately halfway between the floors**.



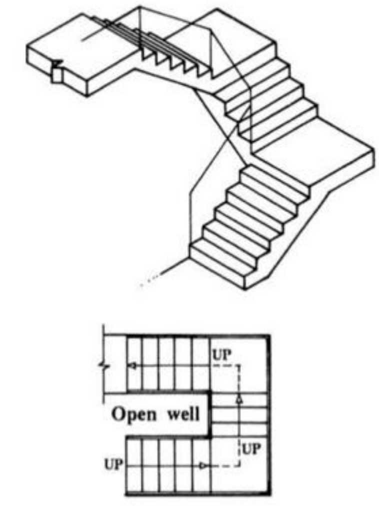
3. Half-Turn (U-Shaped) Stair: Changes direction by **180°** using one or two landings.



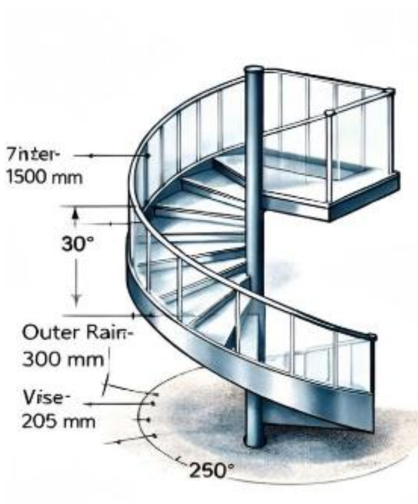
4. Dog-Legged Stair: Two parallel flights running in opposite directions with no open well between them. **Advantages**: Occupies less space **Disadvantages**: Limited lighting and ventilation.



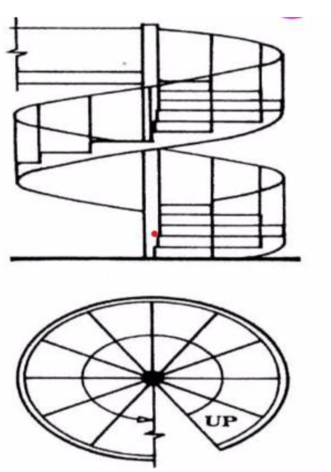
5. Open-Well Stair: Similar to a dog-legged stair but with an open space (well) between the flights.



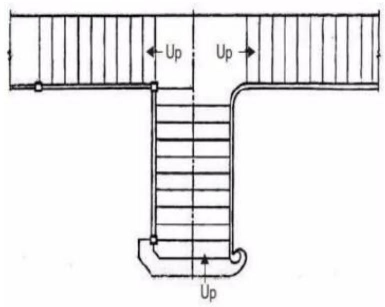
6. Spiral Stair: Steps are arranged around a central pole in a circular pattern.



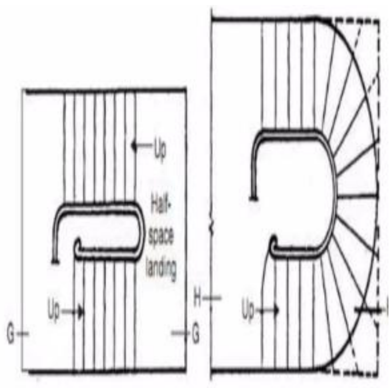
- **7. Circular Stair:** Curved staircase without a central support.



9. Bifurcated Stair: A wide staircase that divides into two separate flights.



10. Geometrical Stair: A staircase without a central newel post, designed with continuous curves.



A staircase without a central newel post, designed with continuous curves.

Summary of Types and Their Uses

Type of Stair	Main Use
Straight Stair	Homes, schools, offices
Quarter-Turn Stair	Residential buildings
Half-Turn Stair	Apartments, hospitals
Dog-Legged Stair	Houses, schools
Open-Well Stair	Hotels, hospitals
Spiral Stair	Towers, rooftops, fire escape
Circular Stair	Hotels, malls
Helical Stair	Luxury buildings
Bifurcated Stair	Hotels, theatres, public buildings
Geometrical Stair	Museums, luxury buildings

Factors to Consider When Choosing a Staircase

1. Available space.
2. Cost of construction.
3. Building purpose.
4. Number of users.

5. Safety requirements.
6. Building regulations.
7. Appearance (aesthetics).
8. Ease of maintenance.

Advantages of Stairs

- Safe means of movement.
- Economical compared to elevators.
- Reliable during power failure.
- Easy to maintain.
- Suitable for emergency evacuation.

Disadvantages of Stairs

- Require physical effort.
- Occupy valuable floor space.
- Difficult for elderly and disabled users without accessibility features.
- Less convenient than elevators in tall buildings.

