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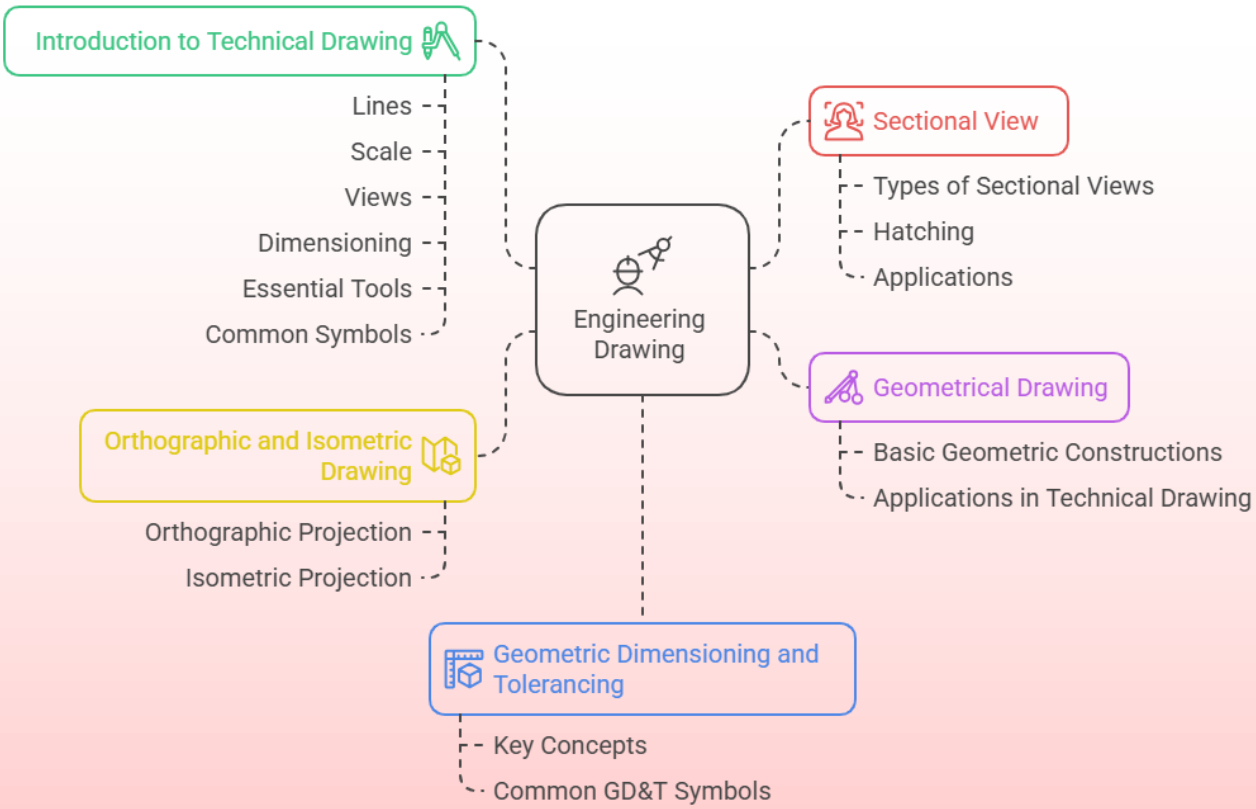
Infographic of Basic Engineering Drawing

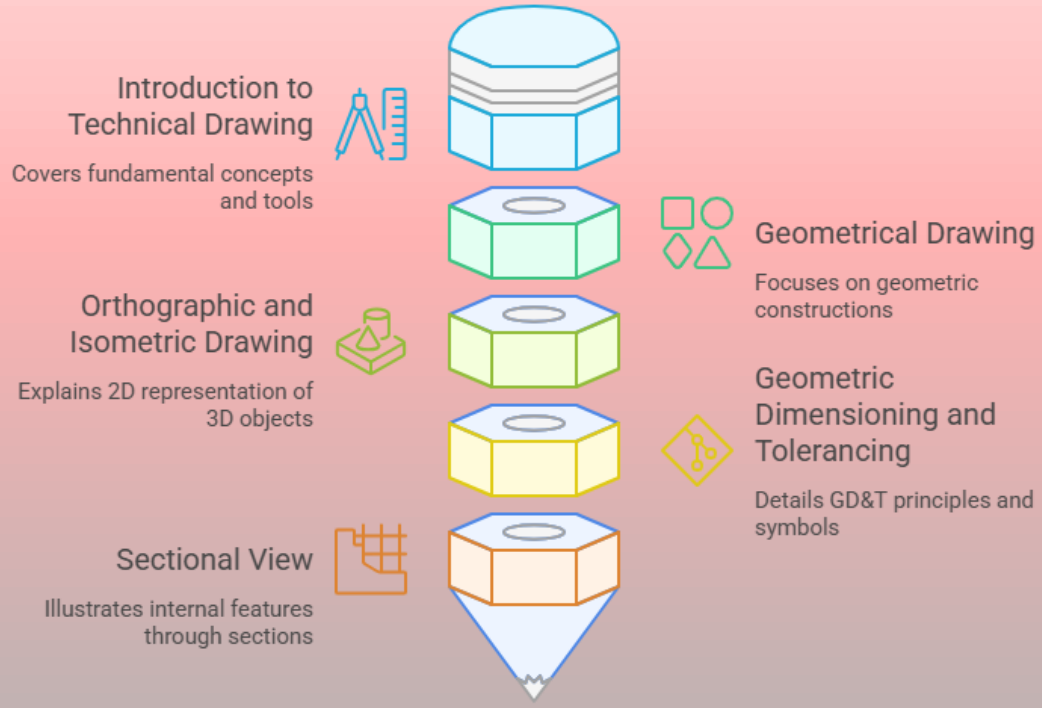
Essential Concepts and Diagrams for Easy Revision

By : Noor Hasanah Tham

e-ISBN 978-967-2742-51-7

Infographic of Basic Engineering Drawing





Preface

This infographic eBook presents the basic concepts of engineering drawing in a visual and easy-to-understand format. It is designed to support learning by combining key information with diagrams, helping to simplify technical concepts.

The content is organized into five main sections:

Introduction to Technical Drawing – Covers fundamental drawing concepts, tools, and commonly used symbols.

Geometrical Drawing – Explains basic geometric constructions used in technical drawing.

Orthographic and Isometric Drawing – Shows standard methods for representing objects in 2D and 3D views.

Geometric Dimensioning and Tolerance – Introduces methods to indicate size, shape, and allowable variation in parts.

Sectional View – Demonstrates how objects are cut to show internal features clearly in technical drawings.

This eBook serves as a quick reference and visual guide for students in mechanical engineering and related fields.

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Published by:

Politeknik Nilai
Kompleks Pendidikan Nilai, Bandar Enstek, 71760 Labu,
Negeri Sembilan, Malaysia

e-ISBN 978-967-2742-51-7

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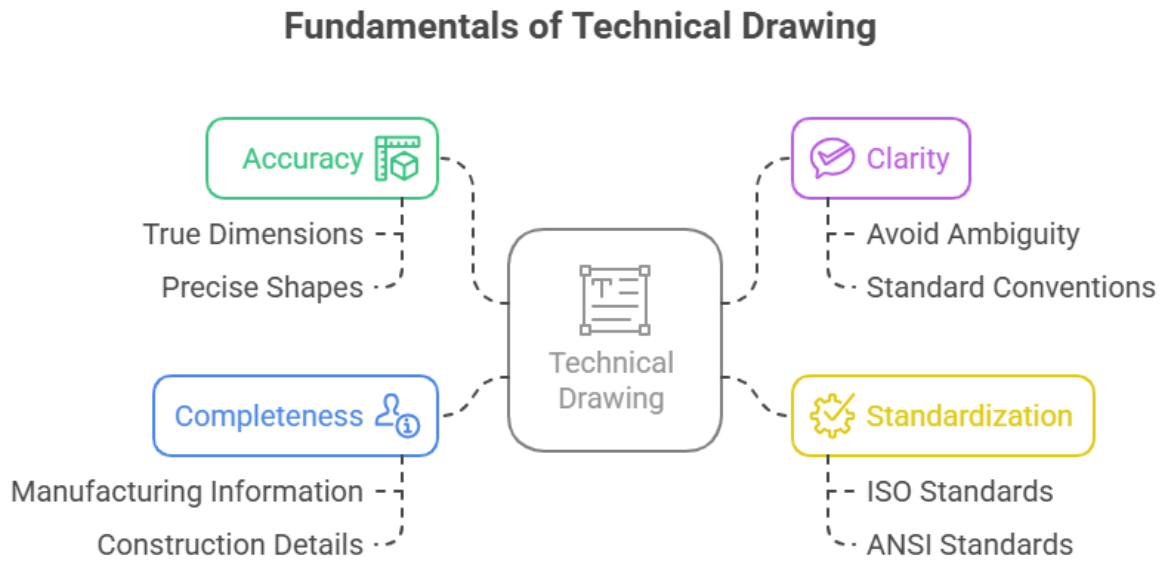
Topic 1
Introduction to Technical Drawing

1.0 Introduction to Technical Drawing

Technical drawing, also known as engineering drawing, is a graphical language used to communicate the design and manufacturing information of objects and structures. It is a precise and standardized method of representing objects, ensuring clarity and accuracy in communication between designers, engineers, and manufacturers. Unlike artistic drawings, technical drawings adhere to specific conventions and standards to convey precise dimensions, shapes, materials, and other relevant details. Key fundamentals include:

- **Accuracy:** Drawings must be precise and reflect the true dimensions and shapes of the object.
- **Clarity:** Drawings should be easy to understand, avoiding ambiguity and using standard conventions.
- **Standardization:** Adherence to established standards (e.g., ISO, ANSI) ensures consistency and interoperability.
- **Completeness:** Drawings must contain all necessary information for manufacturing or construction.

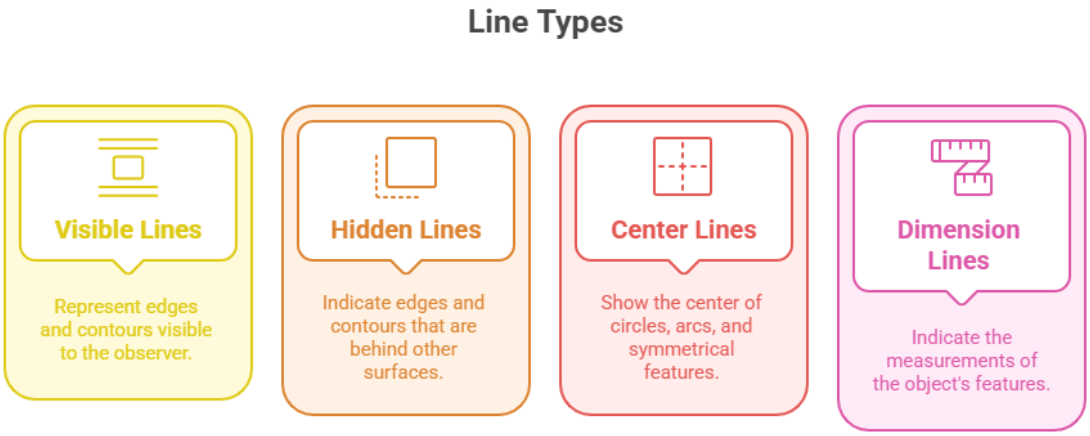


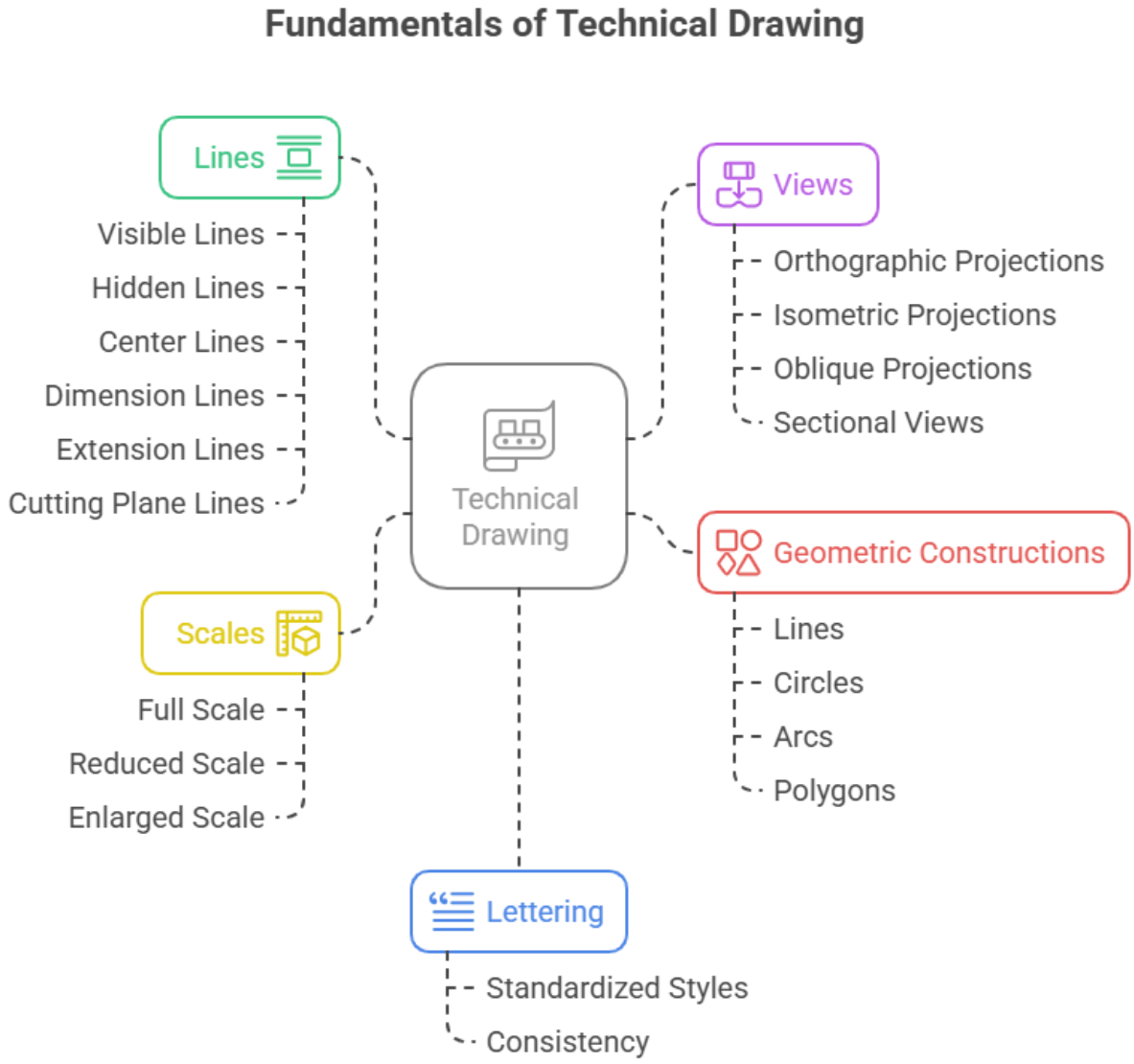
1.1 Fundamentals of Technical Drawing

The fundamentals of technical drawing encompass several key concepts and principles:

- **Lines:** Different types of lines are used to represent various features of an object. These include:
    - **Visible lines (Object lines):** Thick, continuous lines that represent the visible edges and outlines of the object.

    - **Hidden lines:** Dashed lines that represent edges and surfaces that are hidden from view.
    - **Center lines:** Long-short dashed lines that indicate the center of circles, arcs, and symmetrical features.
    - **Dimension lines:** Thin, continuous lines with arrowheads at each end, used to indicate the extent of a dimension.
    - **Extension lines:** Thin, continuous lines that extend from the object to the dimension lines.
    - **Cutting plane lines:** Thick, dashed lines with arrowheads that indicate the location of a cutting plane for sectional views.
- **Views:** Technical drawings typically employ multiple views to fully represent an object. Common types of views include:
    - **Orthographic projections:** Representing the object from different viewpoints (front, top, side) with parallel projection lines.
    - **Isometric projections:** A type of pictorial projection where all three axes are equally foreshortened, providing a 3D representation.
    - **Oblique projections:** A type of pictorial projection where one face of the object is parallel to the projection plane, and the other faces are projected at an angle.
    - **Sectional views:** Revealing the internal features of an object by showing a "cut" through it.
- **Scales:** Technical drawings are often created at a specific scale to represent objects accurately on a manageable size of paper. Common scales include:
    - **Full scale (1:1):** The object is drawn at its actual size.
    - **Reduced scale (e.g., 1:2, 1:10):** The object is drawn smaller than its actual size.
    - **Enlarged scale (e.g., 2:1, 10:1):** The object is drawn larger than its actual size.
- **Lettering:** Clear and legible lettering is essential for labeling and annotating technical drawings. Standardized lettering styles are used to ensure consistency and readability.
- **Geometric Constructions:** The ability to accurately construct geometric shapes (lines, circles, arcs, polygons) is fundamental to technical drawing.

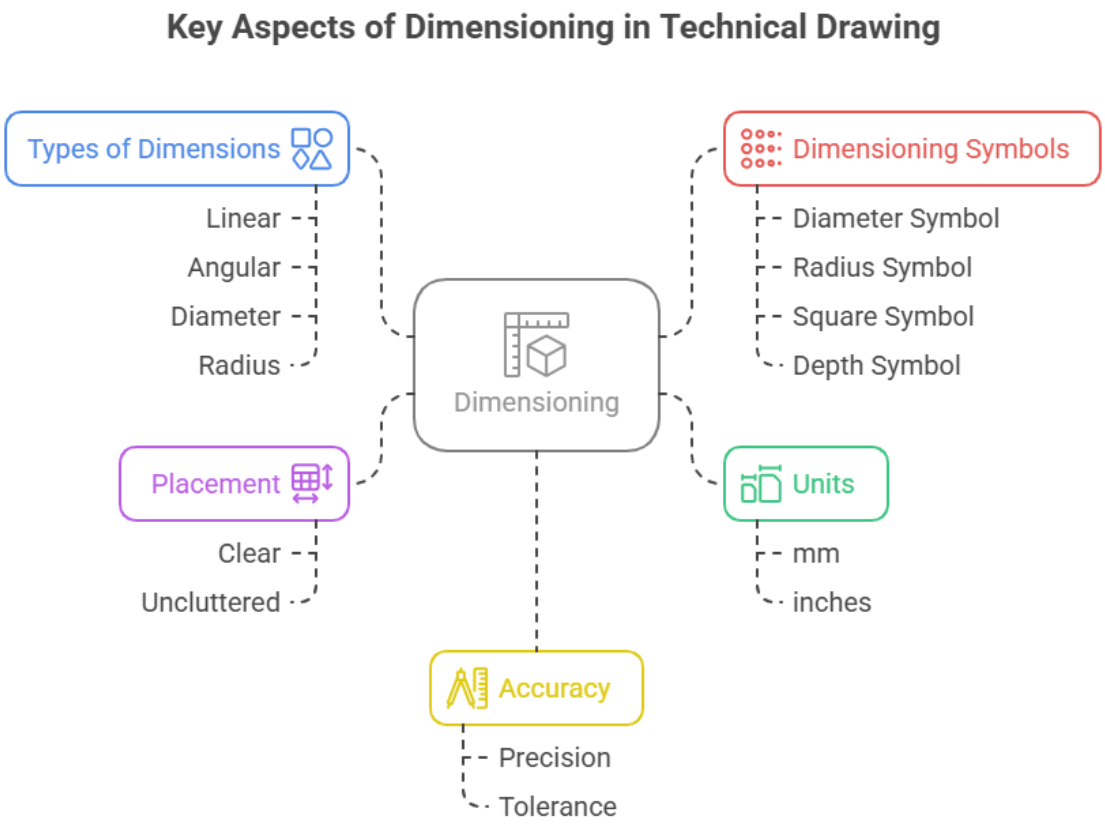




1.2 Basic Drawing Symbols

Technical drawings utilize a variety of symbols to represent common features and components. These symbols are standardized to ensure consistent interpretation across different drawings and industries. Some common drawing symbols include:

- **Circles:** Represent circular features such as holes, shafts, and bearings.
- **Arcs:** Represent curved features.
- **Threads:** Represent screw threads on fasteners and other components.
- **Welds:** Represent welded joints between parts.
- **Surface finish:** Indicate the desired surface texture of a part.
- **Materials:** Indicate the material composition of a part.
- **Fasteners:** Represent bolts, nuts, screws, and other fasteners.
- **Electrical symbols:** Represent electrical components such as resistors, capacitors, and transistors (used in electrical and electronic diagrams).
- **Piping symbols:** Represent pipes, valves, and fittings (used in piping diagrams).
- **Hatching:** Used to indicate the material of a sectioned part.
- **Welding Symbols:** Representing different types of welds.



1.3 Dimensioning Symbols According to Technical Drawing Standard

Dimensioning is the process of adding measurements to a technical drawing to specify the size and location of features. Dimensioning symbols are used to indicate the type and value of dimensions. Technical drawing standards, such as ANSI (American National Standards Institute) and ISO (International Organization for Standardization), provide guidelines for dimensioning practices. Key aspects of dimensioning include:

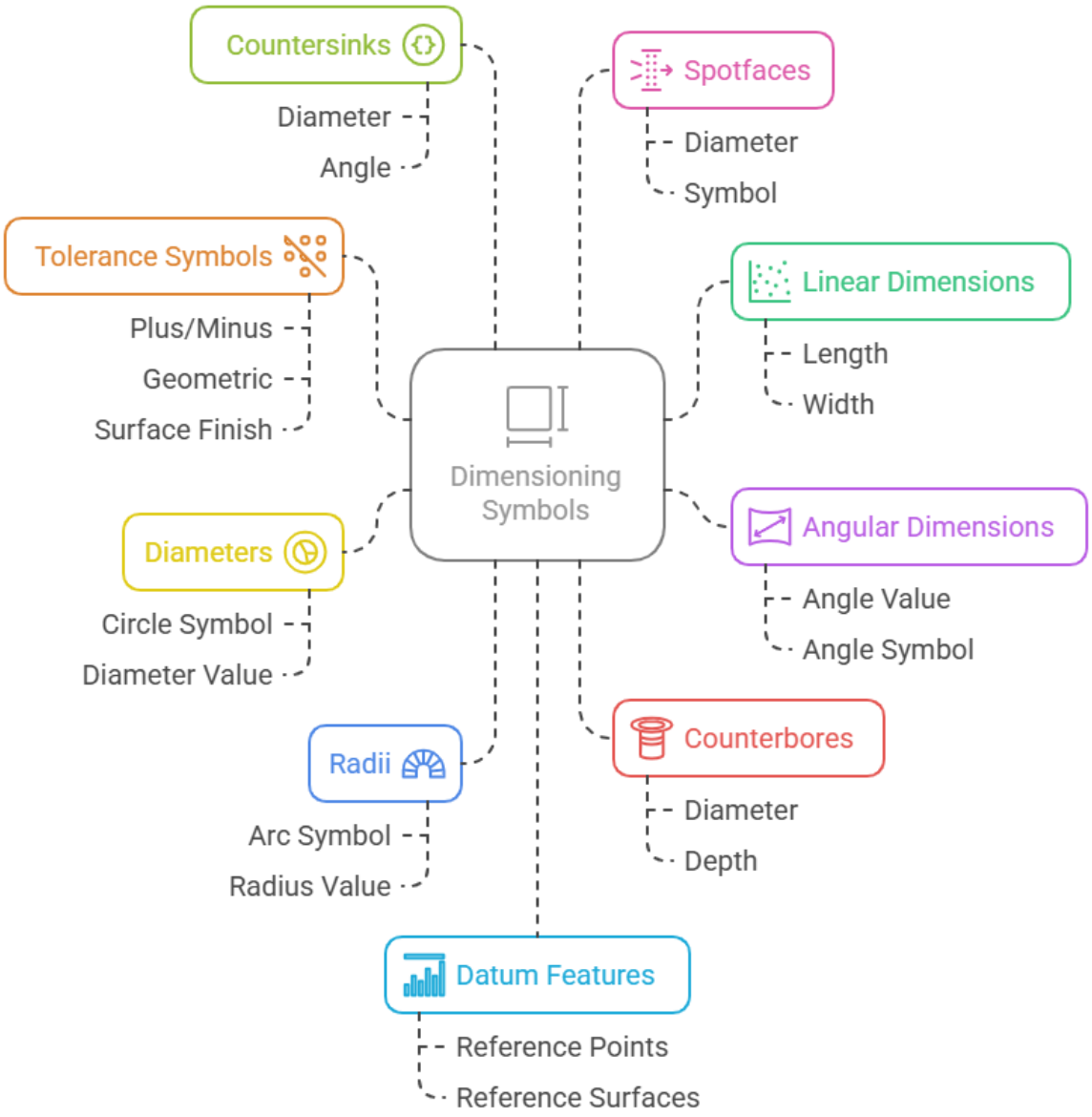
- **Units:** Specifying the units of measurement (e.g., mm, inches).
- **Placement:** Placing dimensions in a clear and uncluttered manner.
- **Accuracy:** Providing dimensions with the appropriate level of precision.
- **Types of Dimensions:** Linear, angular, diameter, radius, etc.
- **Dimensioning Symbols:** Diameter symbol (⌀), radius symbol (R), square symbol (□), depth symbol.

