ENGINEERING DRAWINGS AND PLANS

Course Description – This laboratory course is designed to develop abilities needed to develop, accurately locate and interpret dimensions on and read engineering drawings.

1 Unit Laboratory – 3 hours per week

No Pre -requisite

Course Outcome: After completing this course, the student must be able to:

- Be familiar with engineering drawings
- Understand the concept of drafting
- Recognize the types of engineering drawings
- Properly utilize the scale within a given drawing
- Recognize which type of view, or views appear on a drawing
- Identify the types of lines that appear on a drawing
- Understand dimensions and their respective tolerances.

Course requirement: Drafting Tools (i.e. T – square, Triangles, Mechanical Pencil, Mechanical Pen, French Curves)

Grading System			Laboratory Exercises	
Laboratory Exercises	-	65%	Content (Title Block, Plates)	40
Major Exam	-	25%	Neatness	40
Class Participation	-	10%	Punctuality	20
Total		100%	Total	100

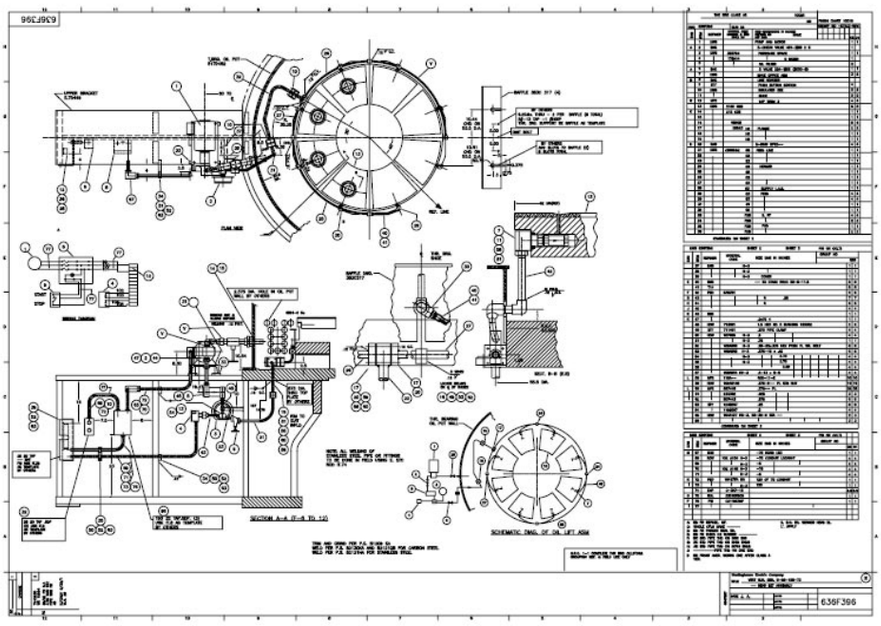
INTRODUCTION

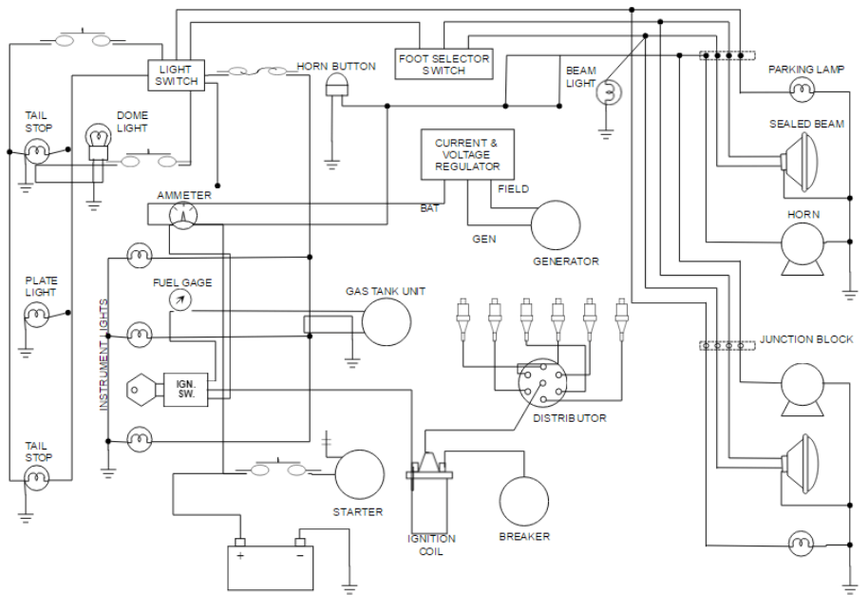
Engineering Drawing is a two dimensional representative of three dimensional objects. In general, it provides necessary information about the shape, size, surface quality, material, manufacturing process, etc., of the object. It is the graphic language from which a trained person can visualize objects.