Assignment

1. Draw and label the main parts of a staircase.
2. Compare **straight**, **spiral**, and **dog-legged** staircases, stating **three advantages and three disadvantages** of each.
3. Explain why **bifurcated staircases** are commonly used in large public buildings.

WEEK 7 - 8 - **Topic: Section and Sectional Views**

Learning Objectives

At the end of this lesson, students should be able to:

1. Define a section and a sectional view.
2. Explain the importance of sectional views in technical drawing.
3. Identify the different types of sections and sectional views.
4. State the uses of each type of sectional view.
5. Interpret sectional drawings correctly.

Definition of a Section

A **section** is the imaginary cutting of an object by a cutting plane to reveal its internal features that cannot be seen clearly from the outside.

The part of the object between the observer and the cutting plane is assumed to be removed so that the inside of the object becomes visible.

Definition of a Sectional View

A **sectional view** is the drawing or view obtained after an object has been cut by an imaginary cutting plane and the front portion removed to expose the interior details.

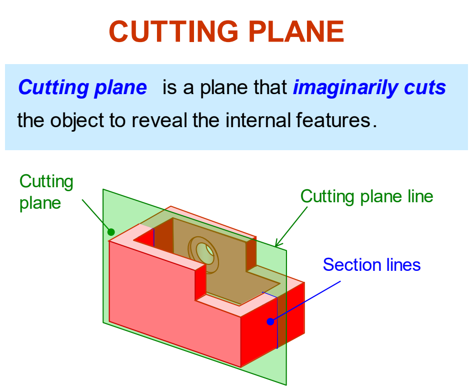
Sectional views replace hidden lines with visible outlines, making drawings easier to read and understand.

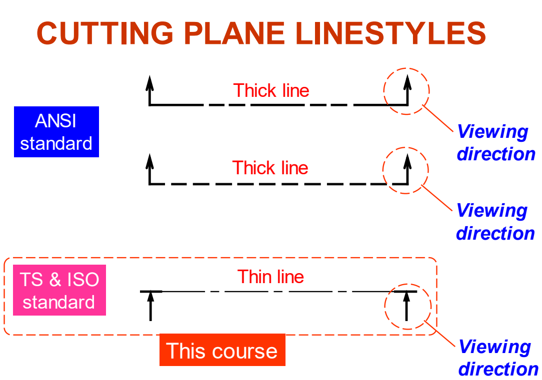
Importance of Sectional Views

1. Shows hidden internal details clearly.
2. Eliminates excessive hidden lines.
3. Improves the readability of engineering drawings.
4. Makes interpretation easier during manufacturing.
5. Reduces errors during fabrication and assembly.
6. Saves drawing time and space.
7. Gives a clearer understanding of complex objects.

Terms Used in Sectioning

1. Cutting Plane



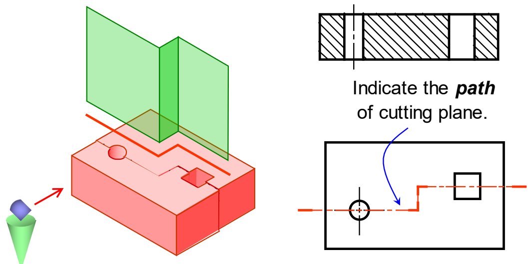


An imaginary plane used to cut through an object.

2. Cutting Plane Line

CUTTING PLANE LINE

Cutting plane line is an ***edge view*** of the cutting plane.



A thick chain line indicating where the object is imagined to be cut.

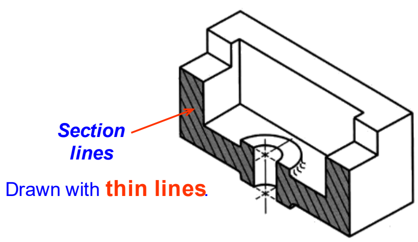
3. Arrowheads

Placed at the ends of the cutting plane line to indicate the direction of sight.

4. Section Lines (Hatching Lines)

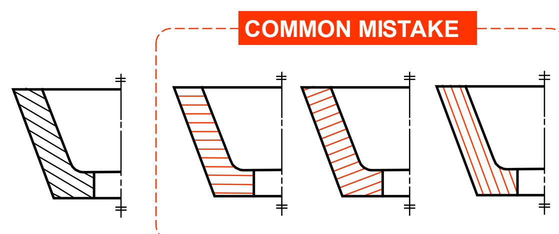
SECTION LINING

Section lines or ***cross-hatch lines*** are used to *indicate the surfaces that are cut* by the cutting plane.