Common dimensioning symbols include:

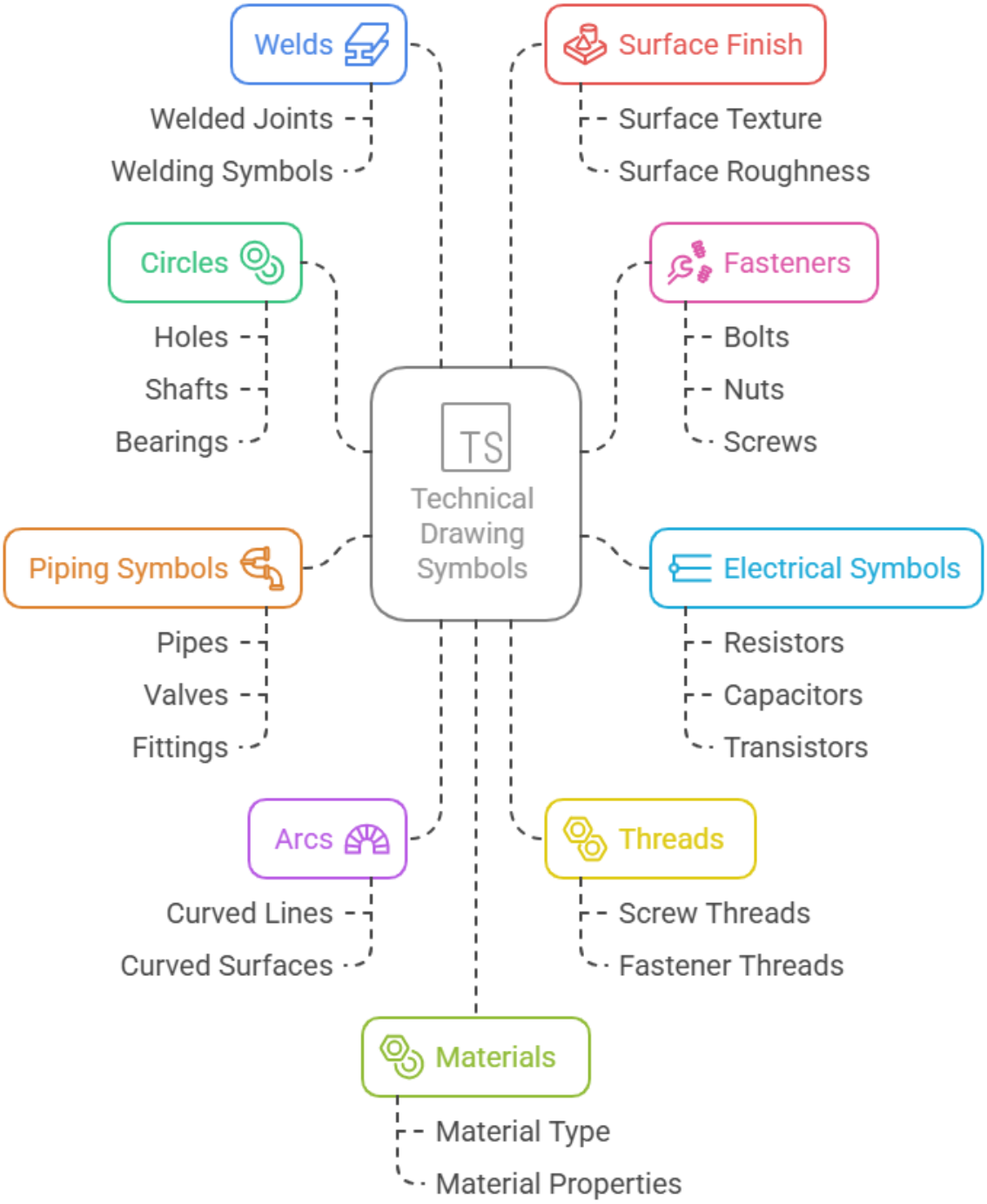
- **Linear dimensions:** Indicate the distance between two points or the length of a line.
- **Angular dimensions:** Indicate the angle between two lines or surfaces.
- **Diameters:** Indicate the diameter of a circle or cylindrical feature. The symbol is a circle with a diagonal line through it (⌀).
- **Radii:** Indicate the radius of an arc or curved feature. The symbol is an "R" followed by the radius value.
- **Counterbores:** Indicate a cylindrical recess that is larger than the diameter of a hole. The symbol is a "⌴" followed by the diameter and depth.
- **Countersinks:** Indicate a conical recess that is used to seat a screw or bolt head. The symbol is a "⌵" followed by the diameter and angle.
- **Spotfaces:** Indicate a shallow recess that is used to provide a flat surface for a fastener. The symbol is "SF" followed by the diameter.
- **Datum features:** Indicate reference points or surfaces used for dimensioning and tolerancing.
- **Tolerance symbols:** Indicate the allowable variation in a dimension. These include symbols for plus/minus tolerances, geometric tolerances (e.g., flatness, cylindricity, position), and surface finish.

Adhering to technical drawing standards ensures that dimensions are clear, unambiguous, and consistent, facilitating accurate manufacturing and assembly.

Dimensioning Symbols in Technical Drawing



Technical Drawing Symbols and Their Applications



Topic 2
Geometrical Drawing

2.0 Geometrical Drawing

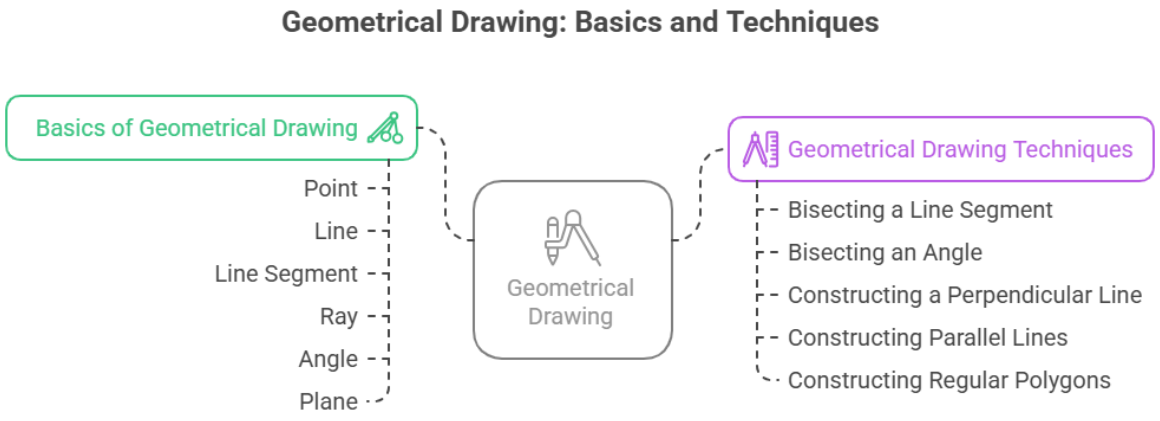
Geometrical drawing is a fundamental skill in various fields, including engineering, architecture, design, and art. It involves the precise construction of geometric shapes and figures using tools such as compasses, straightedges, and protractors. The accuracy and clarity of geometrical drawings are crucial for effective communication and problem-solving.

2.1 Basics of Geometrical Drawing

The foundation of geometrical drawing lies in understanding basic geometric elements and their properties. These elements include:

- **Point:** A point represents a specific location in space and has no dimension. It is typically represented by a dot.
- **Line:** A line is a straight path extending infinitely in both directions. It is defined by two points.
- **Line Segment:** A line segment is a portion of a line bounded by two endpoints.
- **Ray:** A ray is a portion of a line that extends infinitely in one direction from a single endpoint.
- **Angle:** An angle is formed by two rays sharing a common endpoint called the vertex. Angles are measured in degrees or radians.
- **Plane:** A plane is a flat, two-dimensional surface that extends infinitely in all directions.
- **Circles and Arcs:** Drawing circles and arcs with specific radii and centers.
- **Tangency:** Drawing lines and circles that are tangent to each other.
- **Parallel and Perpendicular Lines:** Constructing parallel and perpendicular lines.

Understanding the relationships between these elements is crucial for constructing more complex geometric figures. For example, parallel lines are lines that lie in the same plane and never intersect, while perpendicular lines intersect at a right angle (90 degrees).



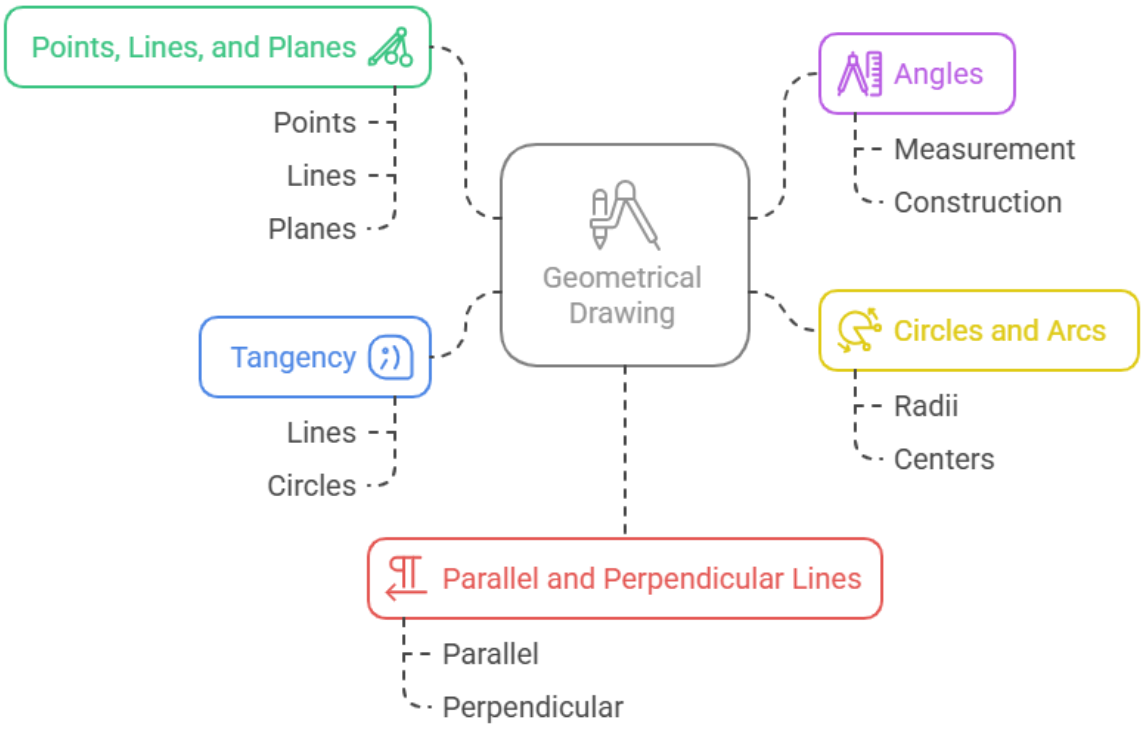
2.2 Geometrical Drawing Techniques

Several fundamental geometrical drawing techniques are essential for creating accurate constructions:

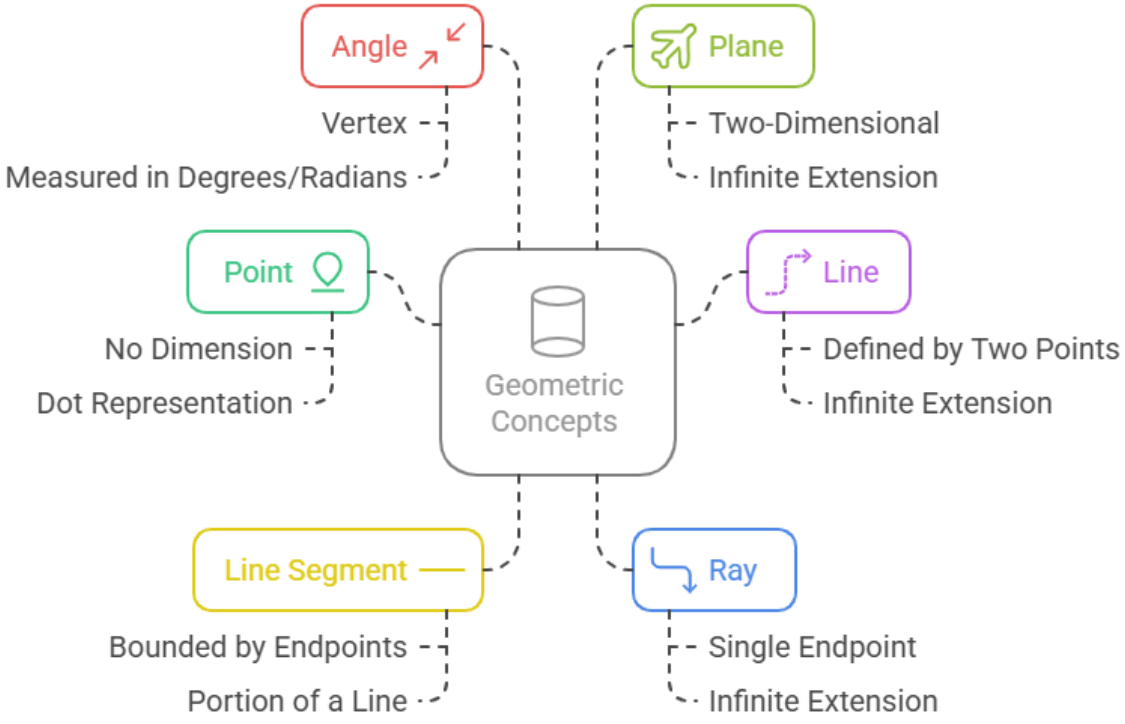
- **Bisecting a Line Segment:** This involves dividing a line segment into two equal parts. Using a compass, draw arcs of equal radius centered at each endpoint of the line segment. The intersection points of the arcs define a line that bisects the original line segment.
- **Bisecting an Angle:** This involves dividing an angle into two equal angles. Using a compass, draw an arc centered at the vertex of the angle that intersects both rays. Then, draw arcs of equal radius centered at the intersection points on the rays. The intersection point of these arcs defines a ray that bisects the original angle.
- **Constructing a Perpendicular Line:** This involves drawing a line that is perpendicular to a given line at a specific point. Using a compass, draw arcs of equal radius centered at the point on the line. Then, draw arcs of equal radius centered at the intersection points on the line. The intersection point of these arcs defines a line that is perpendicular to the original line.
- **Constructing Parallel Lines:** This involves drawing a line that is parallel to a given line. This can be achieved using a T-square and set square, or by using compass and straightedge constructions based on equal corresponding angles.
- **Constructing Regular Polygons:** Regular polygons are polygons with all sides and all angles equal. Common methods for constructing regular polygons involve dividing a circle into equal parts and connecting the points on the circumference.

These techniques form the basis for more complex geometrical constructions and are essential for accurate and precise drawing. Mastering these techniques requires practice and a thorough understanding of geometric principles.

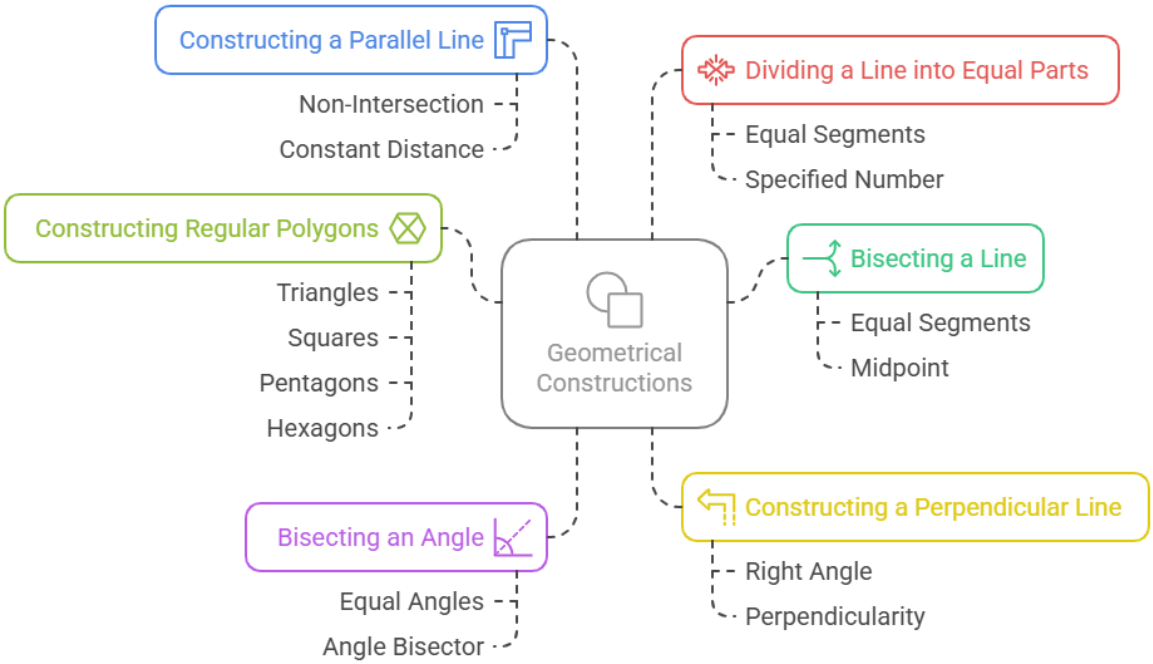
Fundamentals of Geometrical Drawing



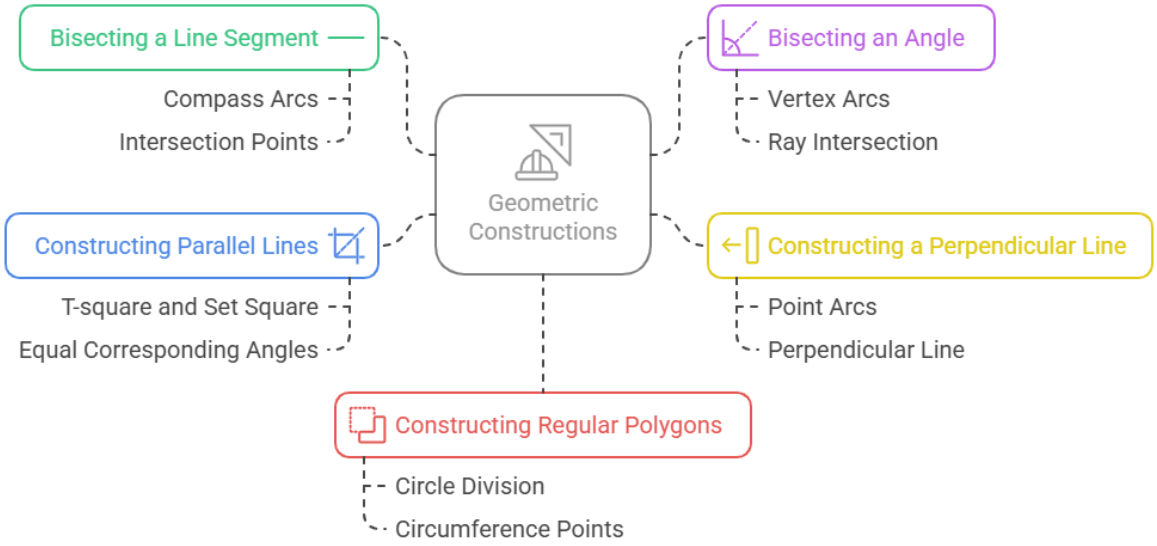
Basic Geometric Concepts



Common Geometrical Constructions



Geometric Constructions: Methods and Techniques

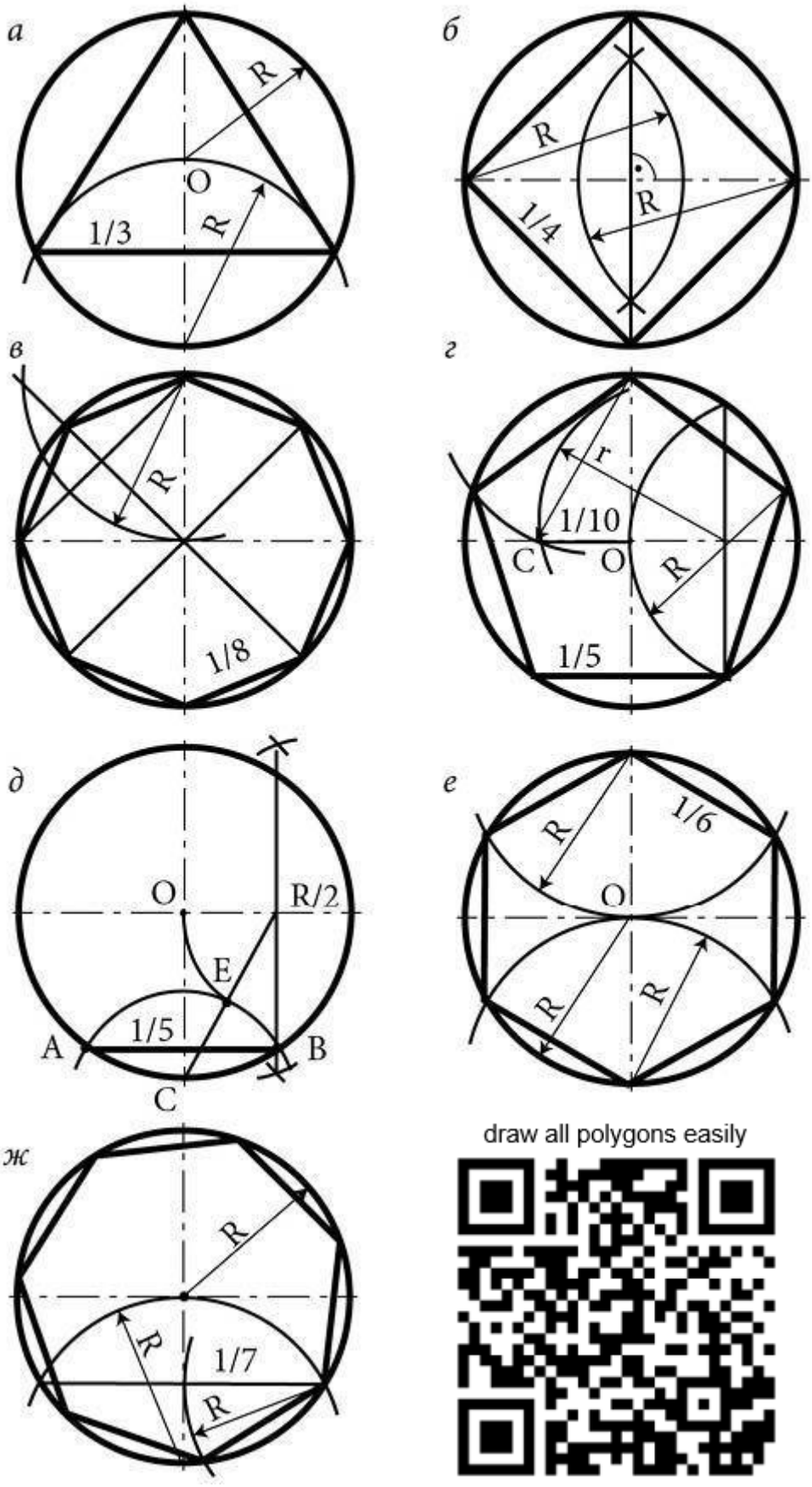


COMPASS METHOD

Draw a Perpendicular on a line AB	Draw a Parallel Line
Bisect a Line Segment	30 Degree Angle Construction
Construct a Hexagon	Construct an Octagon