ROLE OF ENGINEERING DRAWING

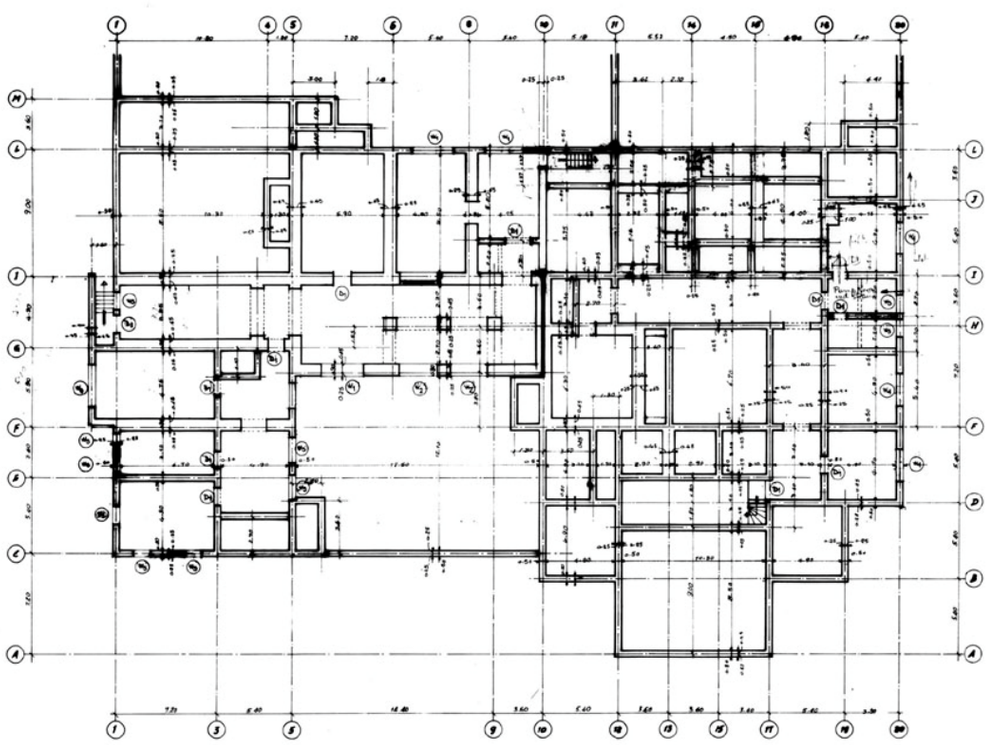
The ability to read drawing is the most important requirement of all technical people in any profession. As compared to verbal or written description, this method is brief and more clear. An engineering drawing made from one country can easily be understood in another irrelevant of the language spoken. Hence, engineering drawing is called the **UNIVERSAL LANGUAGE** of engineers.

EXAMPLES OF ENGINEERING DRAWINGS





WIRING DIAGRAM AUTO ELECTRICAL WIRING DIAGRAM	DRAWN BY	CHECKED	DATE	SCALE	SHEET NO.



DRAWING INSTRUMENTS

1. **Drawing Board** – is a slightly inclined flat surface usually made of softwood that gives a draftsman a flat surface to place papers and drafting instruments used to provide the engineering drawings.