SECTION LINING PRACTICE

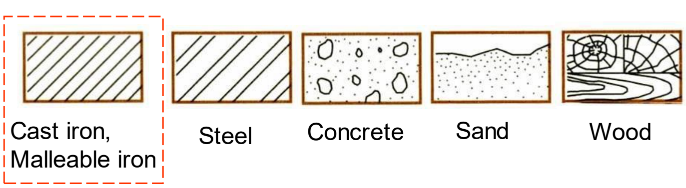
- It ***should not*** be drawn *parallel* or *perpendicular* to contour of the view.



Thin, evenly spaced lines (usually at 45°) drawn on the cut surfaces to indicate solid material

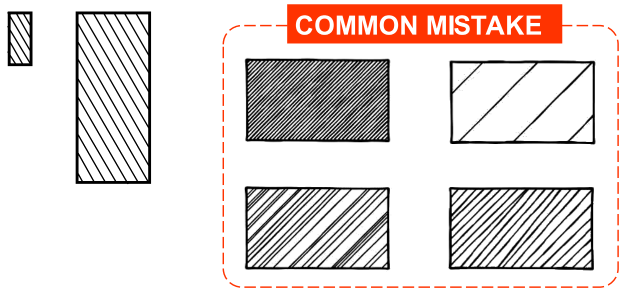
SECTION LINES SYMBOLS

- The section lines are different for each of material's type.
- For practical purpose, the cast iron symbol is used most often for any materials.



SECTION LINING PRACTICE

- The spaces between lines may vary from 1.5 mm for small sections to 3 mm for large sections.



SECTION LINING PRACTICE

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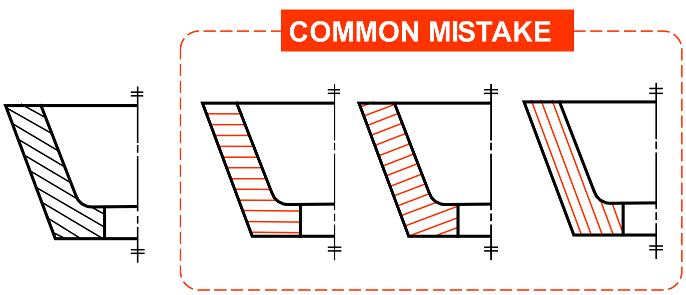
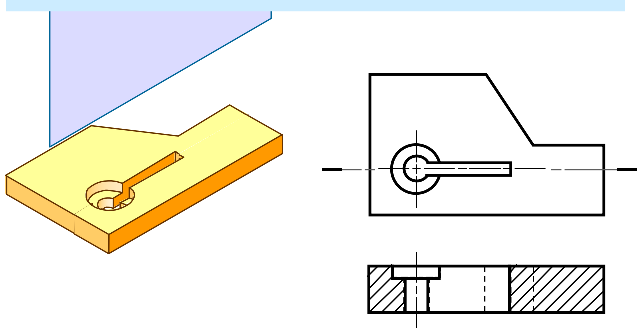


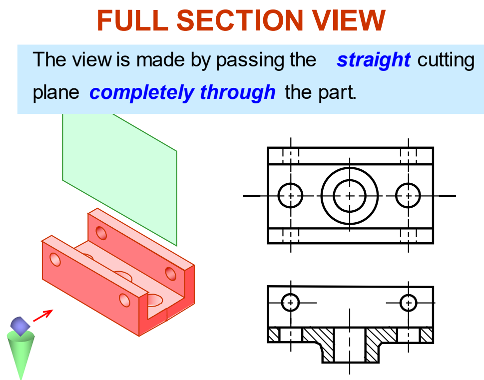
TREATMENT OF HIDDEN LINES

- Hidden lines are ***normally omitted*** from section views.