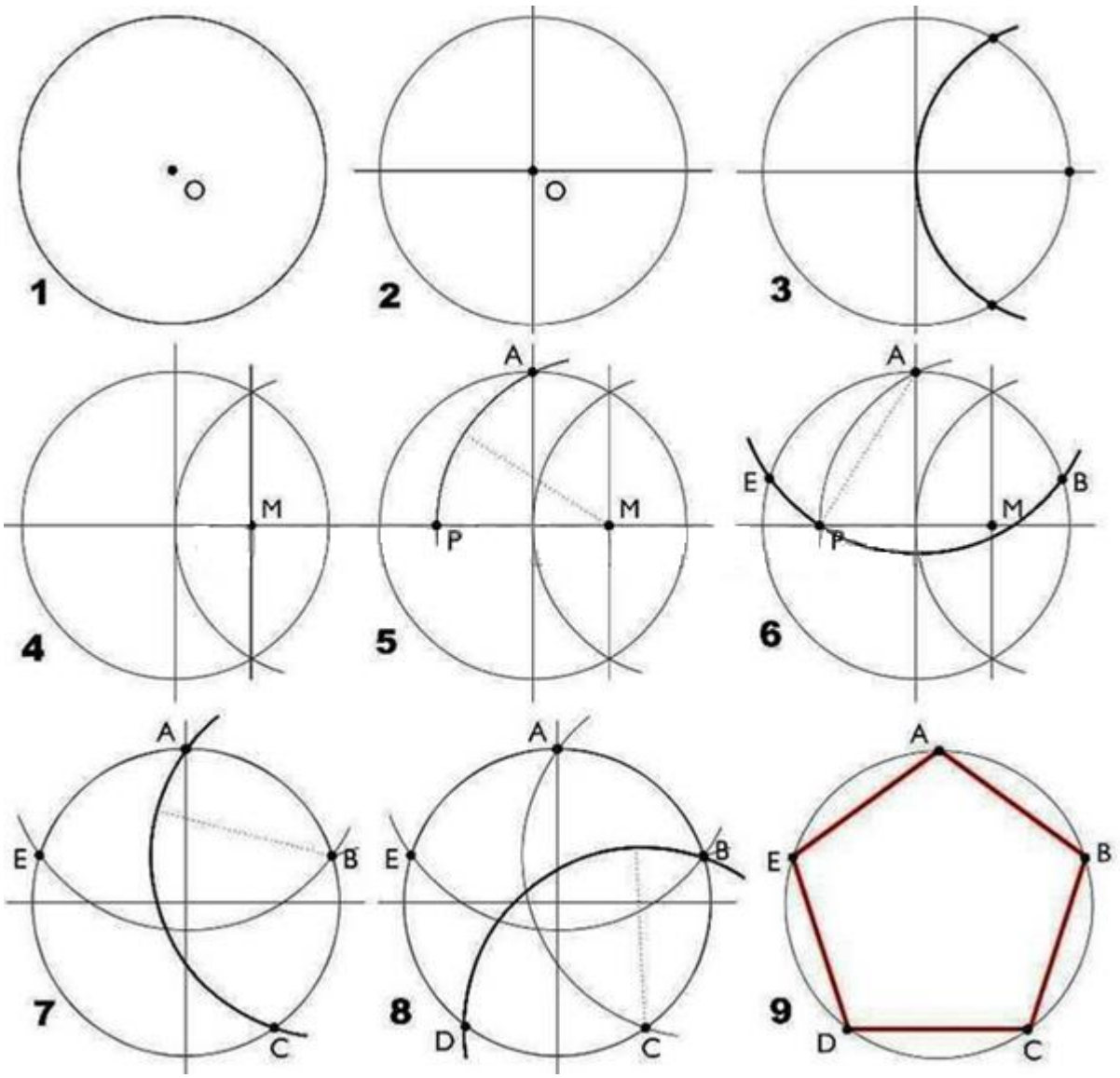
Other notes:-

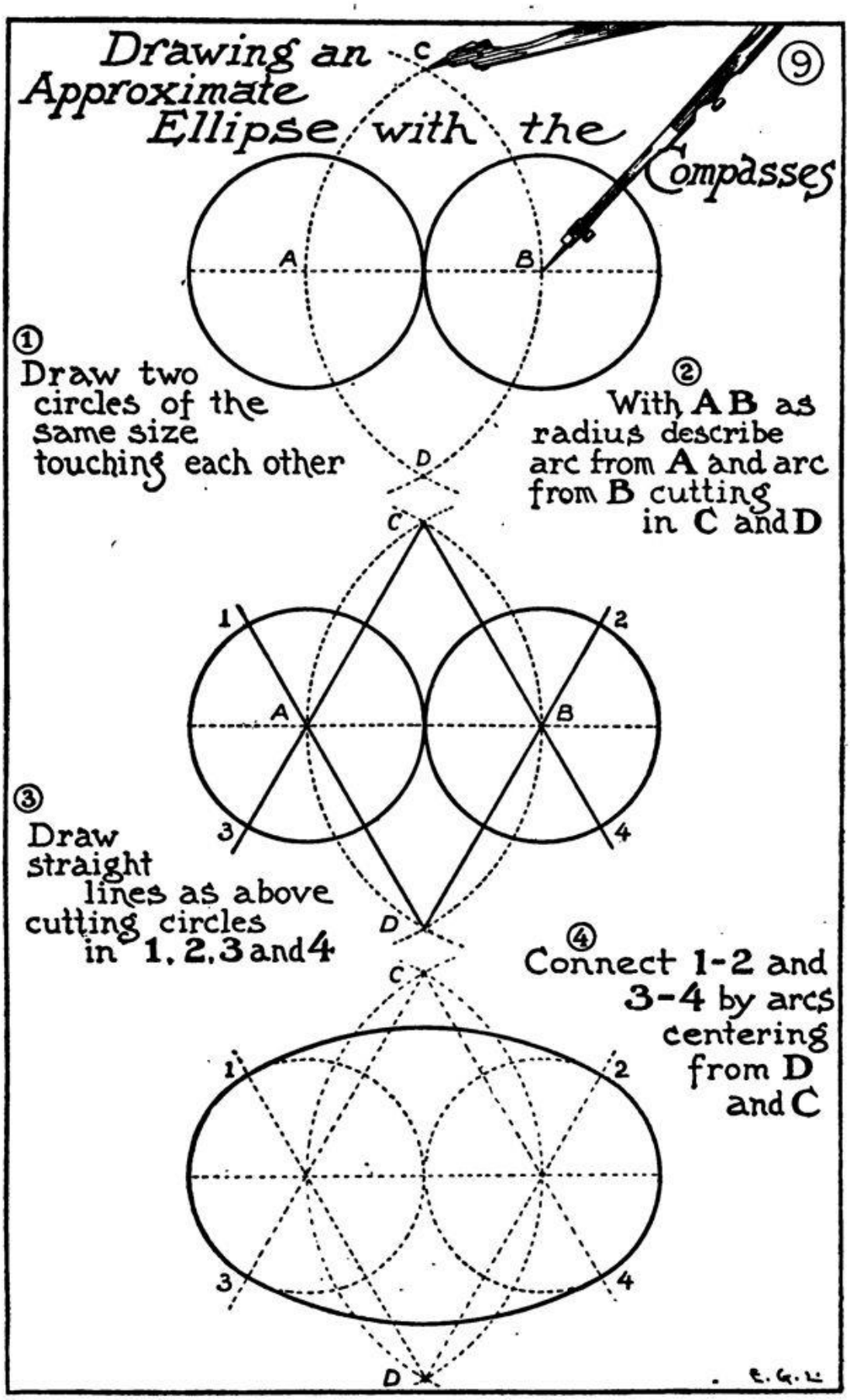
PTSB	Hand & CAD	By Hand	AutoCAD



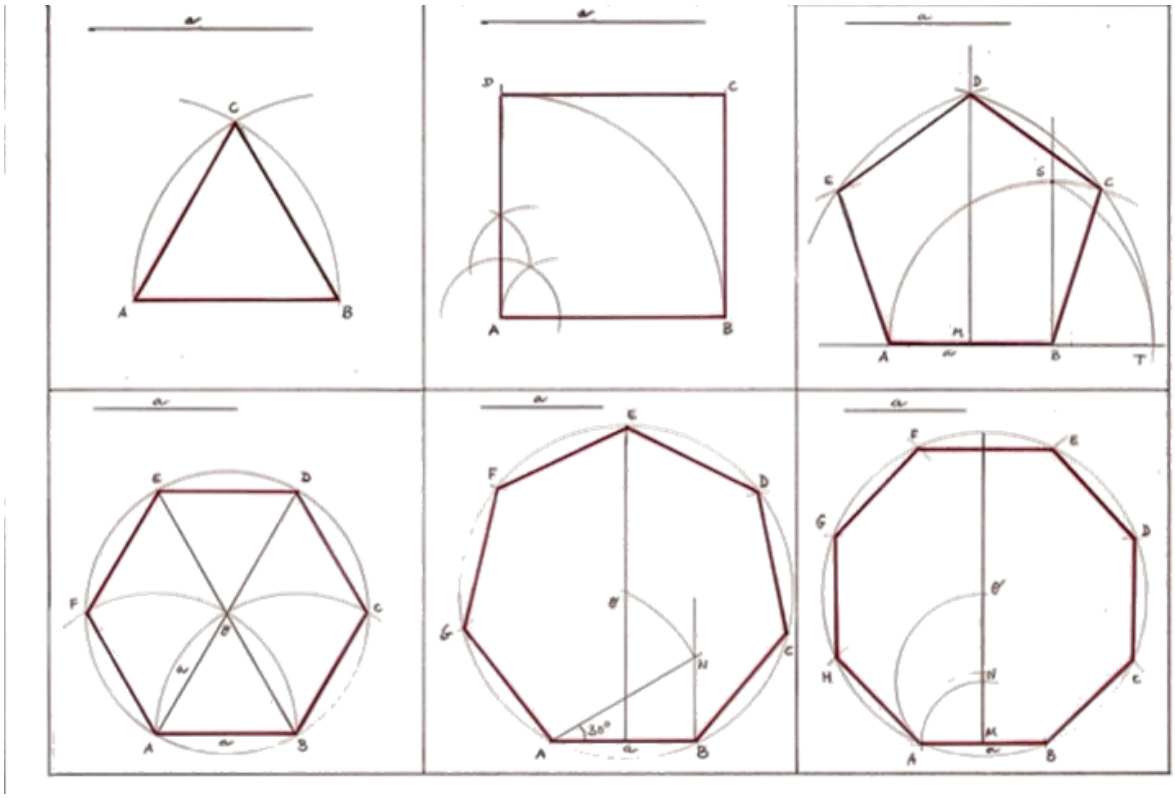
draw all polygons easily

PENTAGON

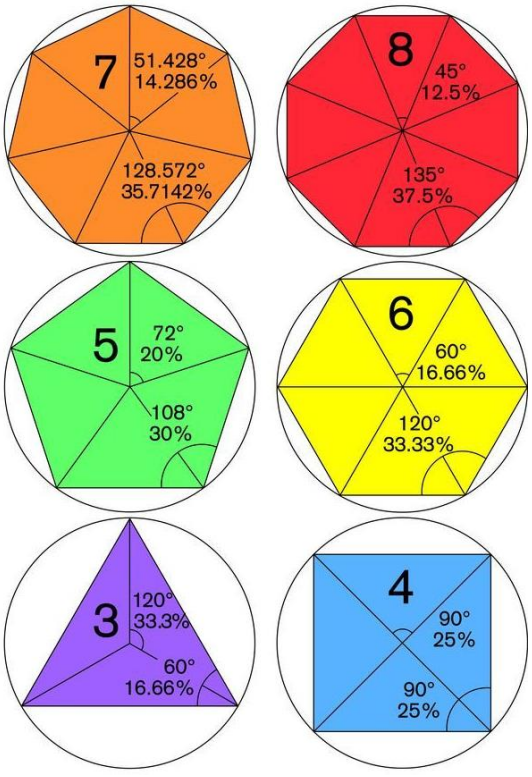



Drawing an Approximate Ellipse with the Compasses
9
C
A
B
D
1
2
3
4
① Draw two circles of the same size touching each other
② With A B as radius describe arc from A and arc from B cutting in C and D
③ Draw straight lines as above cutting circles in 1, 2, 3 and 4
④ Connect 1-2 and 3-4 by arcs centering from D and C

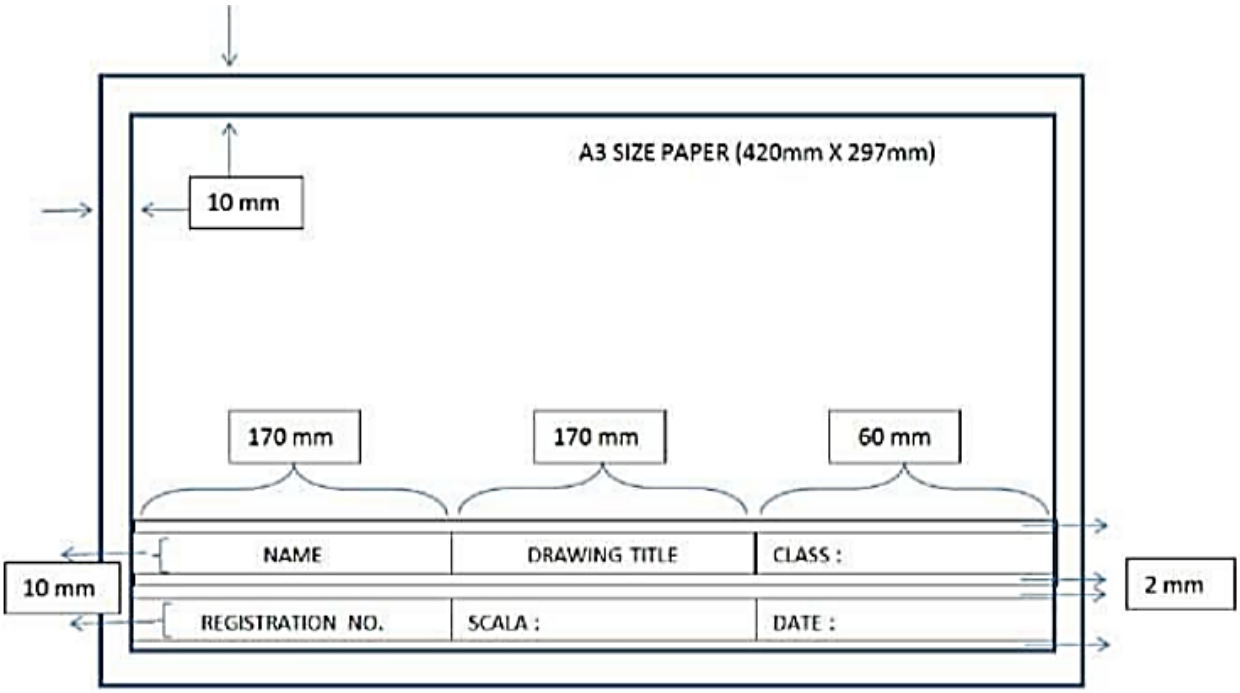
POLYGON

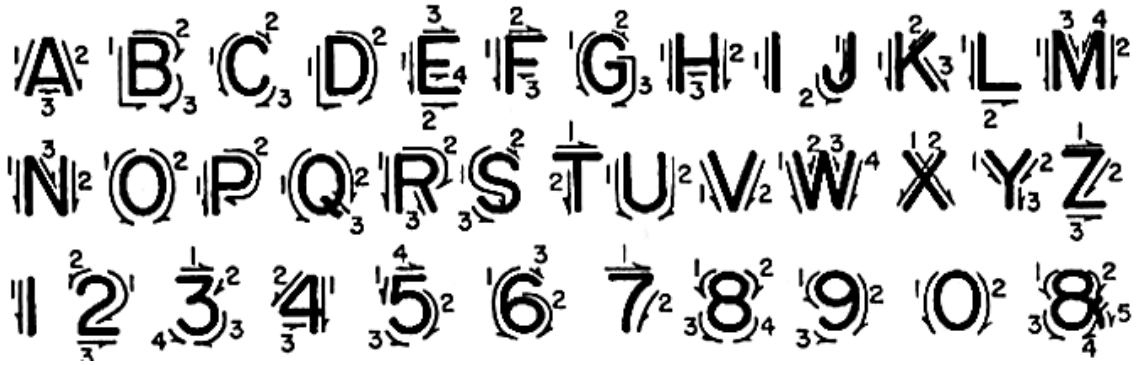


Shape	Interior Angle	Name
	60°	Equilateral Triangle
	90°	Square
	108°	Pentagon
	120°	Hexagon
	128.57°	Heptagon
	135°	Octagon



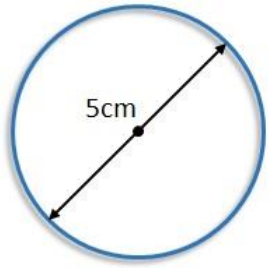
EXAMPLE OF TITLE BLOCK AND HOW TO WRITE ALPHABET



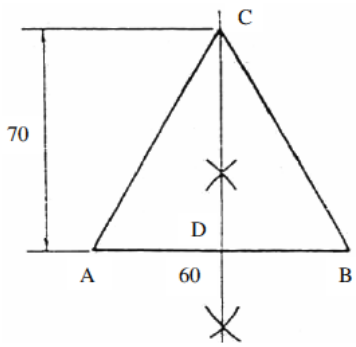


EXERCISE : Geometrical shape using various methods.

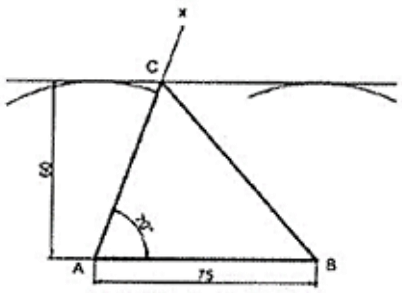
Circle



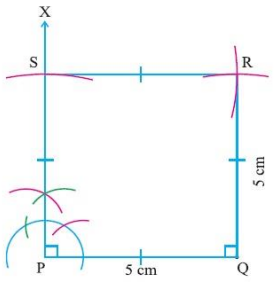
Triangle 1



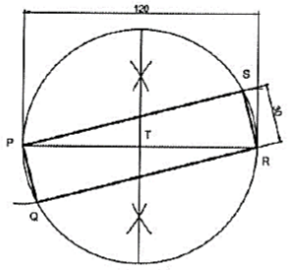
Triangle 2

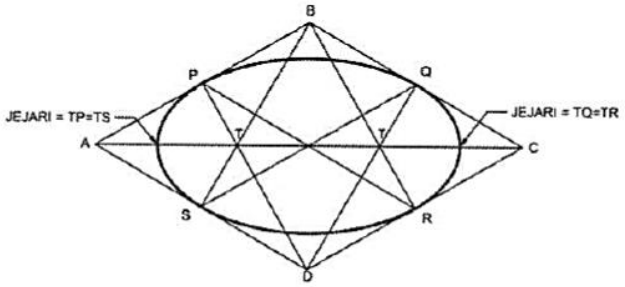


Square.



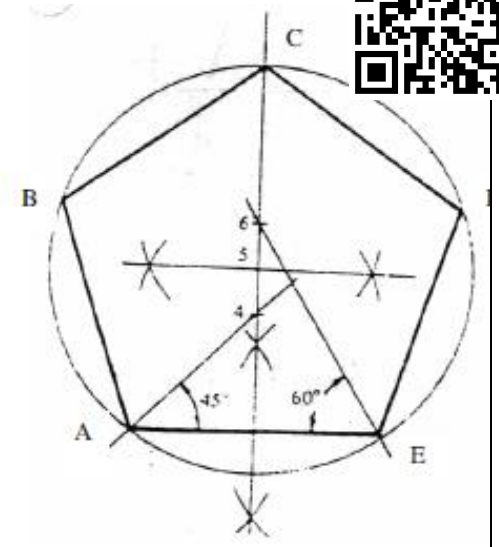
Parallel





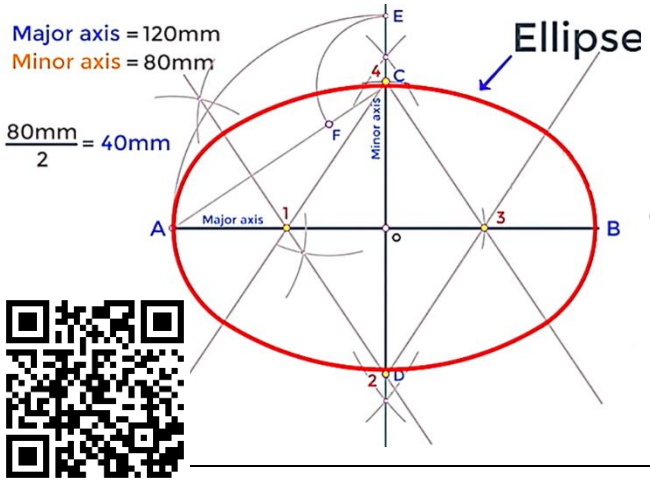
Pentagon

AB = 5cm

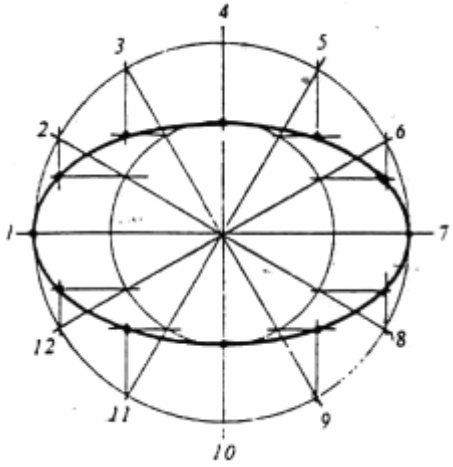


e. Ellipse

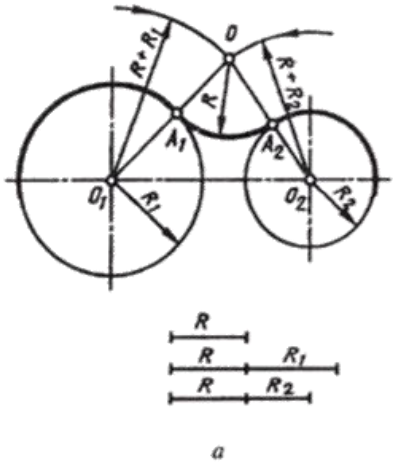
not using 30^0 set square

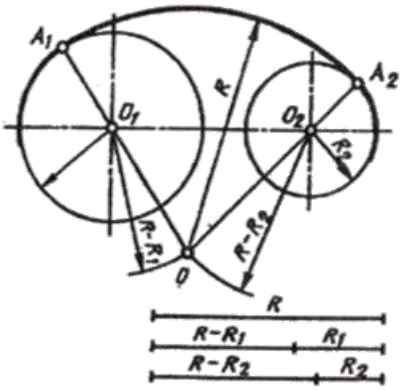


using 30^0 set square



TANGENT


O
R+R1
R
R+R2
A1
A2
O1
O2
R1
R2
R
R R1
R R2
а


A1
A2
O1
O2
R
R2
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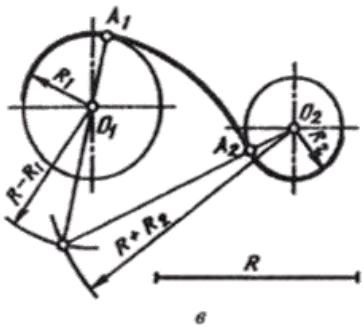
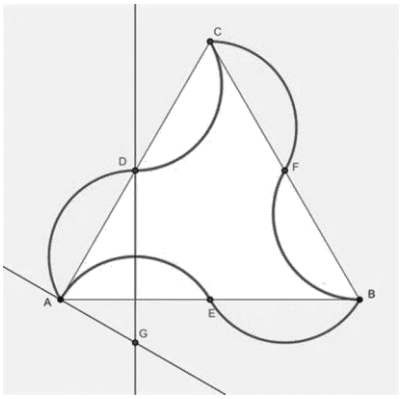
R-R2
O
R
R-R1 R1
R-R2 R2
б


A1
R1
O1
O2
R2
A2
R-R1
R+R2
R
в


C
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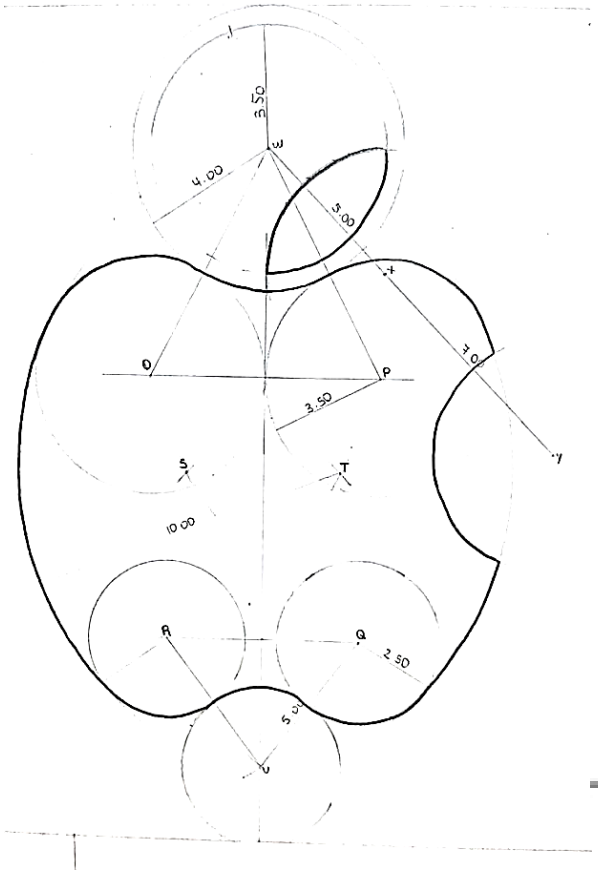
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O
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10.00
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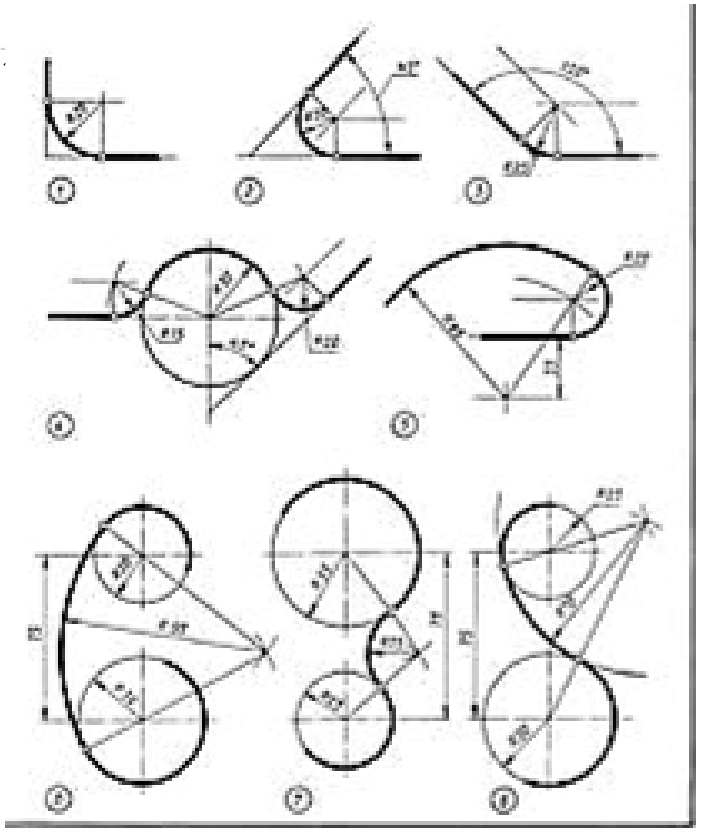
2.50



Topic 3
Orthographic Projection and Isometric

3.0 Orthographic Projection and Isometric

Orthographic and isometric projections are two fundamental methods used in technical drawing to represent three-dimensional objects in two dimensions. They serve different purposes and offer distinct advantages depending on the application. Orthographic projections are used to show true shapes and sizes of individual faces of an object, while isometric projections provide a pictorial view that approximates a 3D representation.

3.1 An Orthographic Projection

An orthographic projection is a method of representing a three-dimensional object by projecting its features onto a plane using parallel lines that are perpendicular to the projection plane. This results in a series of two-dimensional views, typically including the front, top, and side views, each showing the object from a different orthogonal direction.

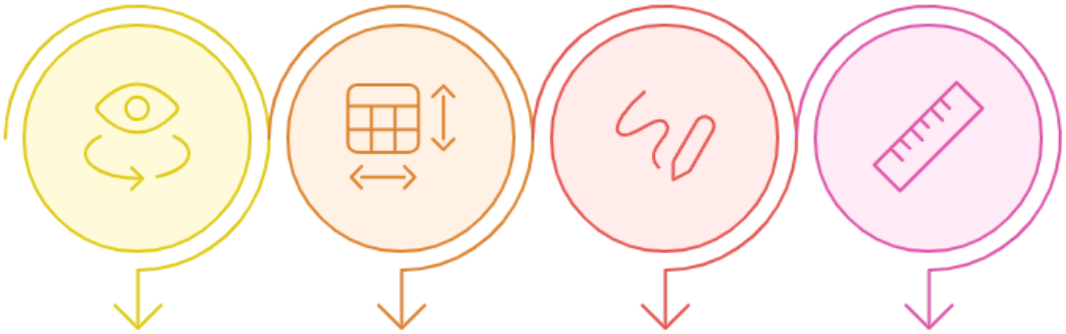
Key Characteristics:

- **Parallel Projectors:** Projection lines are parallel to each other.
- **Perpendicular Projection:** Projection lines are perpendicular to the projection plane.
- **Multiple Views:** Requires multiple views (typically front, top, and side) to fully describe the object.
- **True Shape and Size:** Each view shows the true shape and size of the object's features as seen from that direction.
- **No Perspective:** Does not incorporate perspective, so objects do not appear smaller with distance.