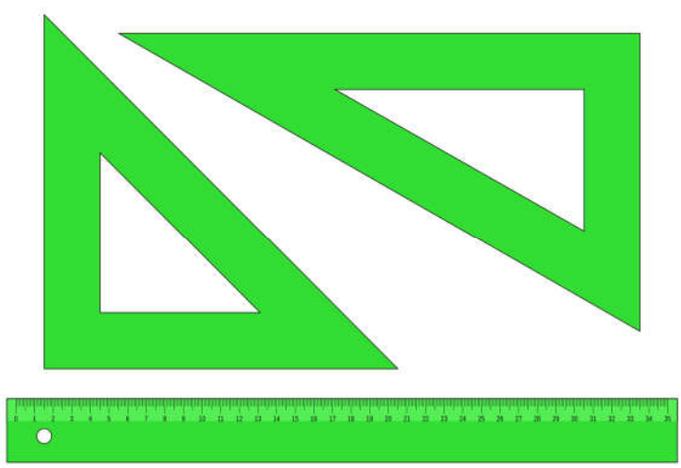
2. **Instrument Box** – Contains the instruments to be used for drafting. This box is used to organize instruments and safely keep them to prevent unnecessary injuries.

3. **Set Squares** - A set square is a triangular tool used to draw straight lines and angles at precise measurements. They are often used in technical drawing, engineering, and geometry classes, and are essential tools for artists, engineers, and architects.

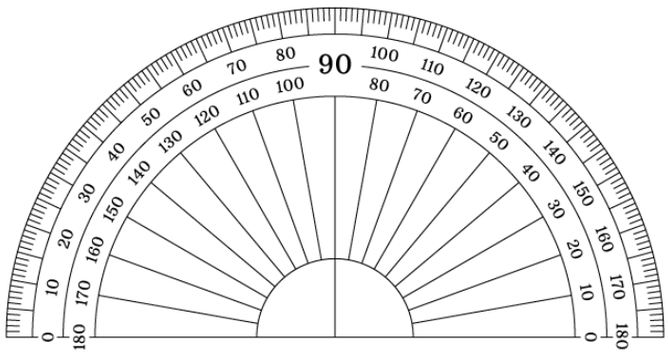
   Set squares are typically made of plastic or metal and have the following features:

   - A ruler edge with centimeter marks and a zero point in the middle
   - Lines that run parallel to the ruler edge
   - A midline that is drawn perpendicular to the ruler edge
   - An angular scale

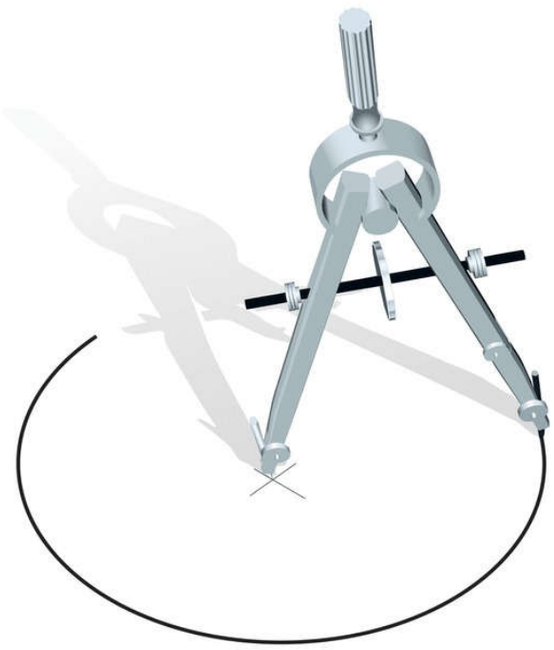
   To use a set square, lay it flat on a page and use the beveled edge to sketch and cut. Set squares are often used in conjunction with a ruler to draw straight lines at precise angles.



4. **Protractor** – A semi-circular or circular tool with markings in degrees that measures angles between two lines. To use a protractor, align the center point with the vertex of the angle and read the degree where the lines meet the protractor's edge.



5. Compass – A tool with two arms, one with a metal point and the other with a place to attach a pencil. To draw a circle, place the metal point in the middle of the paper, hold it steady, and rotate the pencil end to draw a circle. You can adjust the size of the circle by moving the points closer together or further apart.