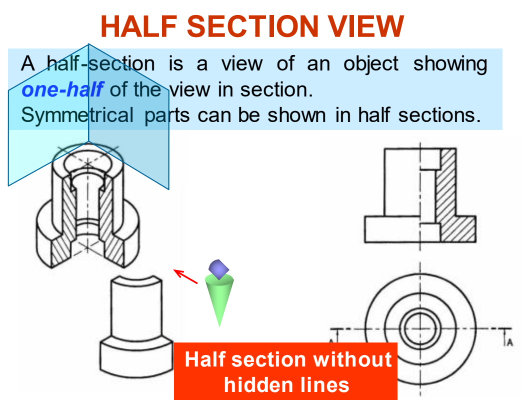


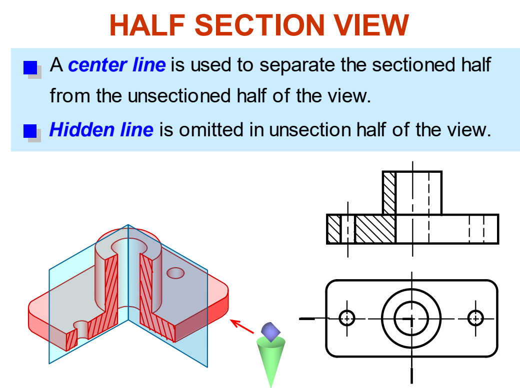
Types of Sections and Sectional Views

1. **Full Section:** A full section is produced when the cutting plane passes completely through the object along its center, dividing it into two equal halves.



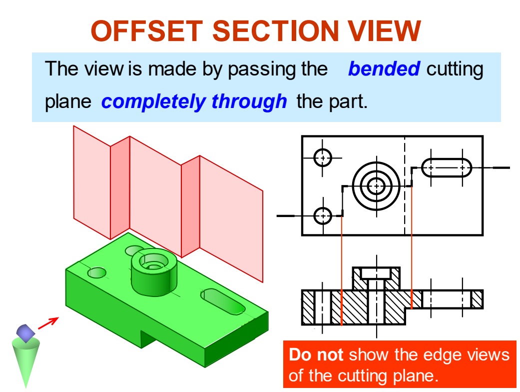
2. Half Section: A half section is obtained by cutting only one-half of a symmetrical object. One half of the drawing shows the outside, while the other half shows the inside.

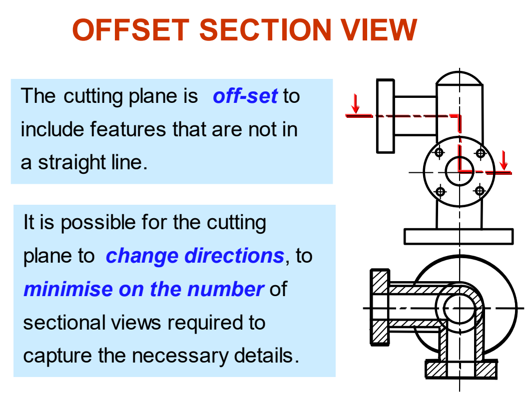




Advantages: Displays both interior and exterior details in one view.

2. **Offset Section:** An offset section is produced when the cutting plane is bent or offset to pass through several important internal features that are not in a straight line

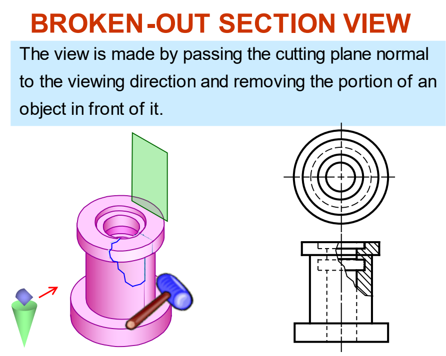


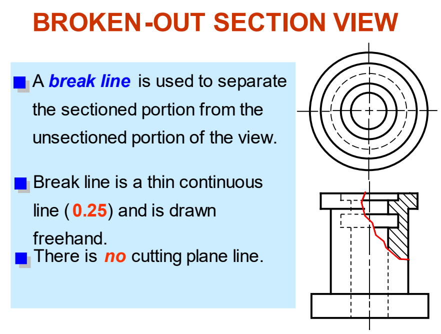


Uses: Complex machine components, Objects with holes at different positions.

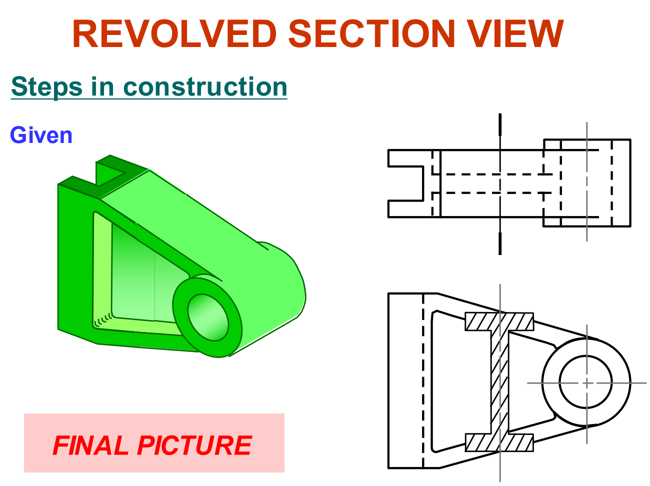
Advantages: Reveals several internal details in one sectional view.