Purpose:

- To accurately represent the shape and dimensions of an object.
- To provide detailed information for manufacturing and construction.
- To facilitate precise measurements and calculations.

Orthographic Projection Steps



Selecting Views

Choose informative views to represent the object. This is the first step in creating an orthographic projection.

Arranging Views

Position the views in a standard arrangement. First-angle or third-angle projection are common arrangements.

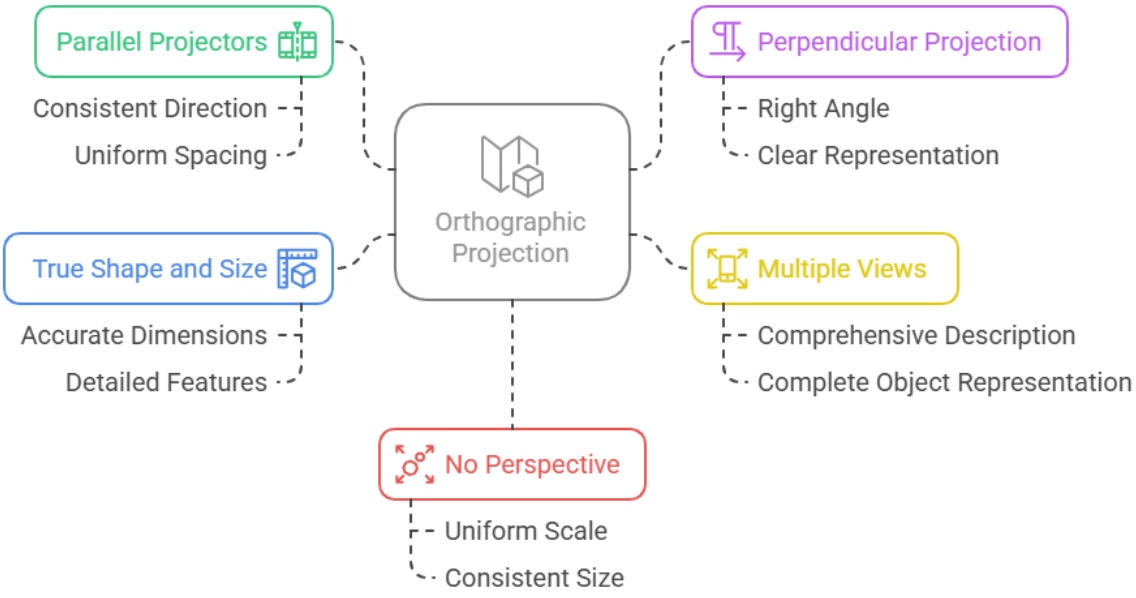
Drawing Conventions

Use appropriate line types and symbols. This ensures clarity and adherence to standards.

Dimensioning

Add dimensions to specify the size and location. This provides necessary information about the object's features.

Orthographic Projection Characteristics



3.2 An Orthographic Projection Drawing According to Standard

Creating orthographic projection drawings according to established standards ensures clarity, consistency, and ease of interpretation. Common standards include those set by organizations like ANSI (American National Standards Institute) and ISO (International Organization for Standardization).

Key Standards and Conventions:

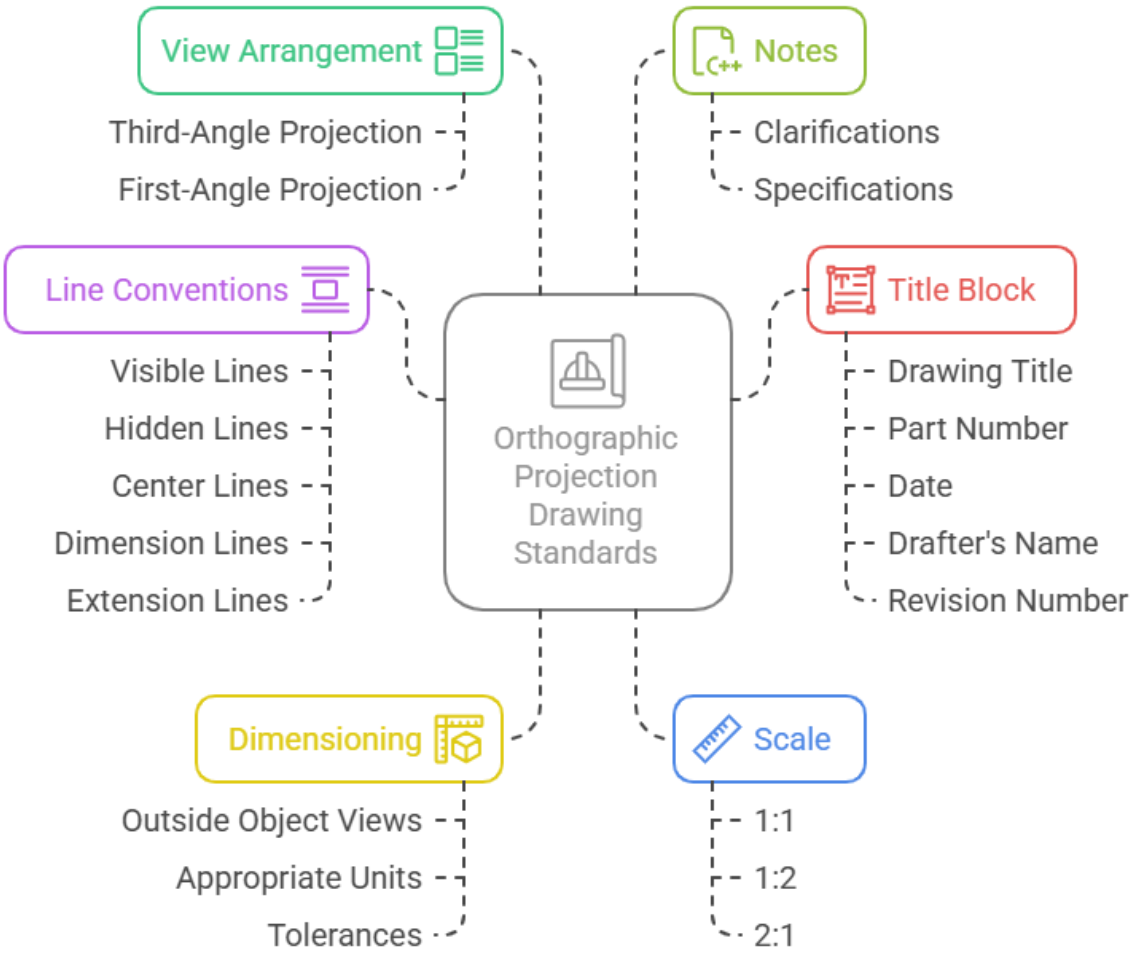
- **View Arrangement:** Typically, the front view is placed in the lower left, the top view directly above it, and the right-side view to the right of the front view. This arrangement is known as third-angle projection (common in the US). First-angle projection (common in Europe and Asia) has a different arrangement.
- **Line Conventions:**
    - **Visible Lines:** Thick, solid lines representing visible edges and contours.
    - **Hidden Lines:** Dashed lines representing edges and contours that are hidden from view.
    - **Center Lines:** Thin, long-dashed dotted lines indicating axes of symmetry, centers of circles, and paths of motion.
    - **Dimension Lines:** Thin, solid lines with arrowheads at each end, indicating the extent of a dimension.
    - **Extension Lines:** Thin, solid lines extending from the object to the dimension lines.
- **Dimensioning:** Dimensions should be placed outside the object views whenever possible and should be clear and unambiguous. Use appropriate units and tolerances.
- **Scale:** Indicate the scale of the drawing (e.g., 1:1, 1:2, 2:1).
- **Title Block:** Include a title block with essential information such as the drawing title, part number, scale, date, drafter's name, and revision number.
- **Notes:** Add any necessary notes or specifications to clarify the drawing.

Importance of Standards:

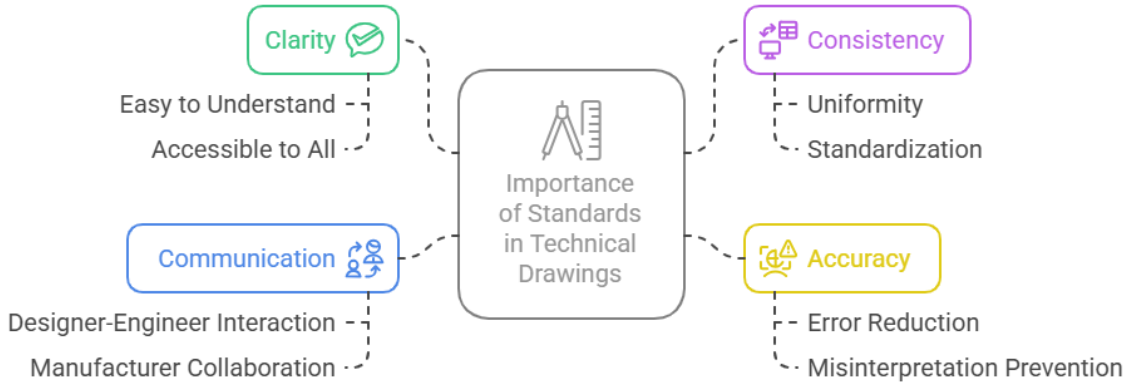
- **Clarity:** Ensures that the drawing is easily understood by anyone familiar with the standards.
- **Consistency:** Promotes uniformity in technical drawings across different projects and organizations.

- **Accuracy:** Reduces the risk of errors and misinterpretations.
- **Communication:** Facilitates effective communication between designers, engineers, and manufacturers.

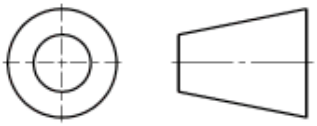
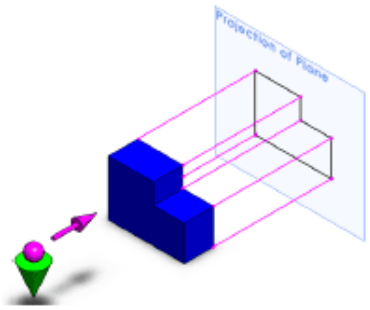
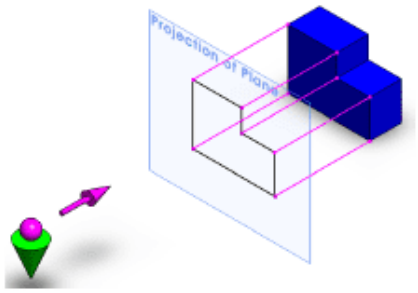
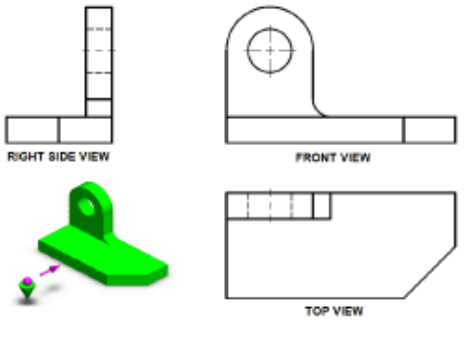
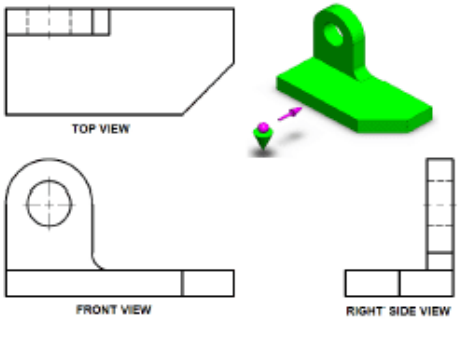
Orthographic Projection Drawing Standards

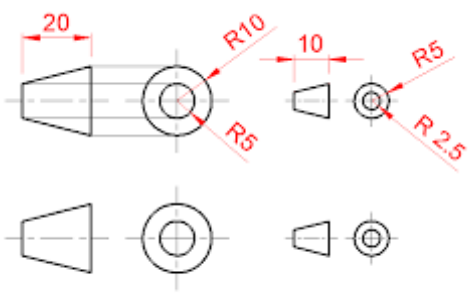


Importance of Standards in Technical Drawings

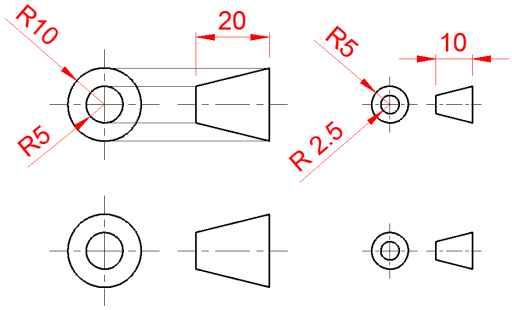


ORTHOGRAPHICS

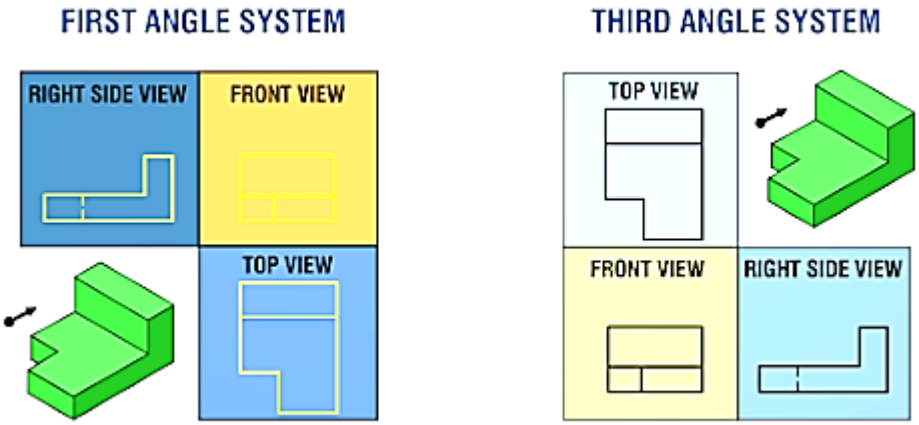
First Angle Projection	Third Angle Projection
The object is imagined to be in first quadrant.	The object is imagined to be in third quadrant.
The object is lies between the observer and plane of projection.	The plane of projection lies between the observer and object.
The plane of projection is assumed to be non transparent.	The plane of projection is assumed to be transparent.
When view are drawn in their relative position Top view comes below Front view, Right side view drawn to the left side of elevation.	When view are drawn in their relative position Top view comes above Front view, Right side view drawn to the right side of elevation.
 SYMBOL	 SYMBOL
	
	

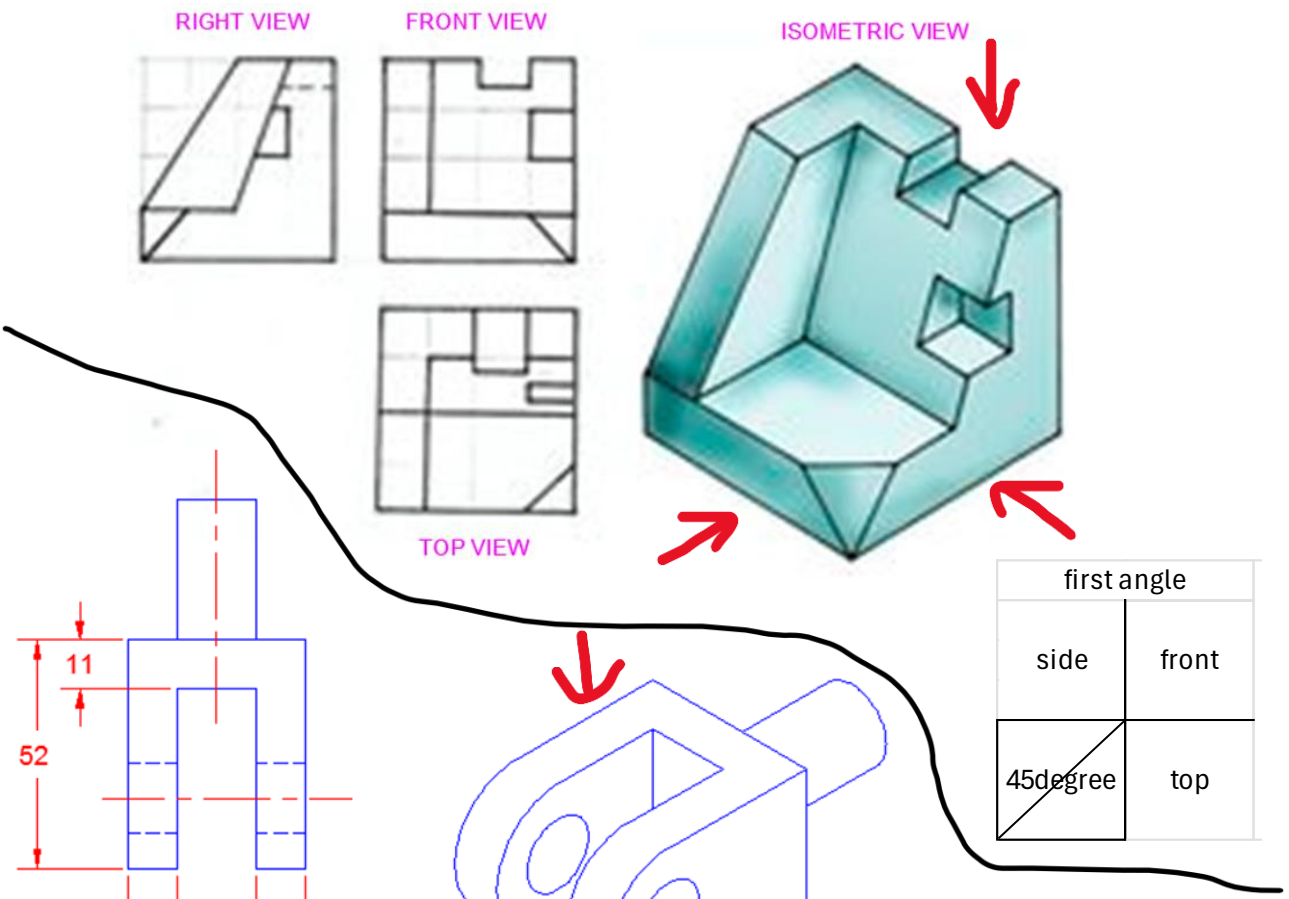


FIRST ANGLE SYMBOL



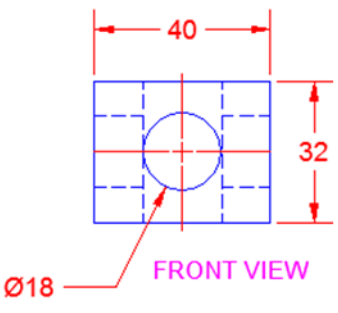
THIRD ANGLE SYMBOL

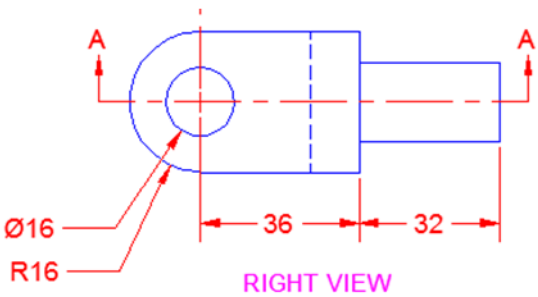




first angle	
side	front
45degree	top

third angle	
top	45degree
front	side





3.3 An Isometric Drawing

An isometric drawing is a type of pictorial drawing in which all three axes (width, height, and depth) are equally foreshortened. This is achieved by orienting the object so that its principal axes make equal angles (120 degrees) with each other.

Key Characteristics:

- **Equal Foreshortening:** All three axes are foreshortened by the same amount (approximately 82% of their true length).
- **120-Degree Angles:** The three axes are drawn at 120-degree angles to each other.
- **Parallel Lines:** Parallel lines in the object remain parallel in the isometric drawing.
- **Non-Perspective:** Does not incorporate perspective, so objects do not appear smaller with distance.
- **Ease of Construction:** Relatively easy to create using basic drafting tools.

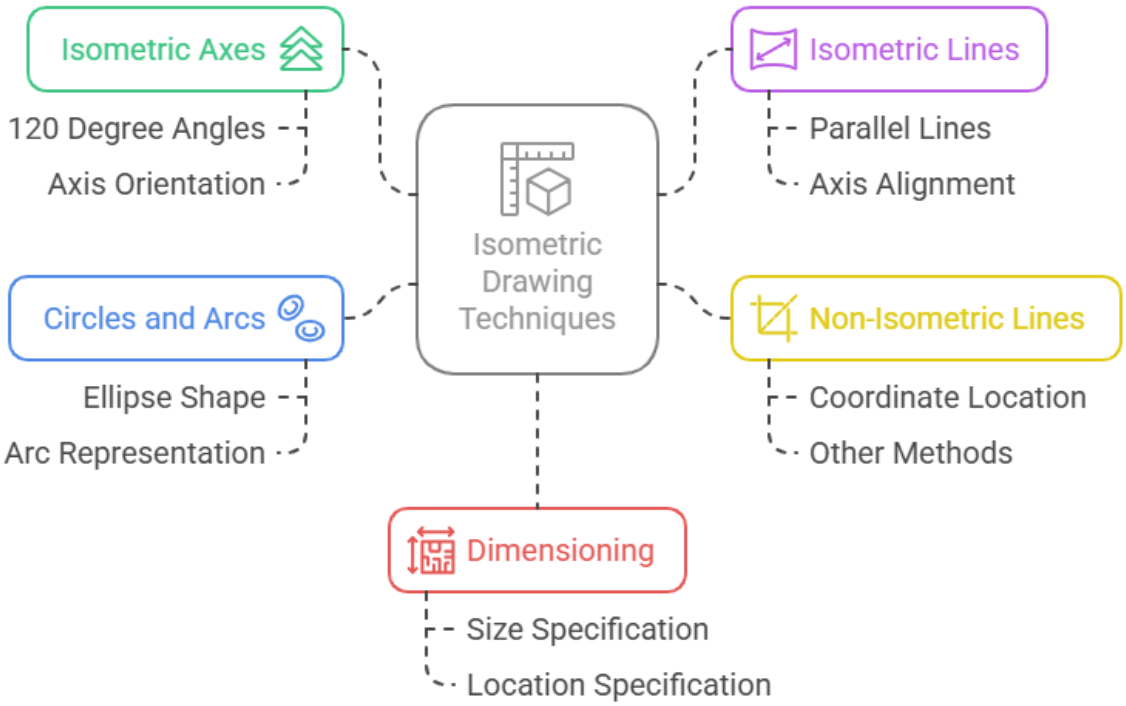
Purpose:

- To provide a visually appealing representation of a 3D object.
- To illustrate the overall shape and features of an object.
- To aid in visualization and understanding.

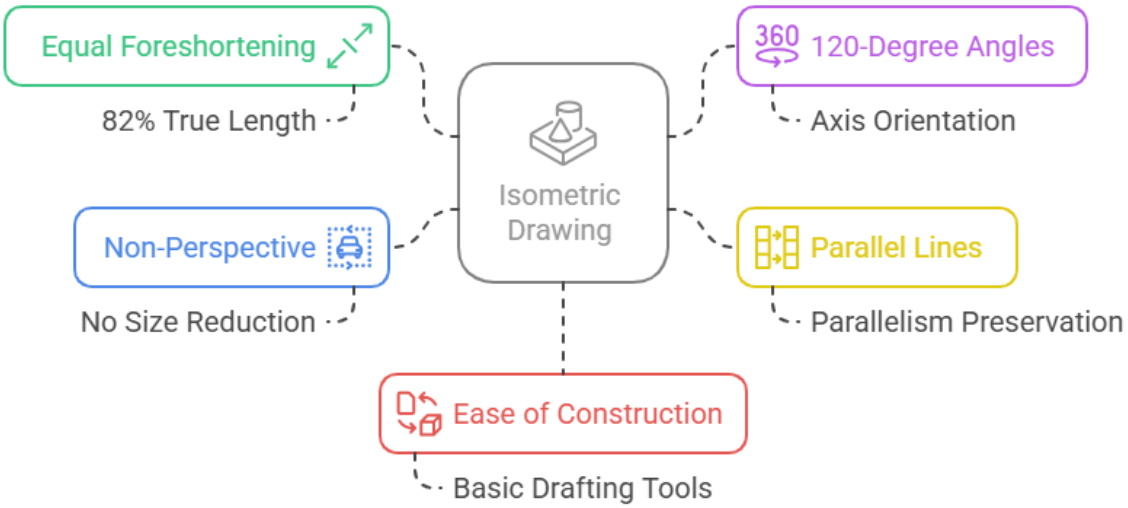
Limitations:

- **Distortion:** Circles appear as ellipses, and true lengths cannot be directly measured along the isometric axes.
- **Not Suitable for Precise Measurements:** Not ideal for applications requiring precise measurements.

Isometric Drawing Techniques



Isometric Drawing Characteristics



3.4 An Isometric Drawing Drawing According to Standard

Creating isometric drawings according to standard practices ensures consistency and clarity. While there isn't a single universally accepted standard for isometric drawings as strict as those for orthographic projections, certain conventions are widely followed.