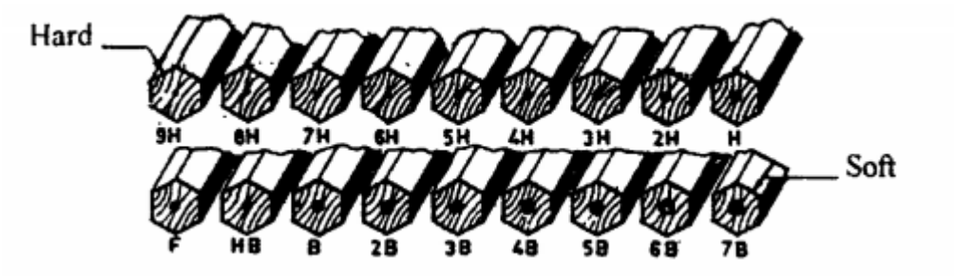
6. Set of Scales – A set of scales used in drafting, also known as a drafting scale or engineering scale, is a specialized ruler that converts real-world measurements into scaled-down drawings. Drafting scales are essential in fields like engineering and architecture, where large objects must be accurately represented on smaller surfaces.

7. French Curves – In drafting, a French curve is a template used to draw smooth curves of varying radii. It's a common tool in manual drafting and fashion design, and can also be used in artwork and technical drawings.

   Here's how to use a French curve:

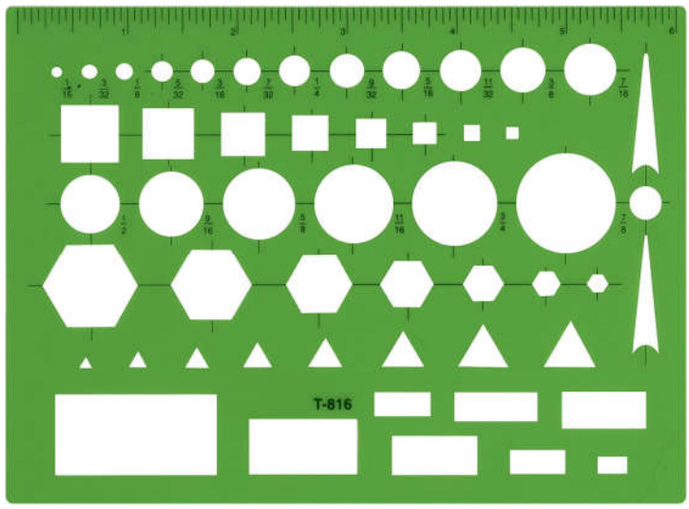
   Draw a rough outline of the desired curve
   Place the French curve against the outline
   Trace around the curve with a pencil, knife, or other tool

8. Pencils – Drafting pencils are used for technical drawing by professionals like architects, designers, and engineers to create accurate and precise technical drawings. They are mechanical pencils with a long, slim lead sleeve that has several benefits:
   - **Visibility**
     The long lead sleeve keeps the pencil's nose out of the way, allowing for a better view of the lead and fine details.
   - **Consistency**
     The lead sleeve helps the pencil run consistently along rulers and templates.
   - **Durability**
     Drafting pencils are made of durable materials like aluminum, brass, high-quality plastic, or wood to withstand heavy use.
   - **Harder lead**
     Drafting pencils have harder lead cores than regular pencils, which results in more precise lines and a less likely broken point. Drafting pencils come in a range of grades, from 6B to 9H, with harder pencils producing lighter lines and softer pencils producing darker and wider lines. For example, a 4H pencil is used for light layout lines, while a sharp H pencil is used for thin dark lines.



9. Templates - also known as drawing stencils, are used to create accurate technical drawings by providing pre-drawn shapes, symbols, and lines. They are a useful tool for architects, engineers, and designers to streamline the drafting process and reduce errors.

   Here are some uses of drafting templates:
   - **Drawing consistent shapes and symbols**
     Drafting templates can be used to quickly and accurately draw commonly used shapes and symbols, such as circles, squares, triangles, arrows, and flowchart elements.
   - **Creating architectural drawings**
     Templates are available for a variety of architectural scales and can be used to design floor plans and elevation systems.
   - **Creating mechanical drawings**
     Drafting templates can be used to create mechanical drawings.
   - **Branding**
     Custom drafting templates can be used to brand a company or industry. They can be used for trade show handouts, employee gifts, and more.