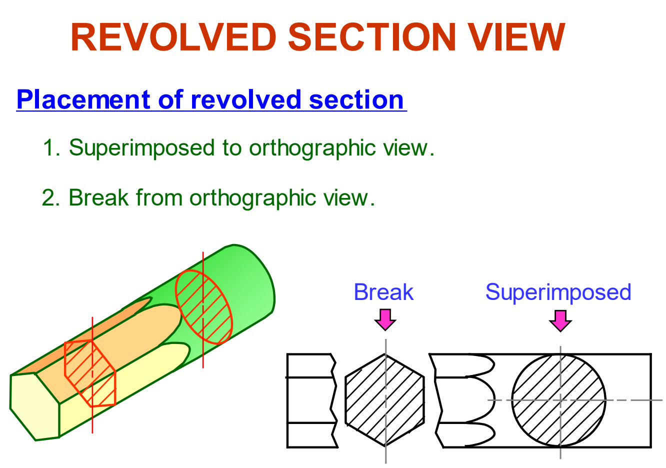
4. Broken-out (Local) Section: A broken-out section exposes only a small part of the interior by breaking away a portion of the object with an irregular freehand line.





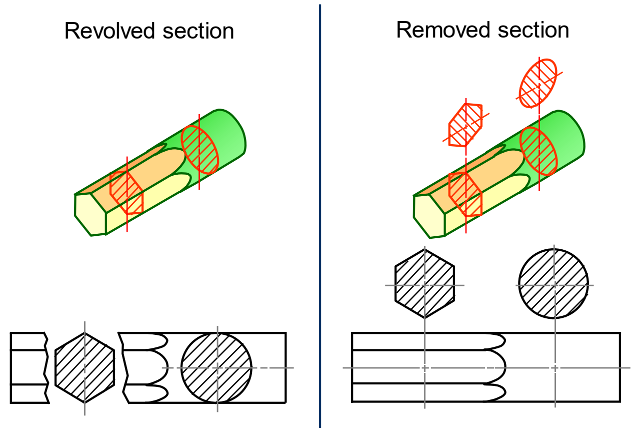
5. Revolved Section: A revolved section is made by cutting the object and rotating the cross-section through **90°** so that it is drawn directly on the view





6. Removed Section: A removed section is similar to a revolved section, but the cross-section is drawn away from the main view.

REMOVED SECTION VIEW



REMOVED SECTION VIEW

- Removed section is revolved section.
- Section view is shown outside the view.
- Used where space does not enough for revolved section
- Can be located elsewhere on a drawing with *properly labeled*
- It may be appropriate to use*removed sections*, for webs, beams or arms,

7. Aligned Section: An aligned section is used when features such as spokes or ribs are arranged at an angle. The cutting plane is bent and the features are rotated into position before drawing.

Summary Table

Type of Section	Description	Common Uses
Full Section	Entire object cut into two halves	Symmetrical objects
Half Section	One-half sectioned, one-half external	Hollow machine parts
Offset Section	Cutting plane bent to pass through several features	Complex components
Broken-out Section	Small part broken away	Local internal details
Revolved Section	Section rotated 90° on the object	Shafts, rods
Removed Section	Section drawn away from object	Large cross-sections
Aligned Section	Angled features rotated into alignment	Wheels, pulleys

Section Lining (Hatching) Rules

1. Draw hatching lines thin and evenly spaced.

2. Hatching lines are usually drawn at **45°**.
3. Adjacent parts should have hatching in opposite directions or different spacing.
4. Do not hatch holes, shafts, or empty spaces.
5. Ribs, webs, spokes, and thin plates are generally not hatched when the cutting plane passes lengthwise through them.
6. Hidden lines are usually omitted in sectional views unless necessary.

Advantages of Sectional Views

- Clearly reveals internal construction.
- Simplifies complex drawings.
- Reduces the use of hidden lines.
- Improves communication between designers and manufacturers.
- Makes dimensions easier to place.
- Enhances accuracy during production.

Disadvantages of Sectional Views

- Takes additional time to prepare.
- Requires knowledge of sectioning conventions.
- May not be suitable for very simple objects.
- Incorrect sectioning can lead to misinterpretation.

Assignment

1. Draw and label:
    - A full sectional view of a hollow cylinder.
    - A half sectional view of a bush.
    - An offset sectional view of a machine block with two holes.
2. Explain the differences between:
    - Full section and broken-out section.
    - Revolved section and removed section.
3. State six applications of sectional views in engineering drawing.