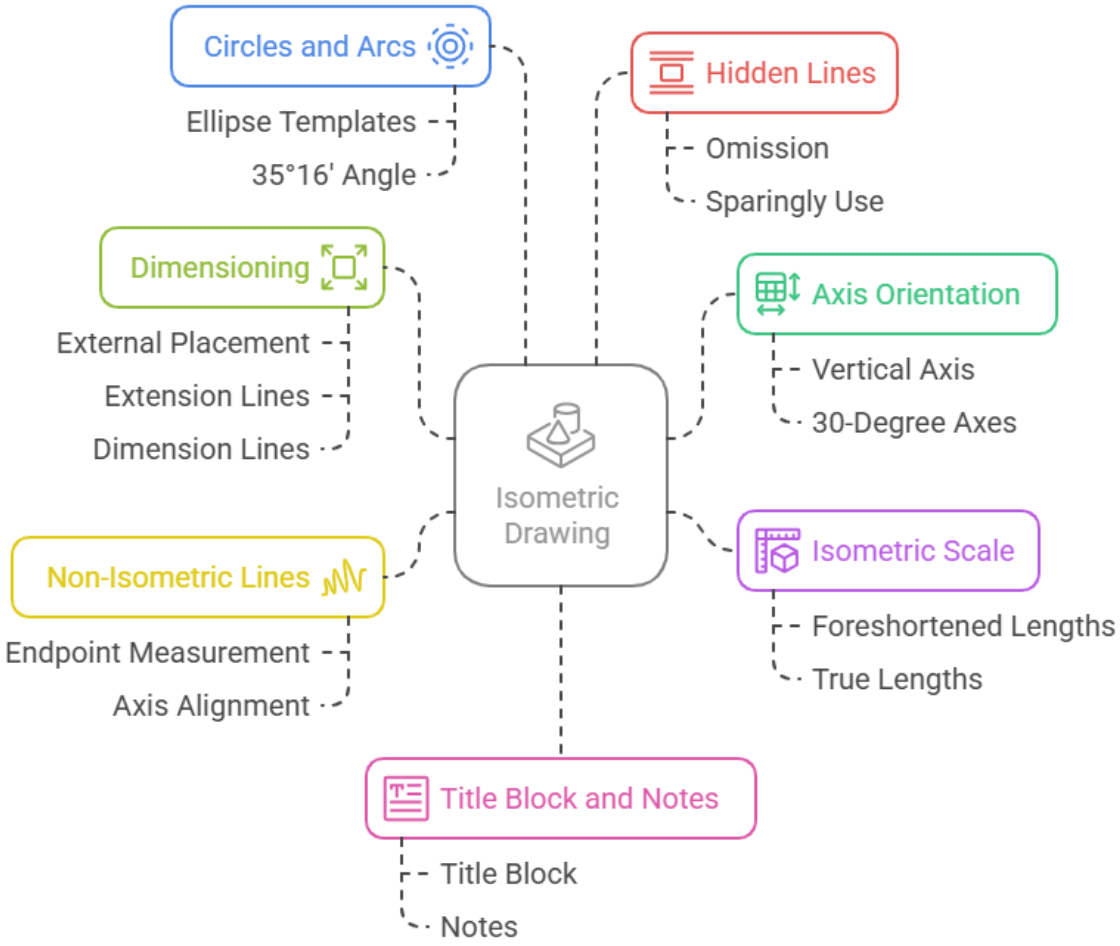
Key Standards and Conventions:

- **Axis Orientation:** The vertical axis represents height, and the two axes at 30 degrees to the horizontal represent width and depth.
- **Isometric Scale:** While true lengths are foreshortened, it's common practice to draw lines along the isometric axes at their true lengths. This simplifies construction, even though it technically results in a slightly distorted representation.
- **Non-Isometric Lines:** Lines that are not parallel to the isometric axes must be located by measuring their endpoints along the isometric axes.
- **Circles and Arcs:** Circles appear as ellipses in isometric drawings. Ellipse templates specifically designed for isometric drawings (typically with an ellipse angle of 35°16') are used to draw these ellipses accurately.
- **Hidden Lines:** Hidden lines are generally omitted in isometric drawings to avoid clutter and maintain clarity. If necessary, they should be used sparingly.
- **Dimensioning:** Dimensioning isometric drawings can be challenging. Dimensions should be placed outside the object whenever possible and should be aligned with the isometric axes. Use extension lines and dimension lines to clearly indicate the extent of the dimension.
- **Title Block and Notes:** Include a title block with essential information and any necessary notes to clarify the drawing.

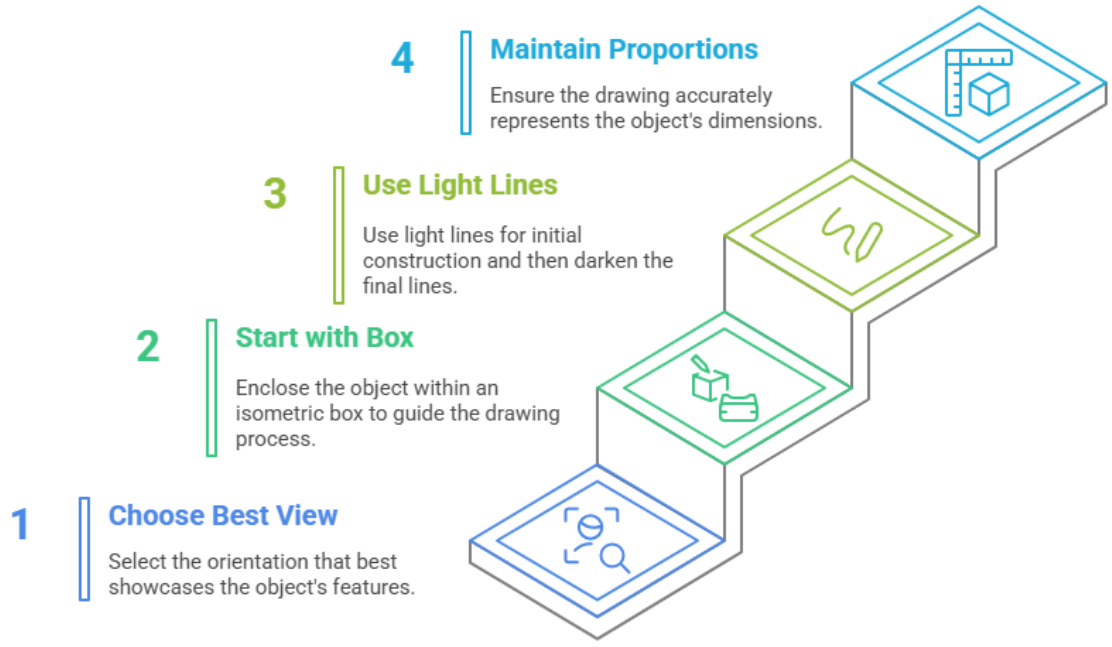
Best Practices:

- **Choose the Best View:** Select the orientation that best showcases the object's features.
- **Start with a Box:** Enclose the object within an isometric box to help guide the drawing process.
- **Use Light Construction Lines:** Use light lines for initial construction and then darken the final lines.
- **Maintain Proportions:** Pay

Isometric Drawing Standards and Conventions

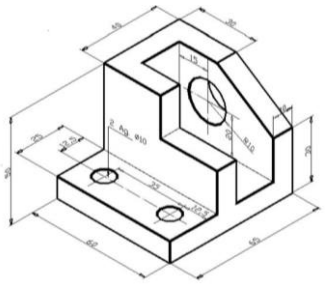


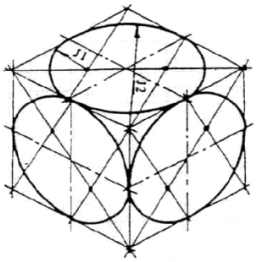
Steps to Create an Isometric Drawing



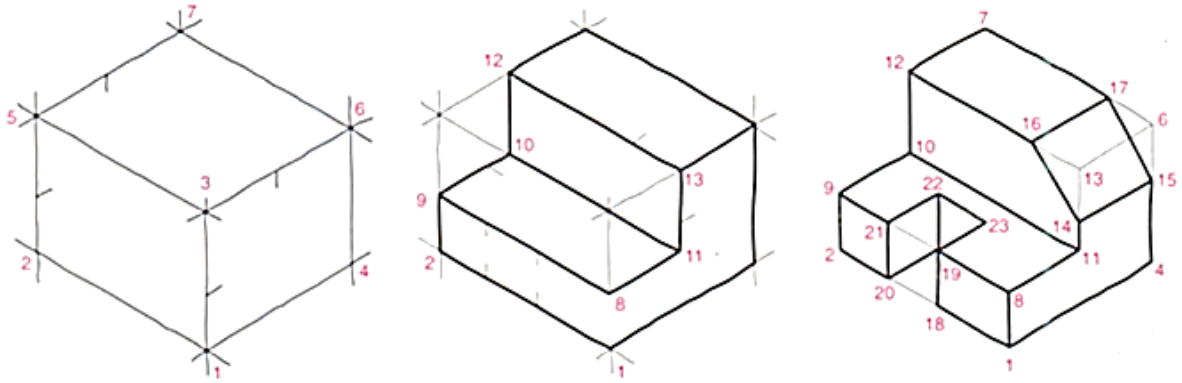
ISOMETRIC

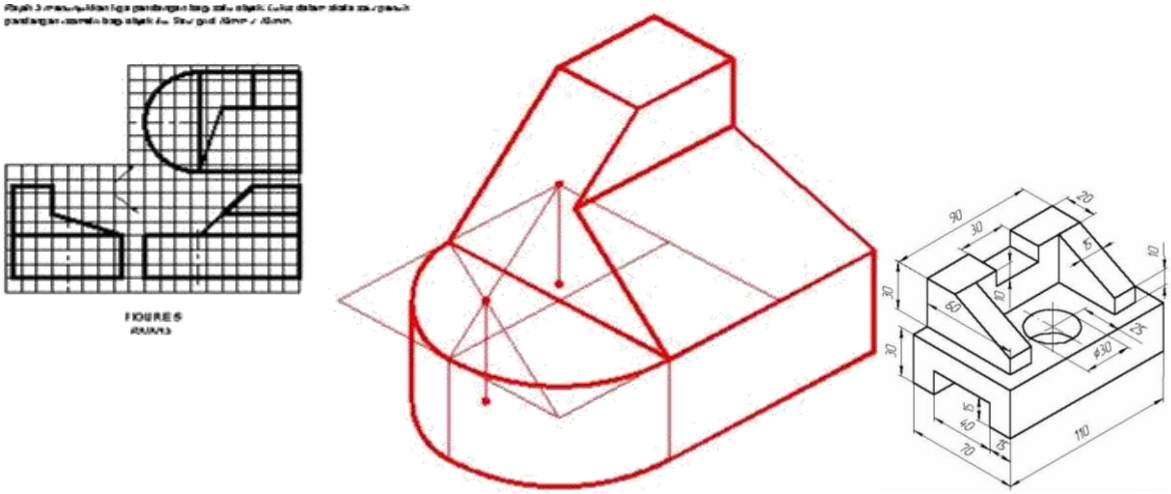
notes, question and answer,

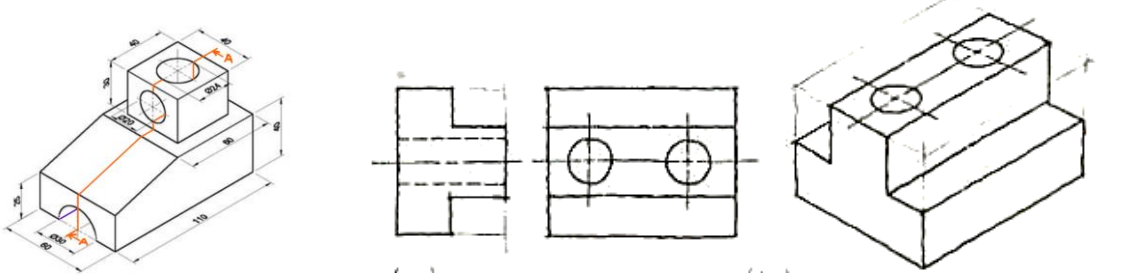




How to draw →





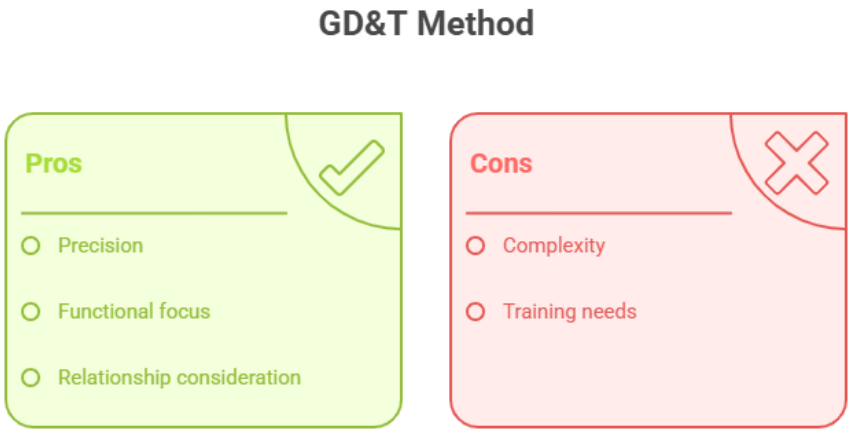


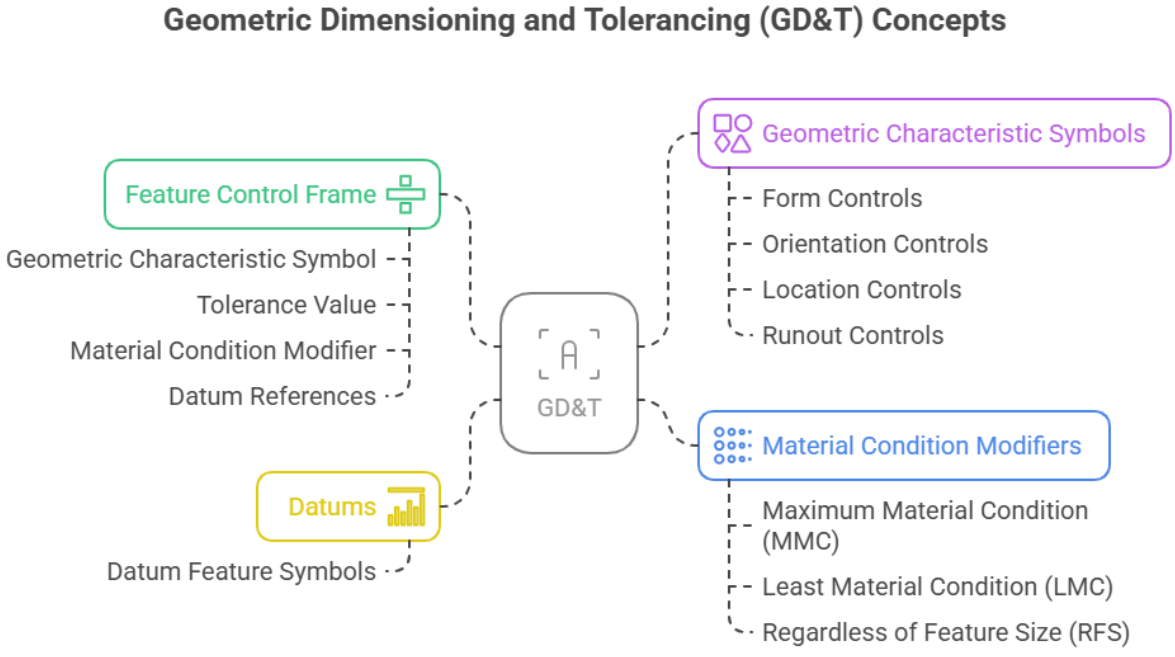
Topic 4

Geometric Dimensioning and Tolerance

4.0 Geometric Dimensioning and Tolerancing (GD&T)

Geometric Dimensioning and Tolerancing (GD&T) is a symbolic language used on engineering drawings and models to precisely define the allowable variation in the form, orientation, and location of part features. It's a more precise method than traditional coordinate dimensioning because it considers the function and relationship of part features.

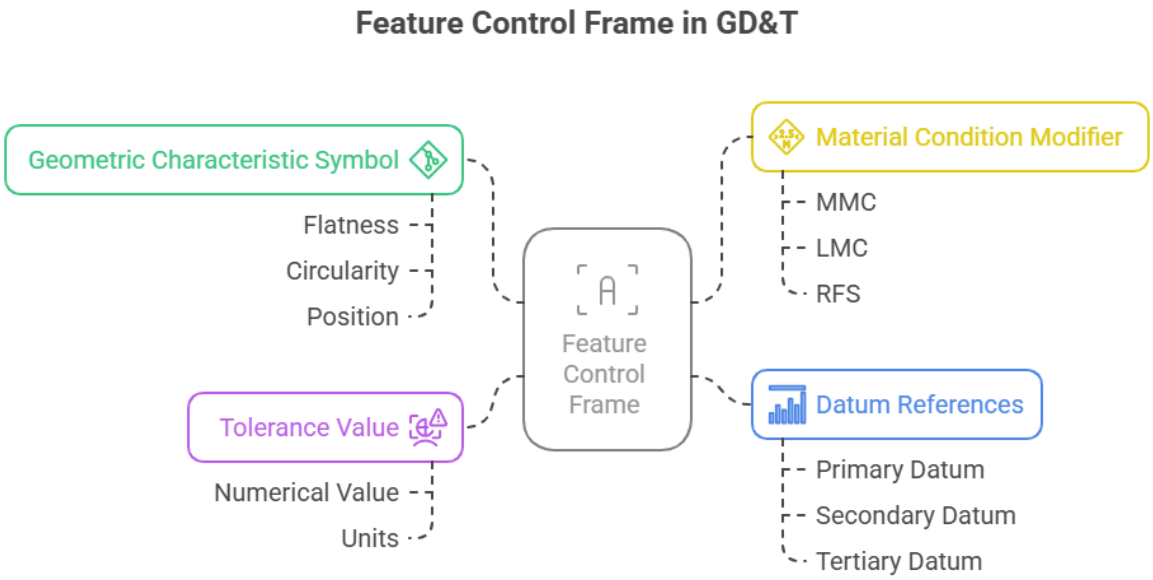




4.1 Standard Geometric Dimensioning for Technical Drawing

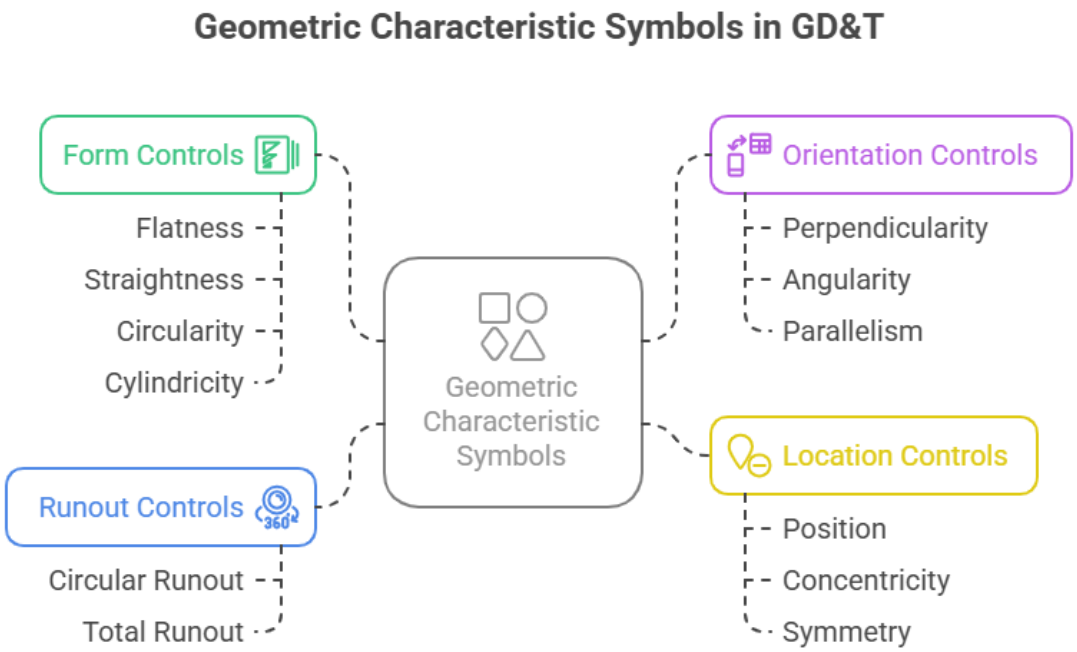
Standard geometric dimensioning involves using symbols and feature control frames to specify geometric controls. Here's a breakdown of key elements:

- **Feature Control Frame:** This is the foundation of GD&T. It's a rectangular box divided into compartments that contain:
    - **Geometric Characteristic Symbol:** Indicates the type of geometric control being applied (e.g., flatness, circularity, position).
    - **Tolerance Value:** Specifies the permissible variation in the feature's geometry.
    - **Material Condition Modifier (MMC, LMC, RFS):** Modifies the tolerance based on the feature's size.
    - **Datum References:** Establishes a reference frame from which the feature's location or orientation is measured.



- **Geometric Characteristic Symbols:** These symbols represent different types of geometric controls:
    - **Form Controls:** Control the shape of a feature independently of any datum reference. Examples include:
        - **Flatness:** Controls how flat a surface must be.
        - **Straightness:** Controls how straight a line element must be.
        - **Circularity (Roundness):** Controls how close a feature is to a perfect circle.
        - **Cylindricity:** Controls how close a feature is to a perfect cylinder.

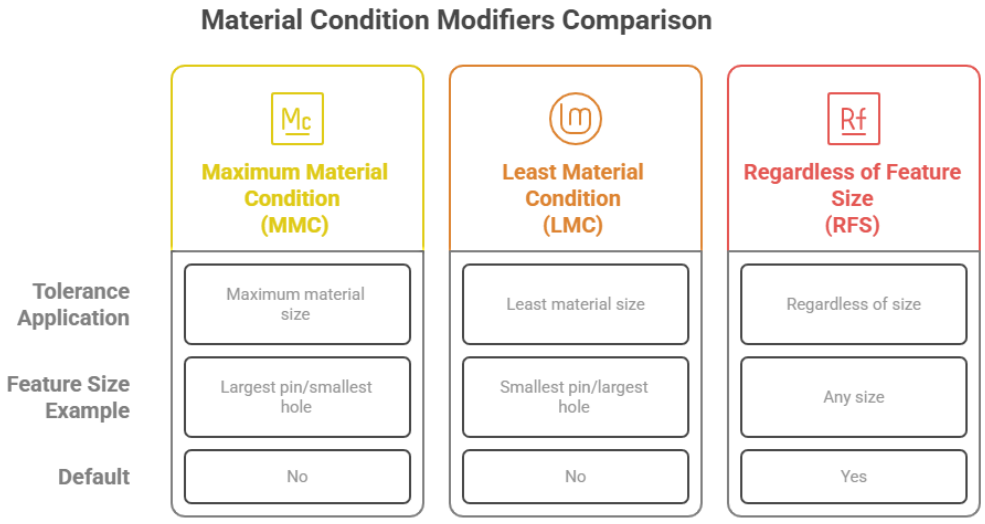
- **Orientation Controls:** Control the orientation of a feature relative to one or more datums. Examples include:
    - **Perpendicularity:** Controls how perpendicular a feature is to a datum.
    - **Angularity:** Controls how angular a feature is to a datum.
    - **Parallelism:** Controls how parallel a feature is to a datum.
- **Location Controls:** Control the location of a feature relative to one or more datums. Examples include:
    - **Position:** Controls the location of a feature within a specified tolerance zone.
    - **Concentricity:** Controls how concentric two or more features are.
    - **Symmetry:** Controls how symmetrical a feature is about a datum.
- **Runout Controls:** Controls the cumulative variation of a surface or feature as it is rotated about an axis. Examples include:
    - **Circular Runout:** Controls the variation of a circular feature as it is rotated about an axis.
    - **Total Runout:** Controls the total variation of a surface as it is rotated about an axis.
- **Datums:** These are theoretically exact points, lines, or planes used as references for establishing the location and orientation of other features. Datums are identified on the drawing with datum feature symbols (a letter enclosed in a box).



Geometric Controls Comparison

Characteristic	Form Controls	Orientation Controls	Location Controls	Runout Controls
Description	Shape control, no datum reference	Orientation relative to datums	Location relative to datums	Cumulative variation during rotation
Flatness	Yes	No	No	No
Straightness	Yes	No	No	No
Circularity	Yes	No	No	Yes
Cylindricity	Yes	No	No	No
Perpendicularity	No	Yes	No	No
Angularity	No	Yes	No	No
Parallelism	No	Yes	No	No
Position	No	No	Yes	No
Concentricity	No	No	Yes	No
Symmetry	No	No	Yes	No
Total Runout	No	No	No	Yes

- **Material Condition Modifiers:** These modifiers affect the tolerance zone based on the actual size of the feature:
    - **Maximum Material Condition (MMC):** Specifies that the tolerance applies when the feature is at its maximum material size (e.g., largest pin, smallest hole).
    - **Least Material Condition (LMC):** Specifies that the tolerance applies when the feature is at its least material size (e.g., smallest pin, largest hole).
    - **Regardless of Feature Size (RFS):** Specifies that the tolerance applies regardless of the actual size of the feature. This is the default if no modifier is specified.

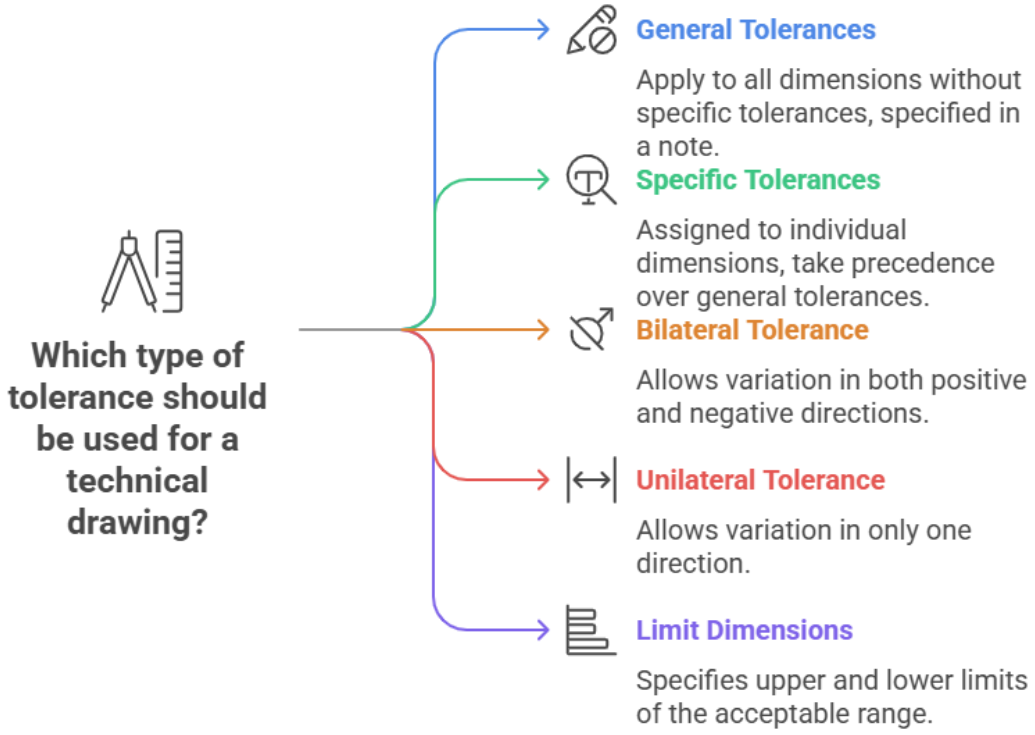


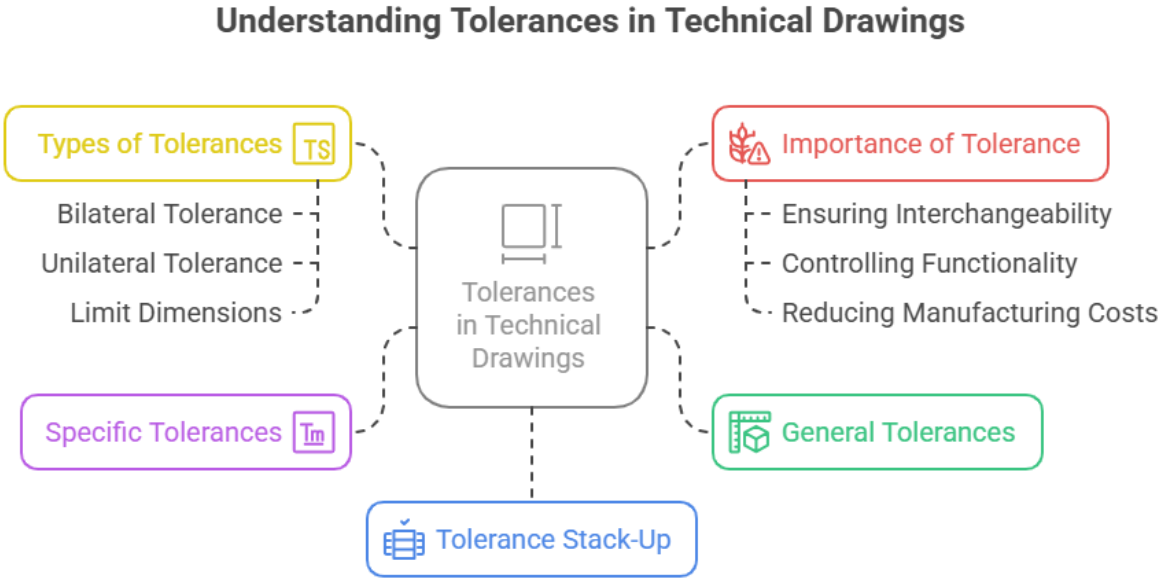
4.2 The Tolerance for Technical Drawing

Tolerance is the permissible variation in a dimension or geometric characteristic. It defines the acceptable range of deviation from the specified nominal value.

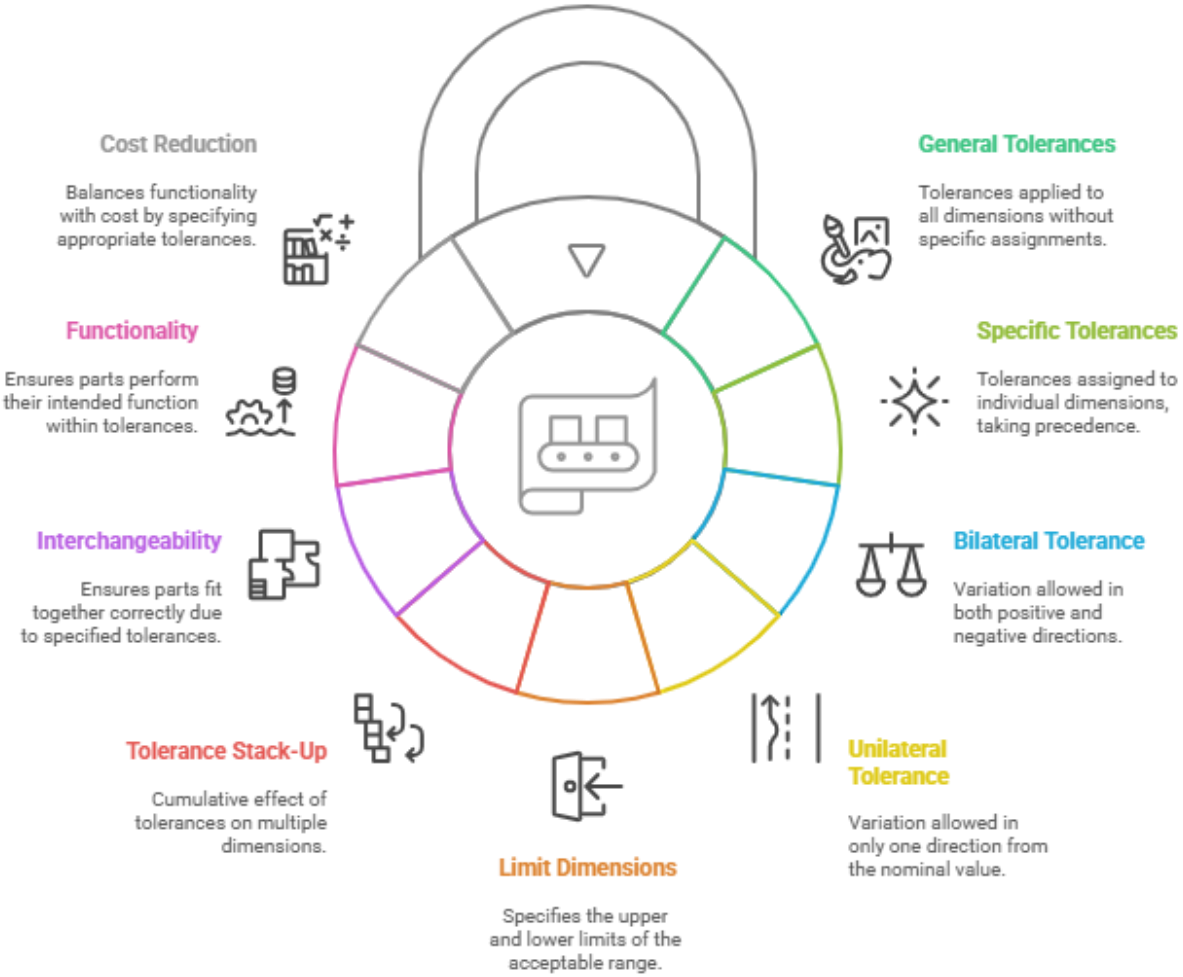
- **General Tolerances:** These are tolerances that apply to all dimensions on a drawing that do not have specific tolerances assigned. General tolerances are typically specified in a note on the drawing.
- **Specific Tolerances:** These are tolerances that are specifically assigned to individual dimensions or geometric characteristics. Specific tolerances take precedence over general tolerances.
- **Types of Tolerances:**
    - **Bilateral Tolerance:** Allows variation in both positive and negative directions from the nominal value (e.g., 1.000 ± 0.005).
    - **Unilateral Tolerance:** Allows variation in only one direction from the nominal value (e.g., 1.000 +0.000/-0.010).
    - **Limit Dimensions:** Specifies the upper and lower limits of the acceptable range (e.g., 1.005 / 0.995).
- **Tolerance Stack-Up:** This refers to the cumulative effect of tolerances on multiple dimensions in a chain. It's crucial to consider tolerance stack-up during design to ensure that the final assembly meets its functional requirements.
- **Importance of Tolerance:** Proper tolerancing is essential for:
    - **Ensuring Interchangeability:** Parts manufactured to the specified tolerances will fit together correctly.

- **Controlling Functionality:** Tolerances ensure that the part performs its intended function.
- **Reducing Manufacturing Costs:** Tighter tolerances generally increase manufacturing costs. Specifying appropriate tolerances balances functionality with cost.

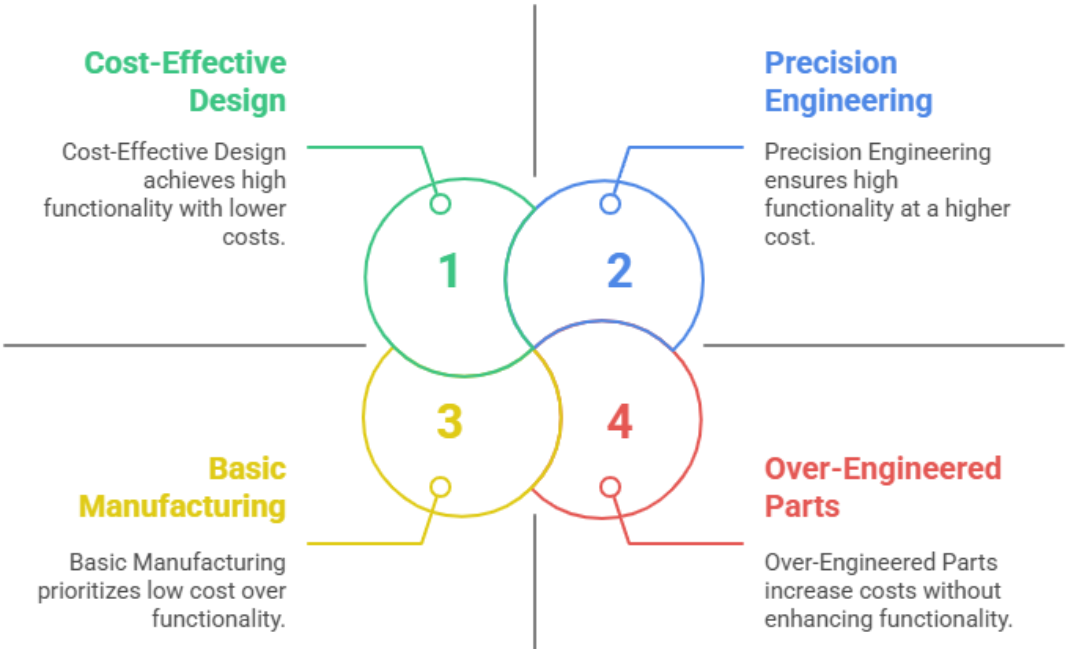




Foundations of Tolerance in Engineering



Balancing Tolerances in Manufacturing



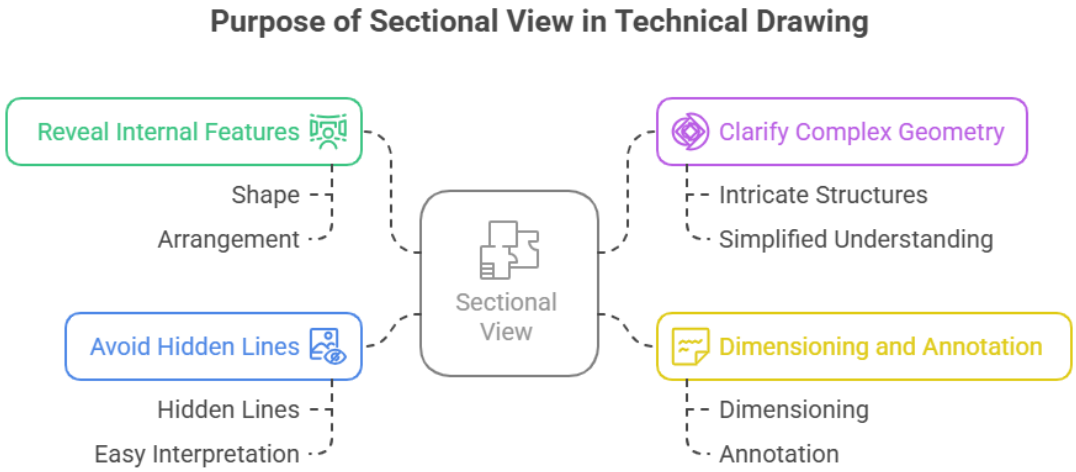
Topic 5
Sectional View

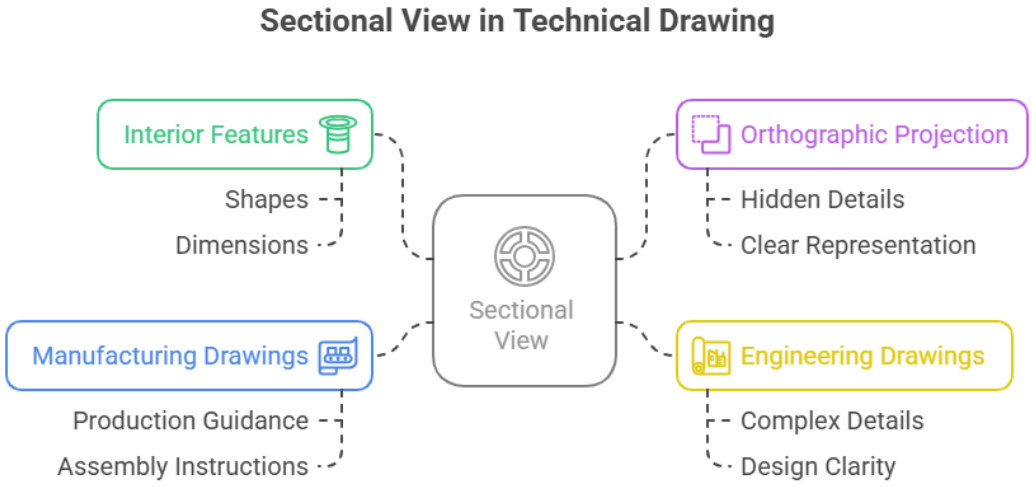
5.0 Sectional View

A sectional view, also known as a section, is a drawing technique used to reveal the interior features of an object by imagining it cut along a plane. This allows for a clearer representation of internal shapes, dimensions, and relationships that would otherwise be hidden in a standard orthographic projection. Sectional views are crucial for conveying complex internal details in engineering and manufacturing drawings.

The primary purpose of a sectional view is to:

- **Reveal Internal Features:** Show the shape and arrangement of internal parts that are not visible from the outside.
- **Clarify Complex Geometry:** Simplify the understanding of intricate internal structures.
- **Dimensioning and Annotation:** Provide a clear surface for dimensioning and adding notes about internal features.
- **Avoid Hidden Lines:** Reduce the number of hidden lines in a drawing, making it easier to read and interpret.



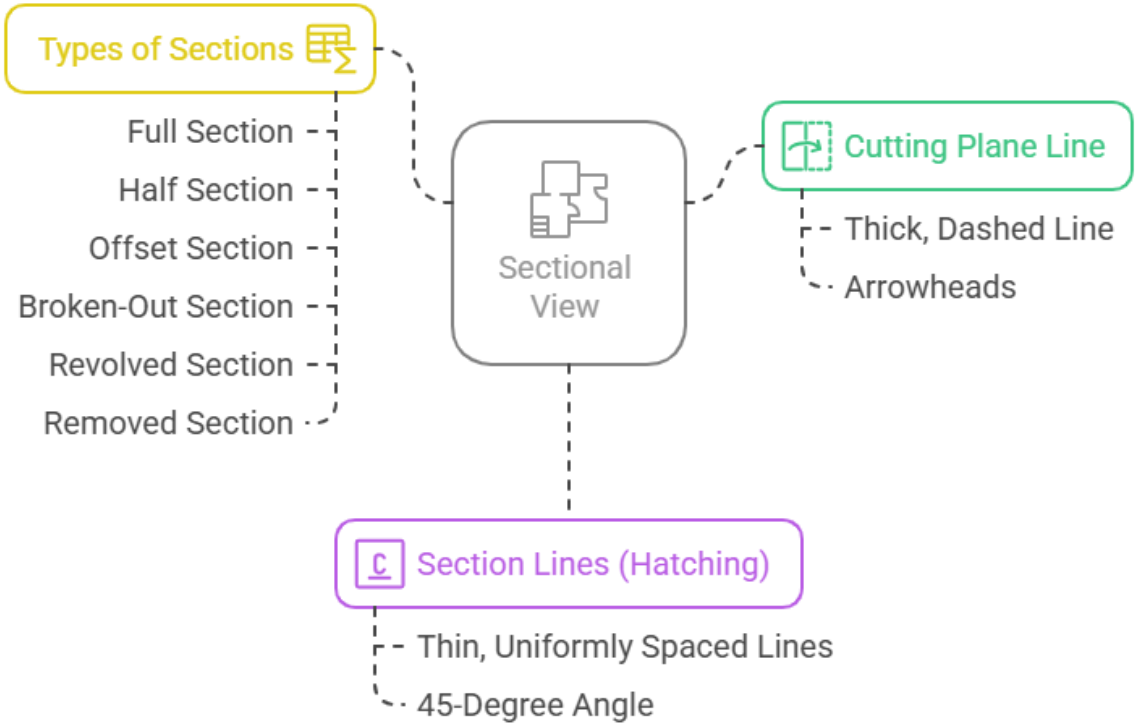


5.1 Sectioning for Technical Drawing

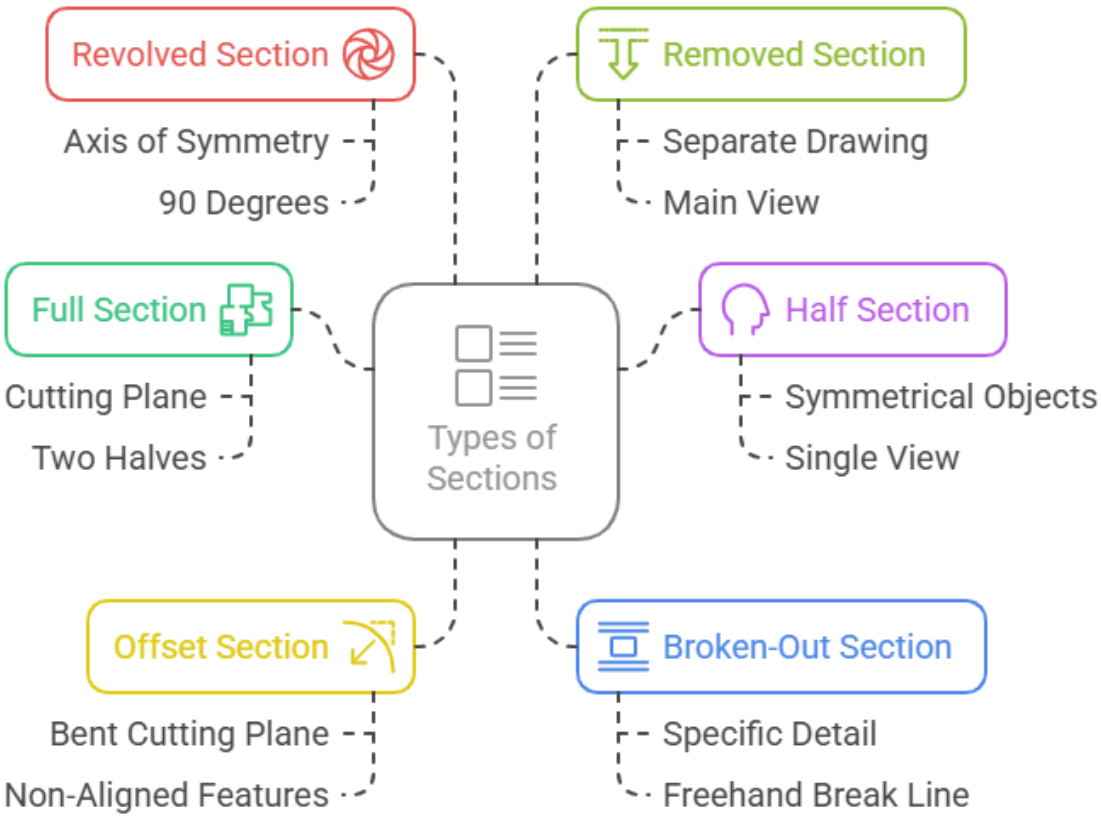
Sectioning involves several key elements:

- **Cutting Plane Line:** This line indicates the location of the imaginary cut. It is a thick, dashed line with arrowheads at each end, pointing in the direction of sight. The arrowheads are labeled with letters (e.g., A-A, B-B) to identify the corresponding sectional view.
- **Section Lines (Hatching):** These lines are used to indicate the surfaces that have been "cut" by the cutting plane. They are thin, uniformly spaced lines drawn at an angle (typically 45 degrees) to the horizontal. The specific pattern of section lines can vary depending on the material being represented.
- **Types of Sections:**
    - **Full Section:** The cutting plane passes entirely through the object, dividing it into two halves.
    - **Half Section:** The cutting plane extends halfway through the object. This is often used for symmetrical objects to show both the internal and external features in a single view.
    - **Offset Section:** The cutting plane is bent or offset to pass through specific features that are not aligned.
    - **Broken-Out Section:** Only a portion of the object is sectioned to reveal a specific internal detail. The boundary of the sectioned area is indicated by a freehand break line.
    - **Revolved Section:** A section is created by revolving a feature 90 degrees about an axis of symmetry and superimposing it on the view.
    - **Removed Section:** Similar to a revolved section, but the section is drawn separately from the main view.

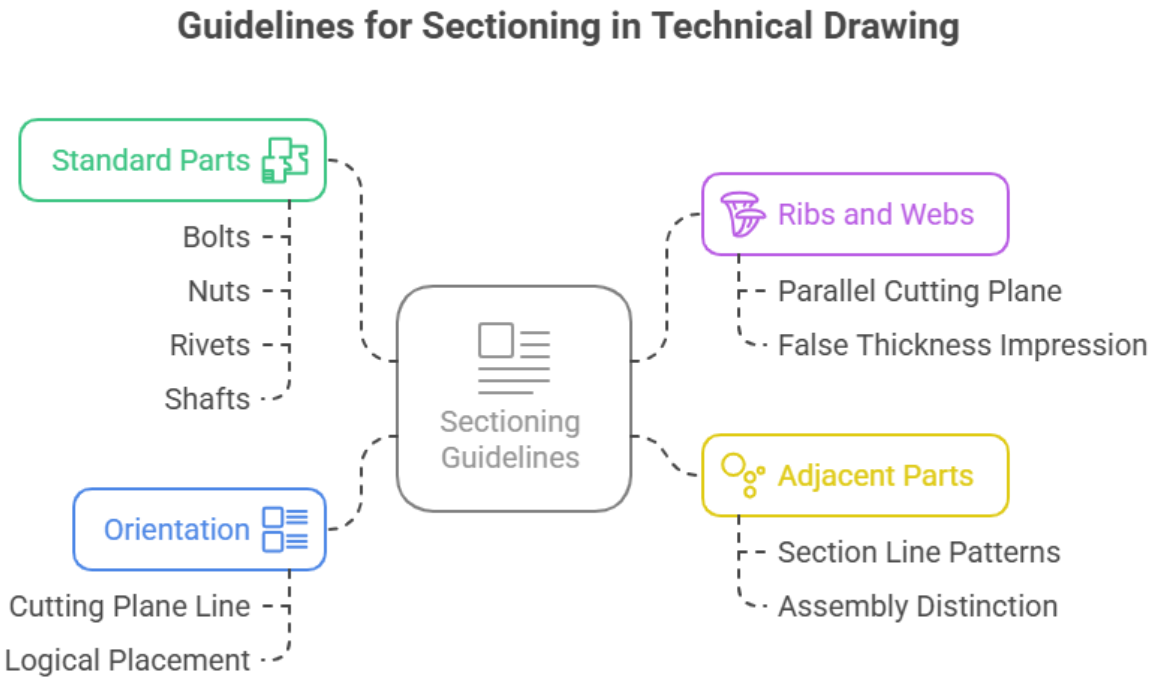
Sectional View Elements and Types



Types of Sections in Technical Drawings



- **Avoid Sectioning Standard Parts:** Standard parts like bolts, nuts, rivets, and shafts are generally not sectioned, even if the cutting plane passes through them. This is to avoid giving the impression that they are solid.
- **Ribs and Webs:** Thin features like ribs and webs are typically not sectioned if the cutting plane passes through them parallel to their length. This is to avoid giving a false impression of thickness.
- **Adjacent Parts:** When sectioning an assembly, different section line patterns should be used for adjacent parts to distinguish them.
- **Orientation:** The cutting plane line should be clearly visible and labeled. The sectional view should be placed in a logical position relative to the other views.



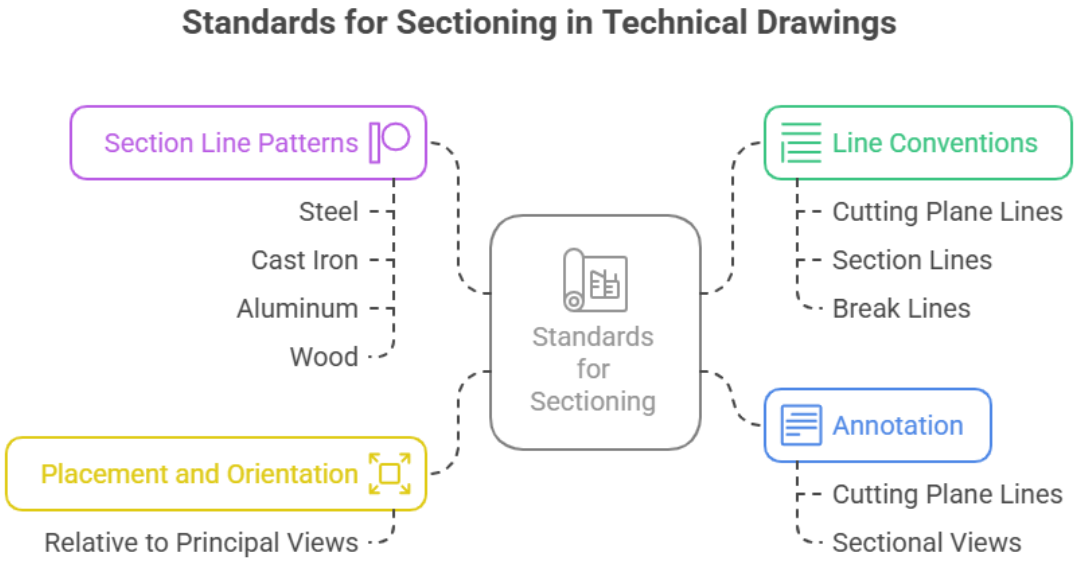
5.2 Sectioning for Technical Drawing According to Standard

Several standards govern the creation and interpretation of technical drawings, including those related to sectioning. These standards ensure consistency and clarity in communication. Common standards include:

- **ANSI (American National Standards Institute):** Defines standards for technical drawings in the United States.
- **ISO (International Organization for Standardization):** Develops international standards for a wide range of industries, including engineering.
- **DIN (Deutsches Institut für Normung):** The German national standards organization.

Key aspects covered by these standards in relation to sectioning include:

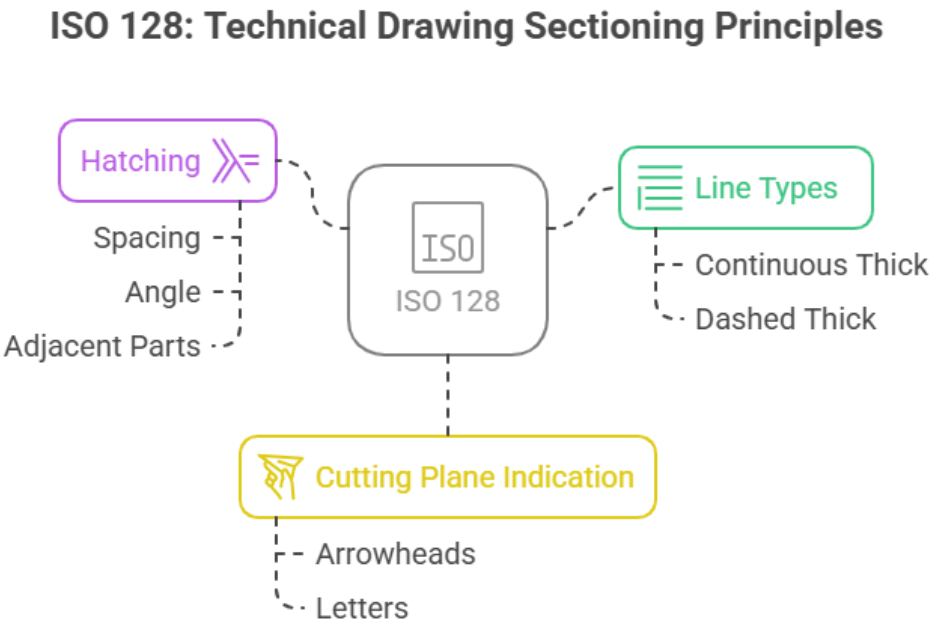
- **Line Conventions:** Specifies the types of lines to be used for cutting plane lines, section lines, and break lines, including their thickness and style.
- **Section Line Patterns:** Defines the standard patterns for different materials, such as steel, cast iron, aluminum, and wood. While specific patterns may vary, the principle of using different patterns for adjacent parts remains consistent.
- **Placement and Orientation:** Provides guidelines for the placement and orientation of sectional views relative to the principal views.
- **Annotation:** Specifies the requirements for labeling cutting plane lines and sectional views.



Example of Standard Application (ISO 128):

ISO 128 is a key standard that defines the general principles of presentation in technical drawings. Regarding sectioning, it specifies:

- **Line Types:** Defines the specific line types (e.g., continuous thick, dashed thick) to be used for cutting plane lines and outlines of sectioned areas.
- **Hatching:** Provides guidelines on the spacing and angle of hatching lines. It also emphasizes the importance of using different hatching patterns for adjacent parts.
- **Cutting Plane Indication:** Specifies how the cutting plane line should be drawn, including the use of arrowheads and letters to identify the corresponding sectional view.

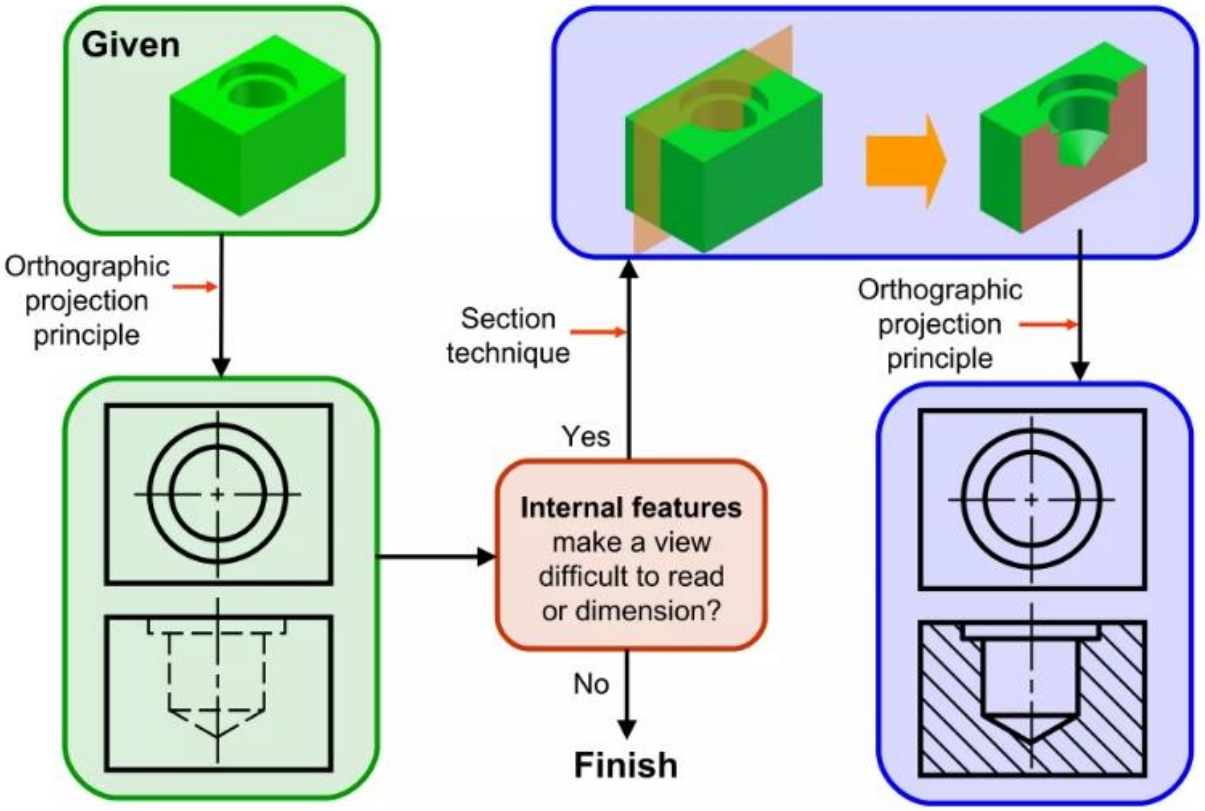


Importance of Adhering to Standards:

- **Clarity and Consistency:** Standards ensure that technical drawings are clear, consistent, and easily understood by anyone familiar with the standard.
- **International Communication:** Adhering to international standards facilitates communication and collaboration between engineers and manufacturers in different countries.
- **Reduced Errors:** Consistent application of standards reduces the risk of errors and misinterpretations.

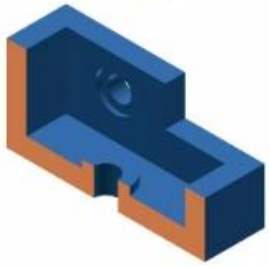
In conclusion, understanding and applying the principles of sectioning, along with adherence to relevant standards, are essential for creating effective and unambiguous technical drawings. This ensures that internal features are clearly communicated, leading to improved design, manufacturing, and communication processes.

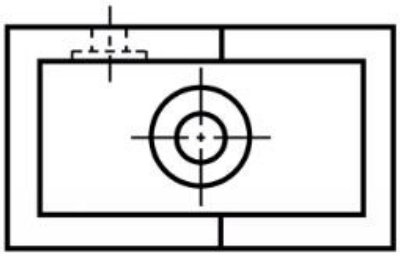
Necessity of a section view



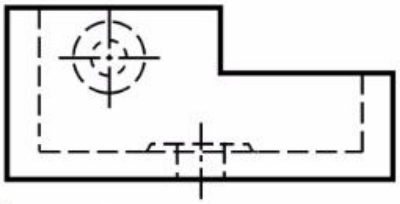
- Clarify an internal feature.
- Facilitate dimensioning.

Example

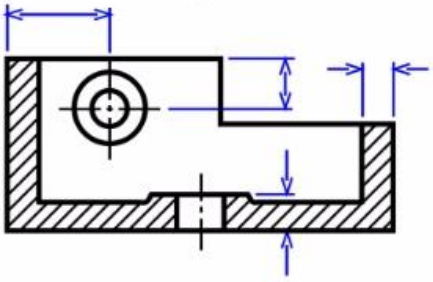


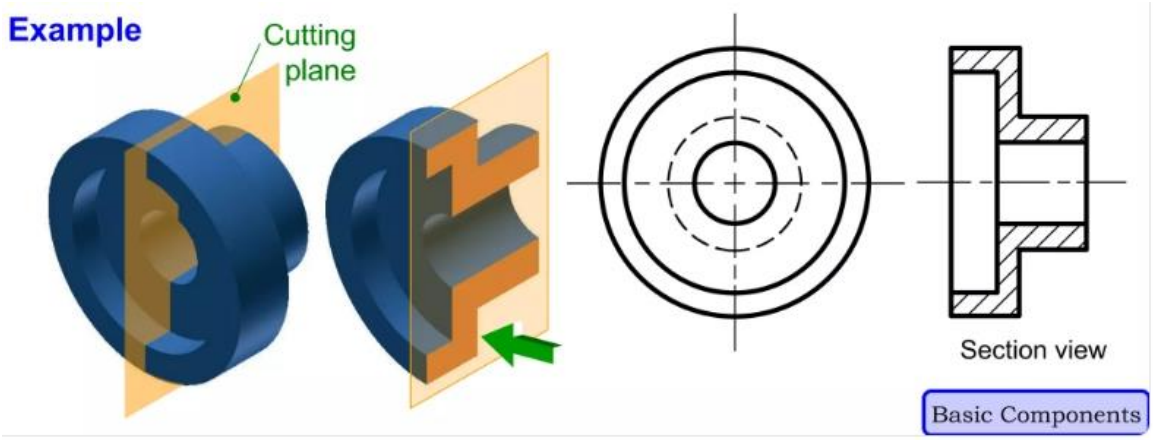


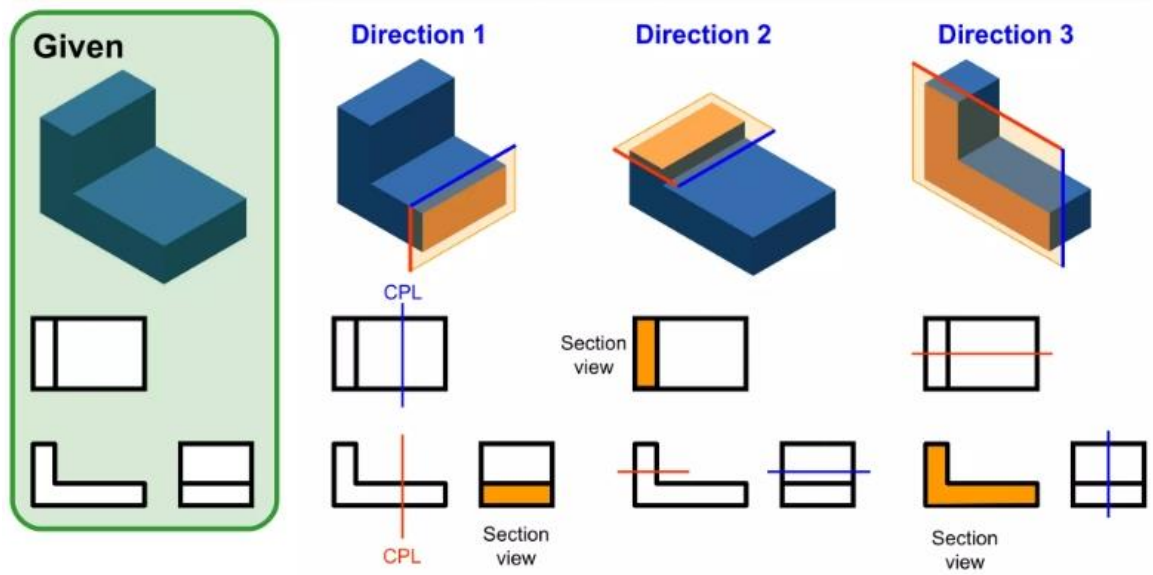
Regular view



Section view

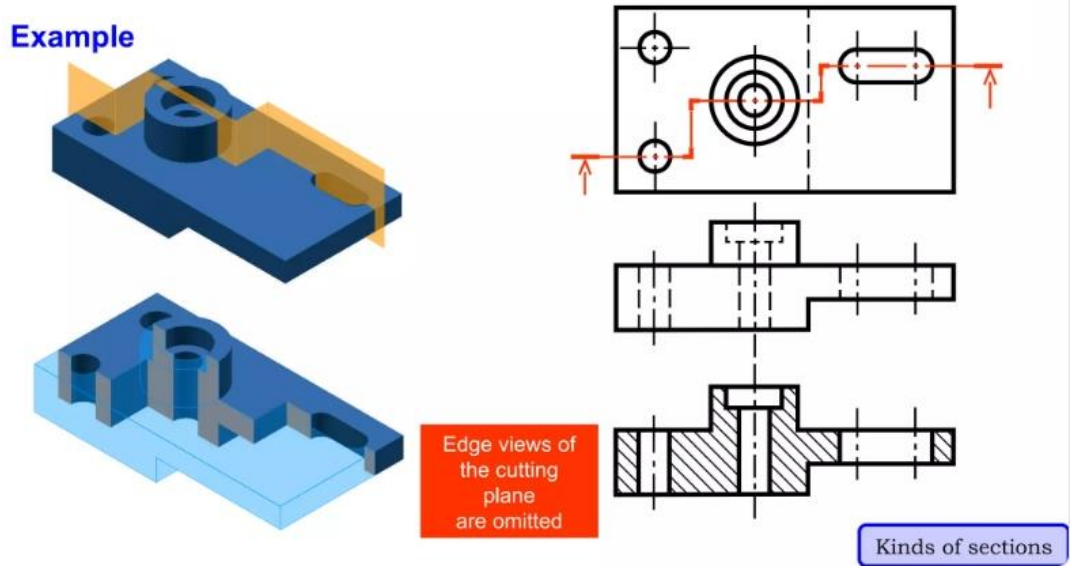






Offset section : Concept & example

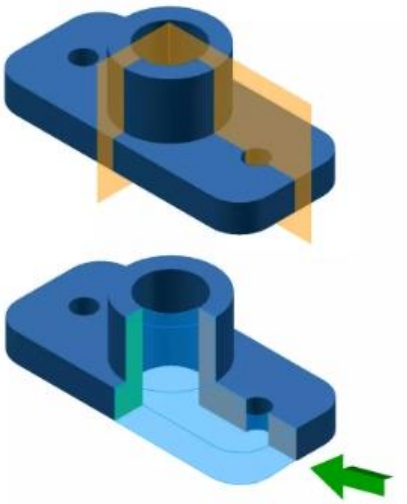
- A section view is made by passing the ***bended*** cutting plane ***completely through*** the part.

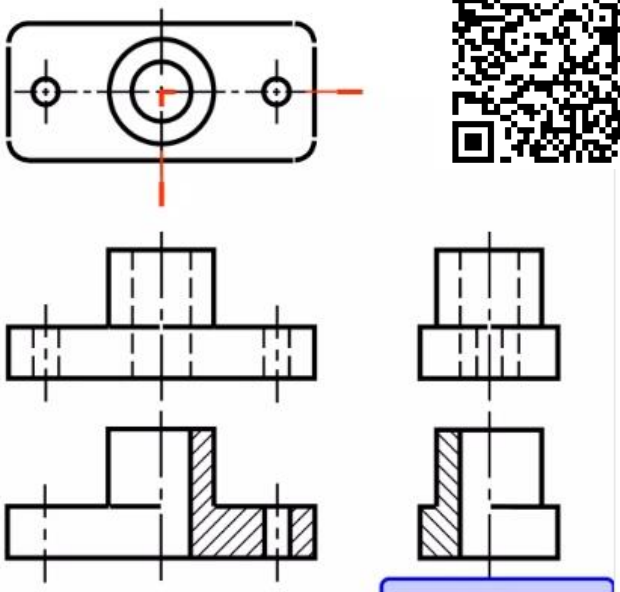


Half section : Concept & example

- A section view is made by passing the cutting plane ***halfway*** through an object and remove a ***quarter*** of it.

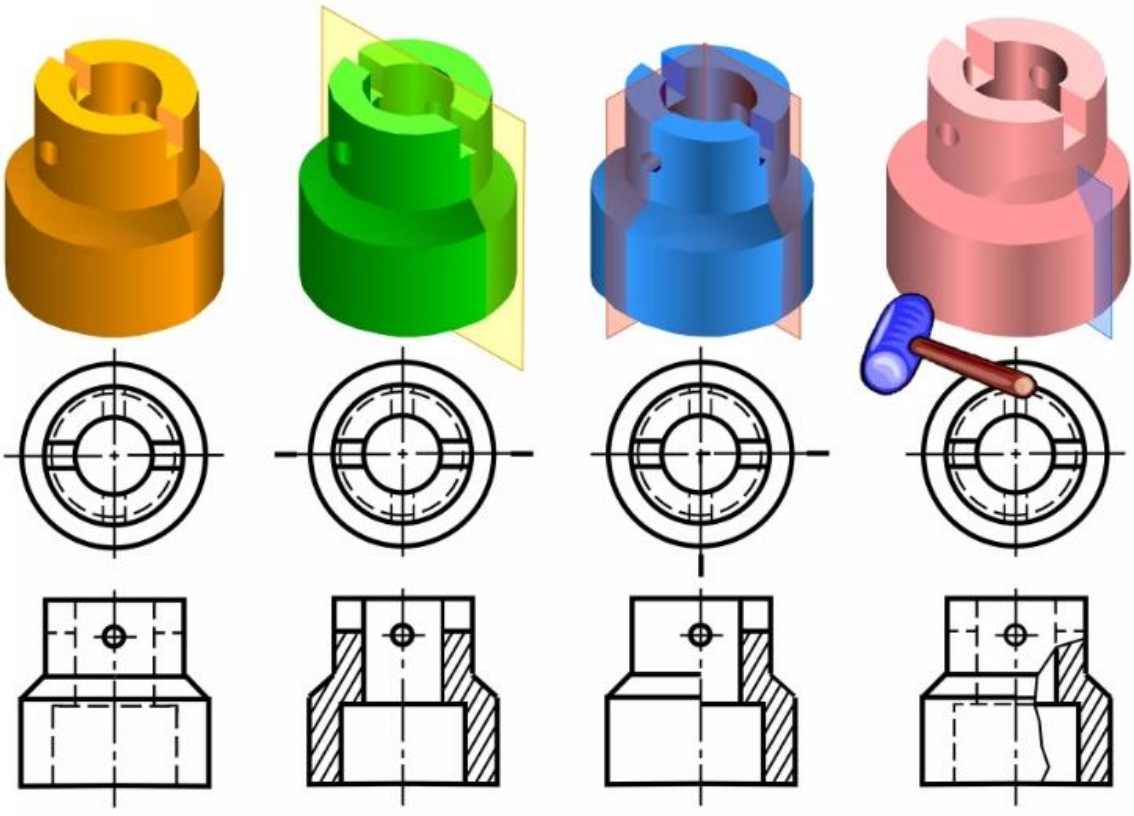
Example

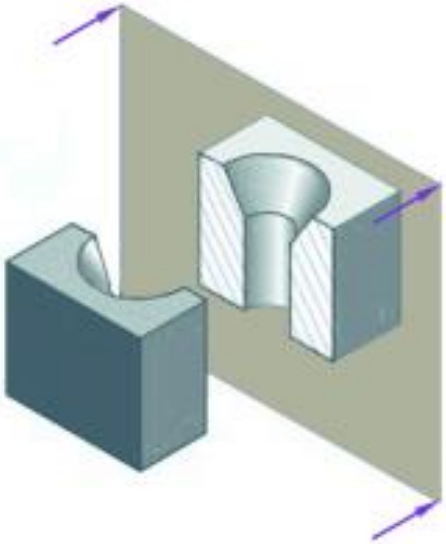


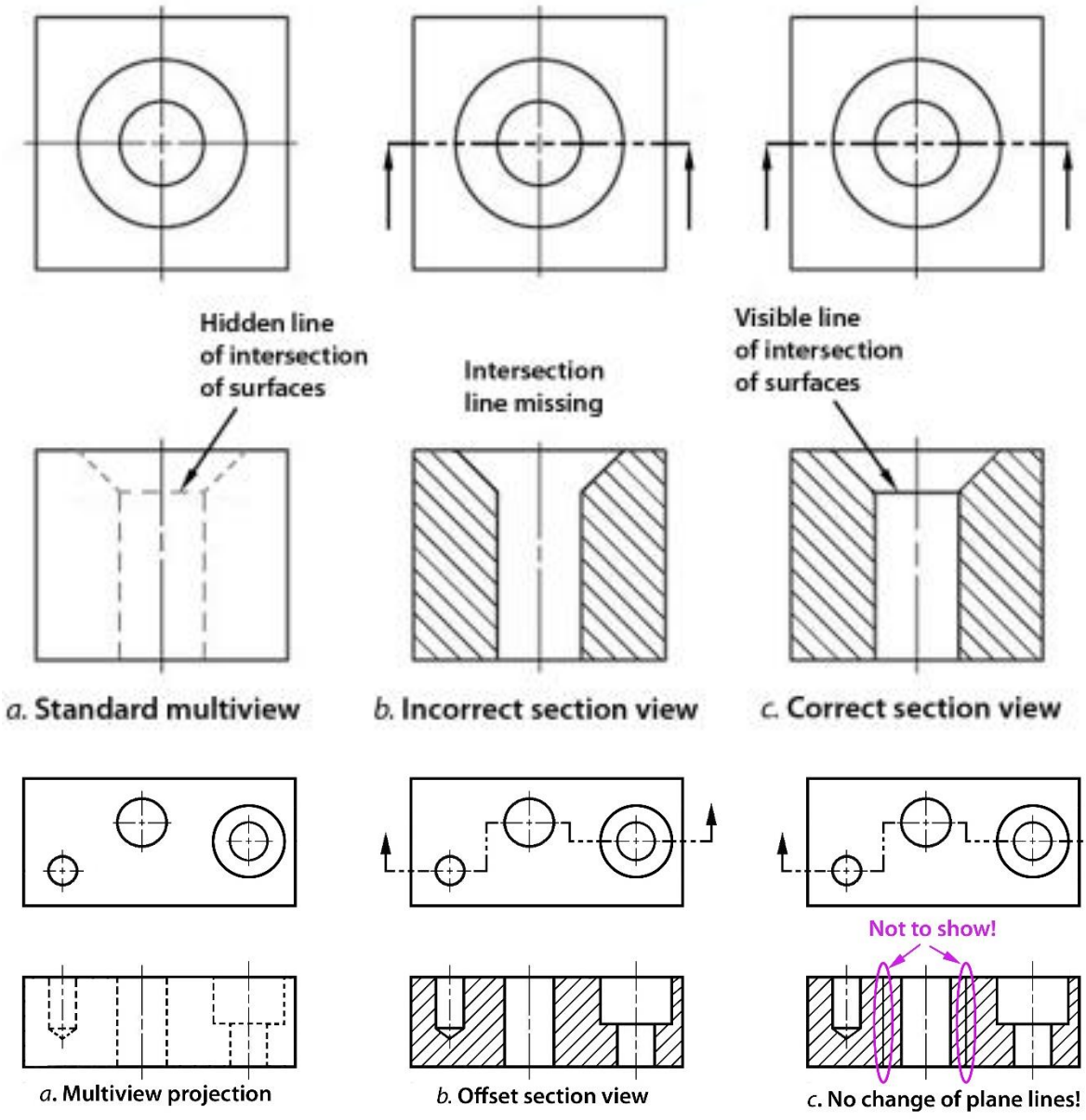


Kinds of sections

Comparison of a different section techniques







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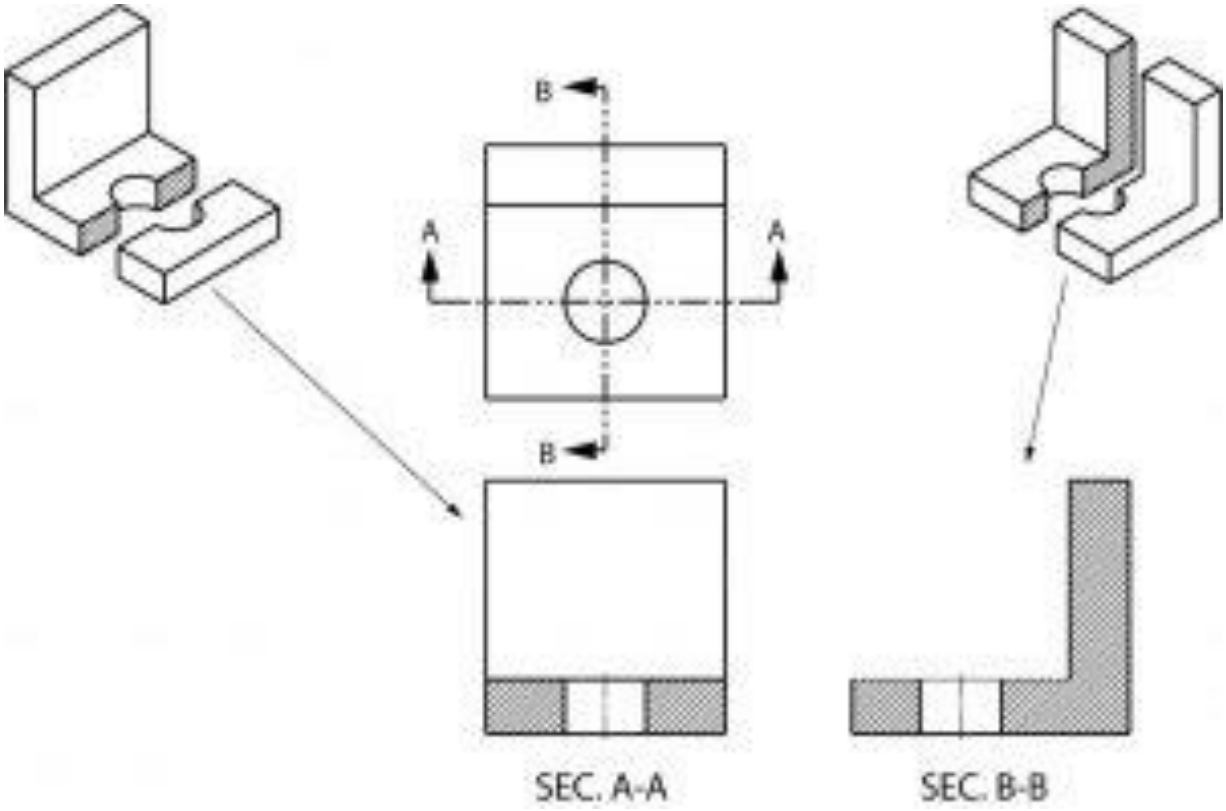
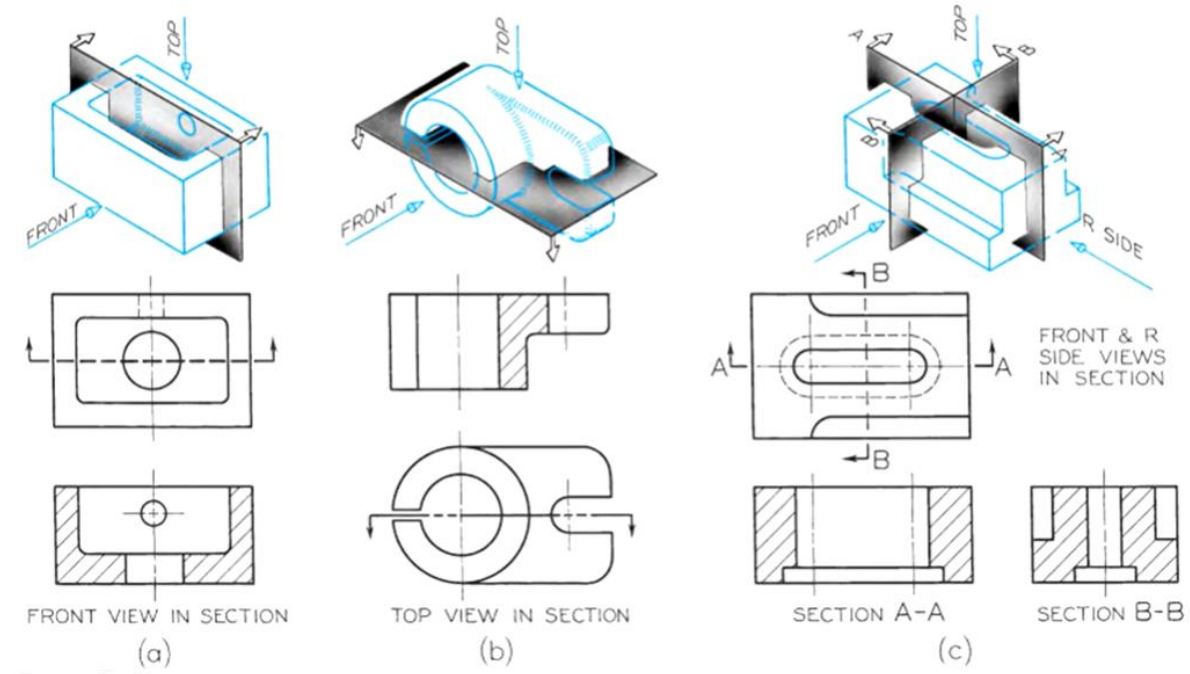
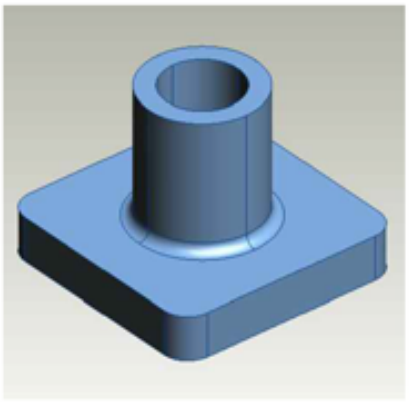


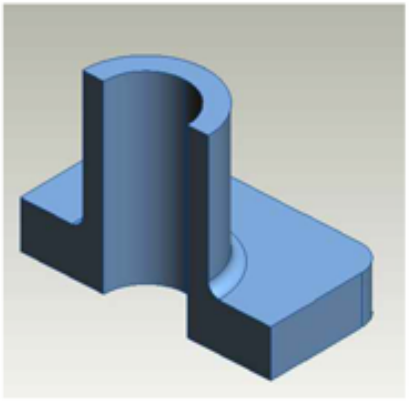


sectional view

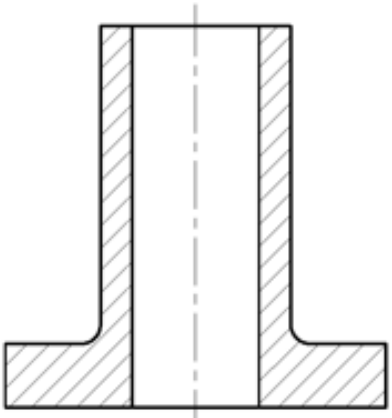
Sectional Views notes

- Sectional views are used in orthographic projection (1st / 3rd angle) to show hidden/internal parts.
- The part between the cutting plane and the viewer is discarded.
- The hatching lines are drawn at 45° for the same component/material.
- In the case of two or more components/materials we use other angles/mirrored hatching.
- RIBS and WEBS sliced across are not sectioned.
- Hidden lines are not drawn in sectional views.

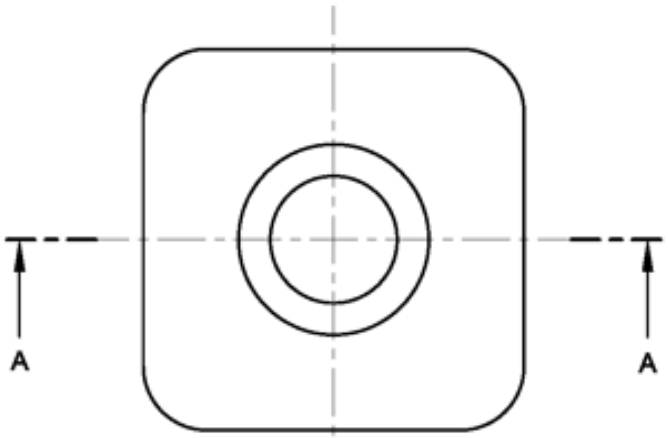




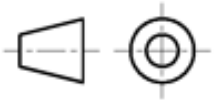
Cross-section view of a pipe bracket

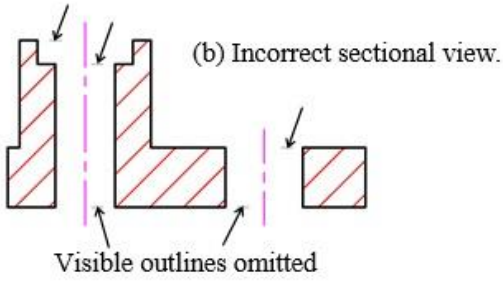


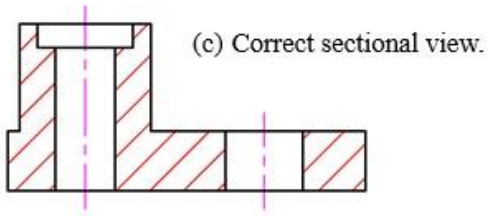
A-A



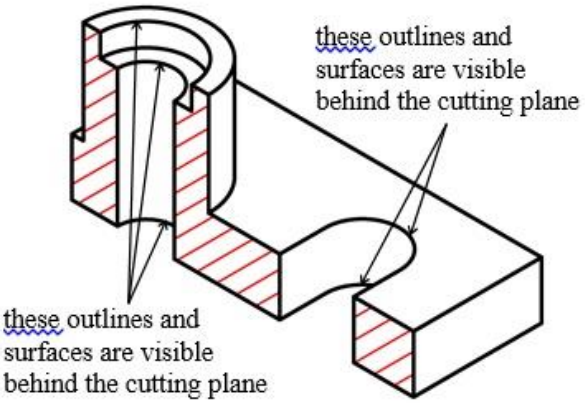
PLAN

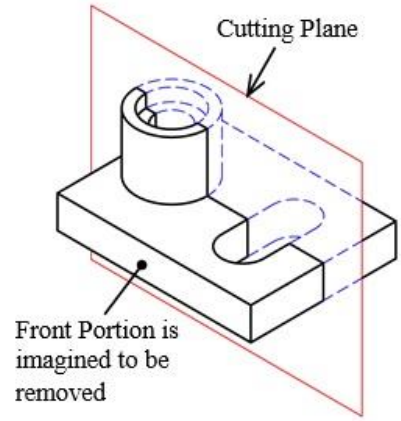




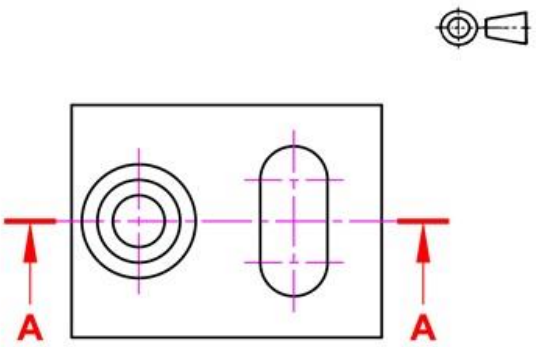


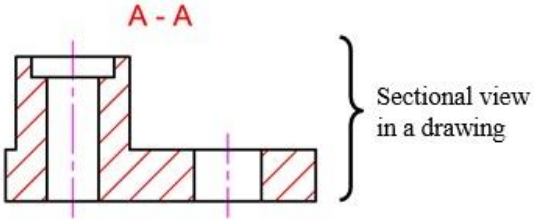
(a)



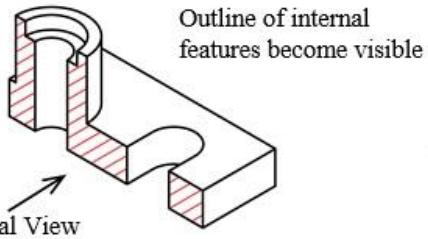


a. Generating a sectional view

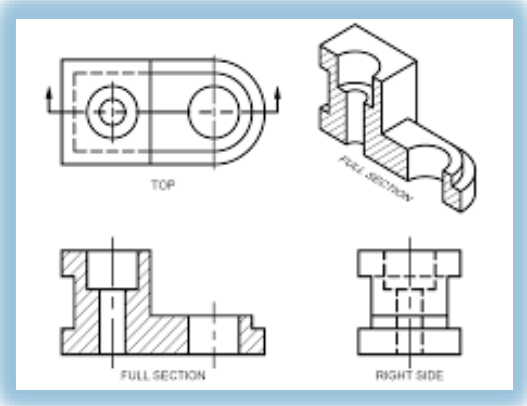


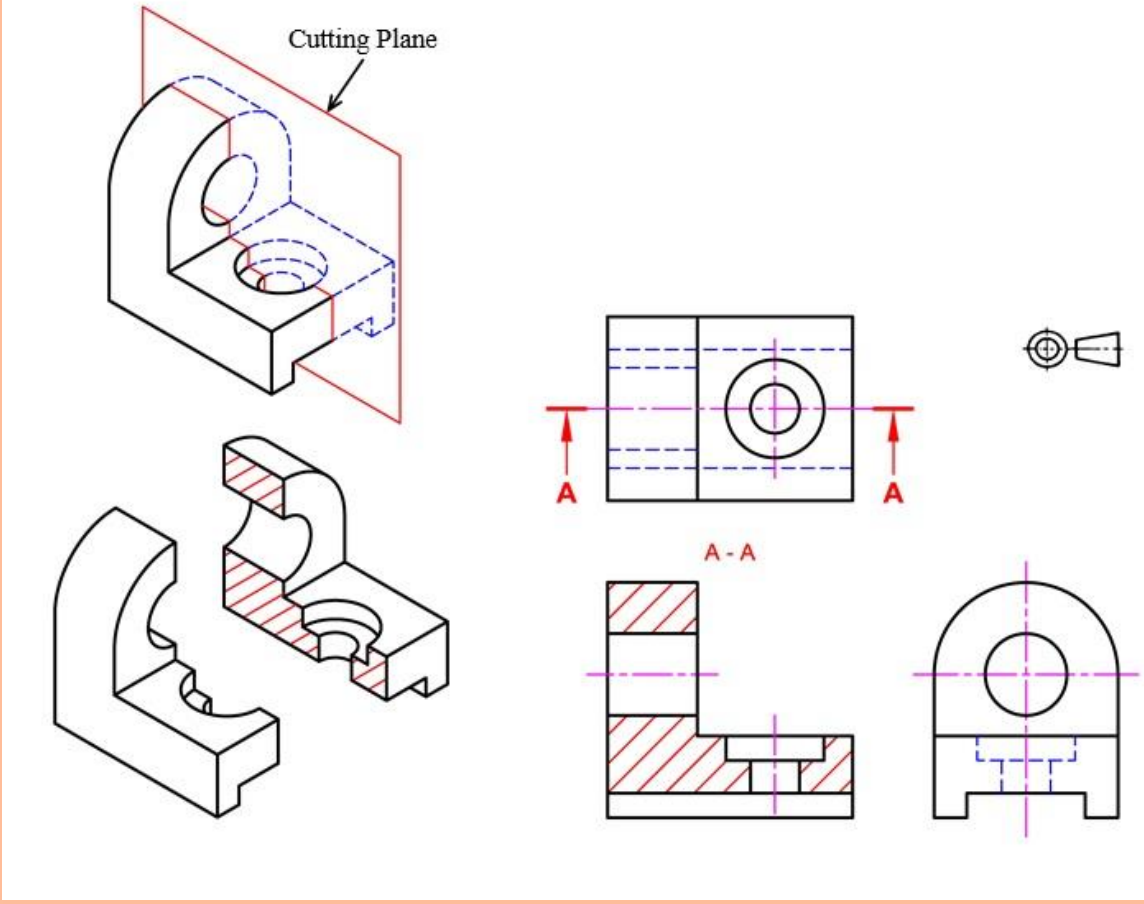


c. Resulting sectional view in a drawing



b. Observing a sectional view





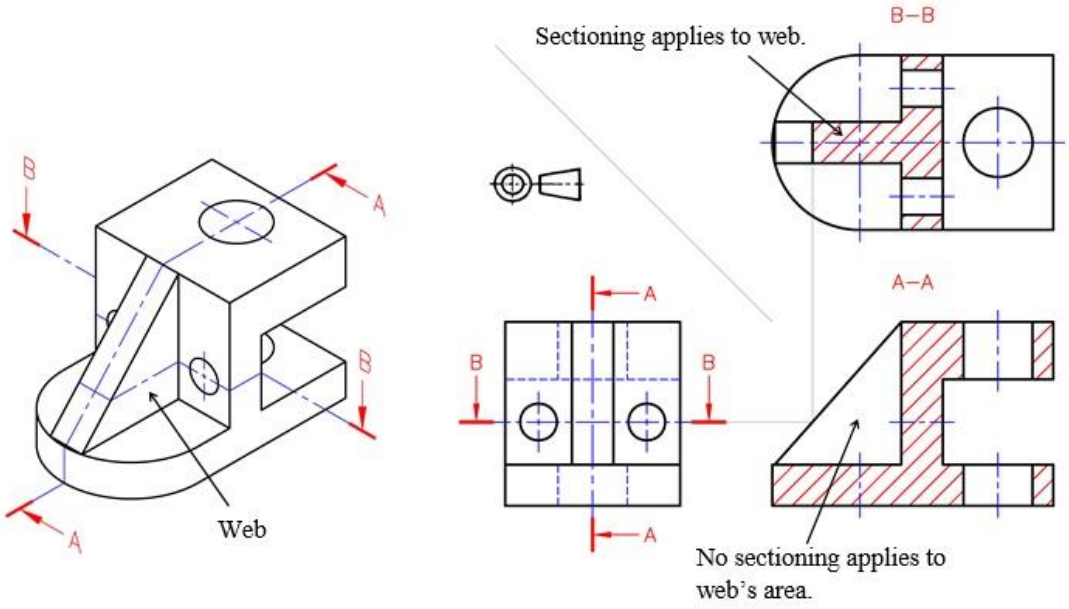
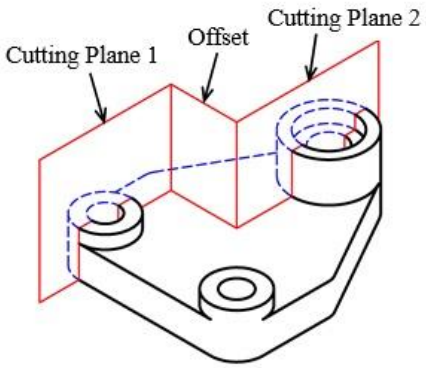
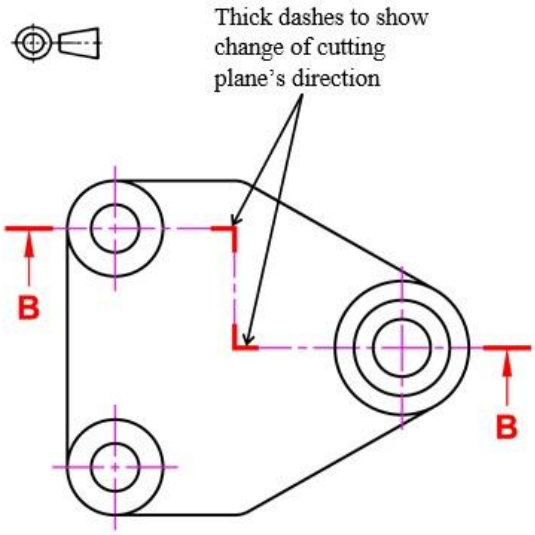
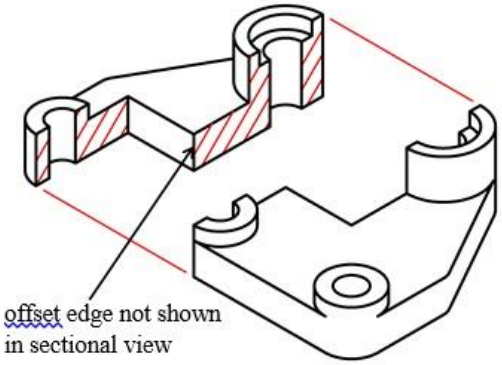
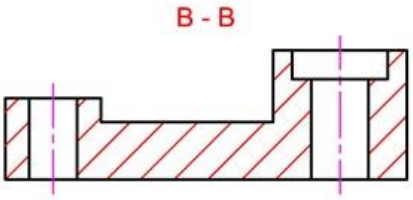


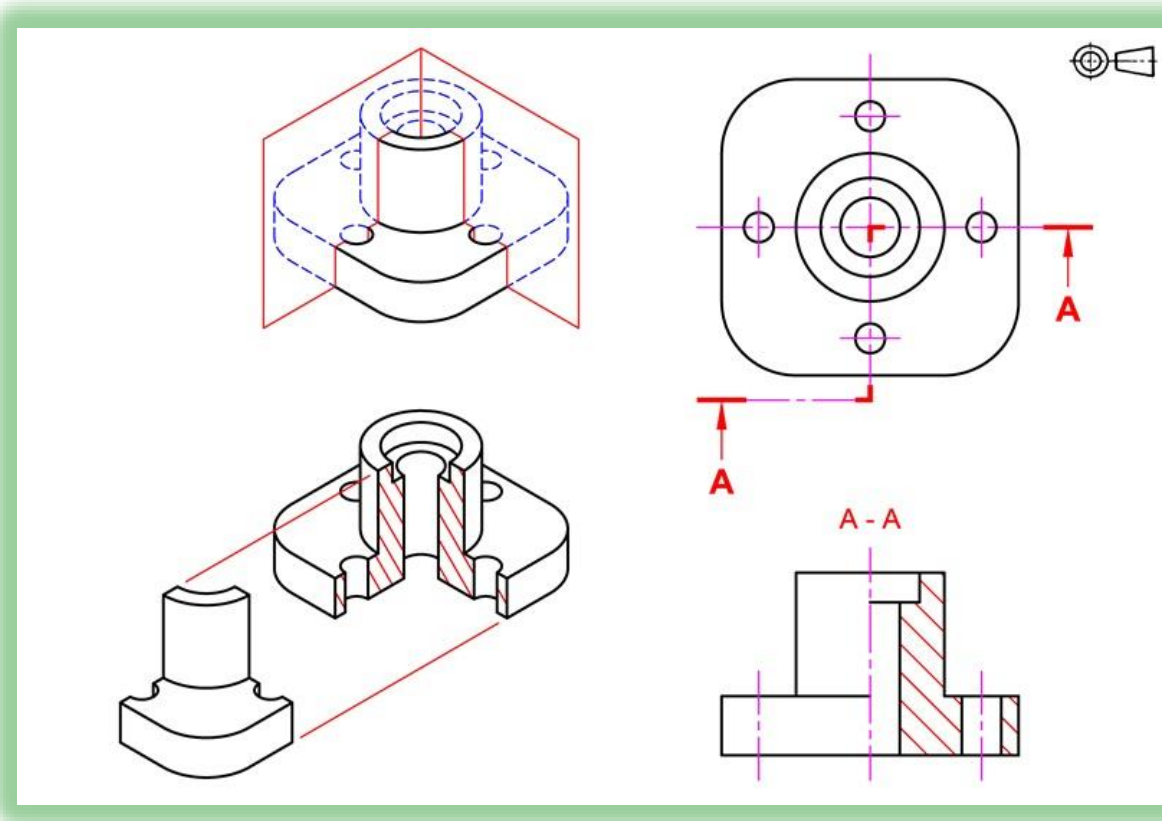
Figure 5.6. Application of sectioning to web.

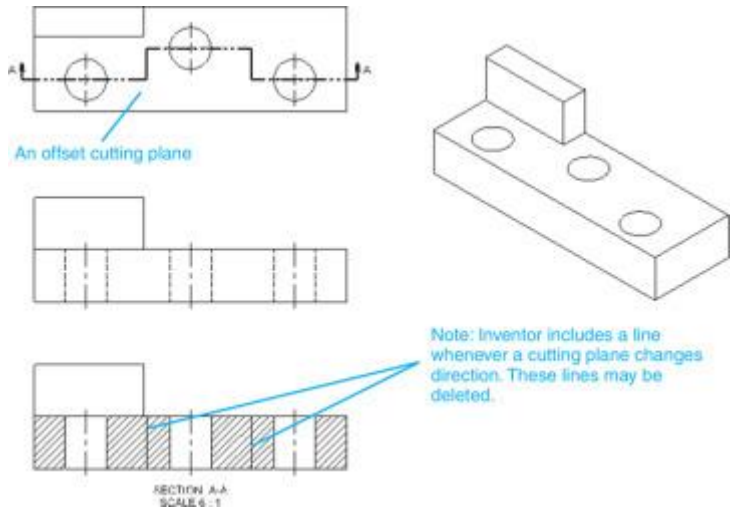

Cutting Plane 1
Offset
Cutting Plane 2


Thick dashes to show change of cutting plane's direction
B
B

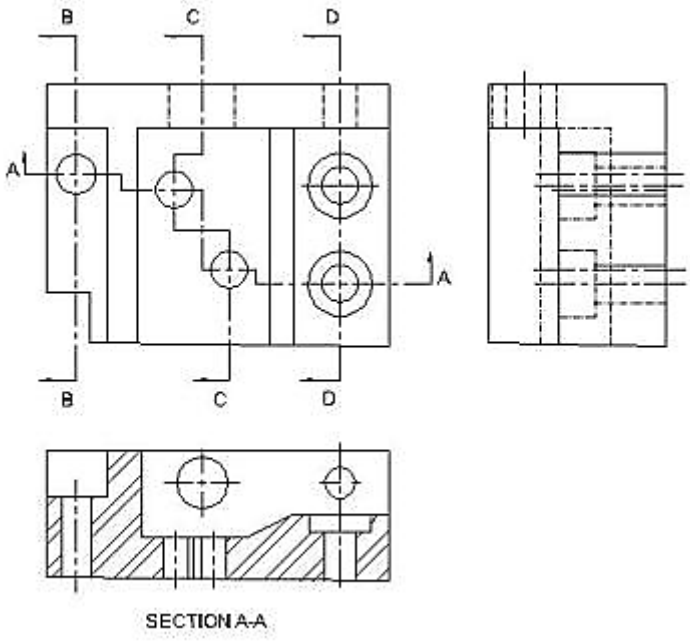

offset edge not shown in sectional view


B - B

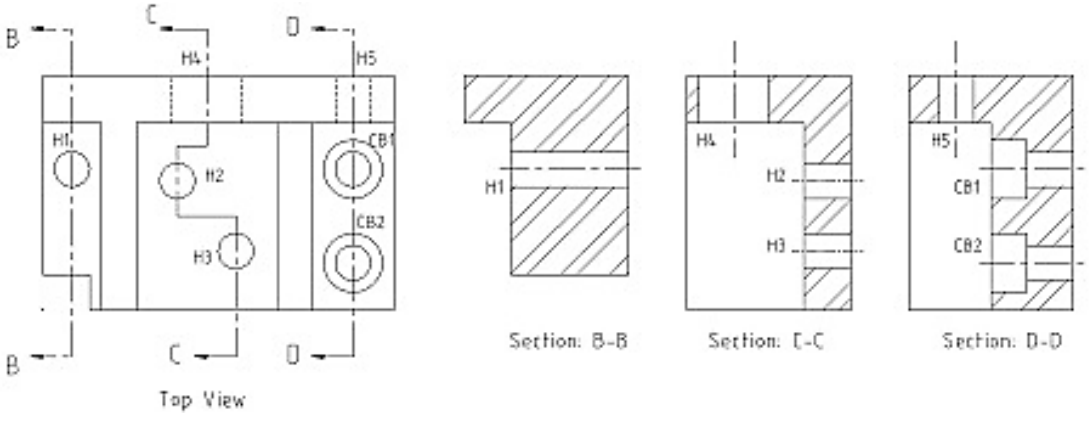

A
A
A - A



Exercise : Draw the following sectional views of the below sketch. The material of the part is Steel a) Section B-B b) Section C-C c) Section D-D



Answer:-



Infographic of Basic Engineering Drawing

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e ISBN 978-967-2742-51-7

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Published by:

Politeknik Nilai
Kompleks Pendidikan Nilai, Bandar Enstek, 71760 Labu,
Negeri Sembilan, Malaysia