10. Drawing Sheet

Designation	Dimensions (mm)	
	Length	Width
A0	1189	841
A1	841	594
A2	594	420
A3	420	297
A4	297	210

Line Types:
In an engineering drawing, every line has a definite meaning. Various types of lines are used to represent different parts or portions of an object.

Type of line	Used for drawing	Pencil Grade	Sample Drawing
Continuous thick	Visible outlines	H	
Continuous thin	Dimension line,leader line,extension, construction lines and hatching lines	2H	
Continuous thin (drawn free hand)	Irregular boundary line,short break line	2H	
Continuous thin with zigzag	Long break line	2H	
Short dashes (Hidden line)	Invisible edges	H	
Long chain (thin)	Center lines	2H	
Long chain (thick at ends and thin else where)	Cutting plane	H&2H	

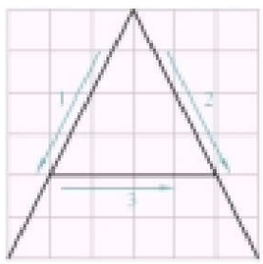
Lettering in Drawing: Lettering plays a major role in engineering drawing. It indicates details like dimensioning, name of the drawing, etc. The use of instruments for lettering is not advised, as it will consume more time. Free hand lettering should be used instead.

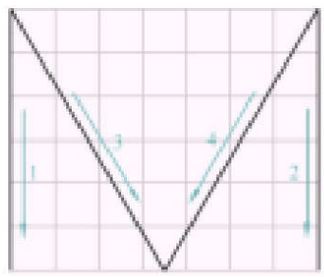
Features:
The essential features of lettering used in engineering drawing are:

- Legibility
- Uniformity
- Similarity

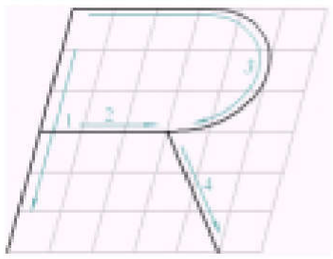
Single stroke letters are the simplest form of letters and are generally used in engineeringdrawing.

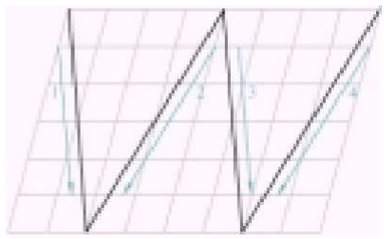
Vertical Lettering: Vertical lettering is upright, i.e. 90 (to the horizontal. Both uppercase or large and lowercase or small letters are used.





Inclined Lettering: Inclined lettering has letters inclined at 75° to the horizontal and as for vertical lettering both uppercase and lowercase letters are used.

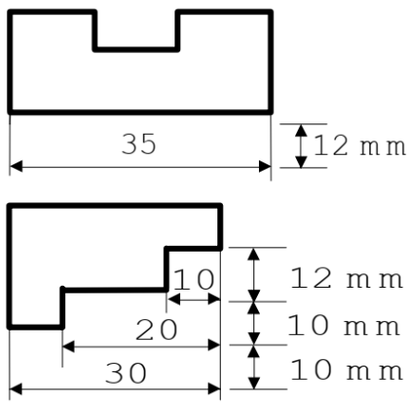




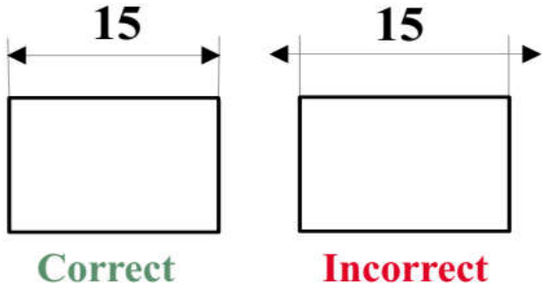
Dimensioning Methods: Dimensioning is used to describe a drawing in terms of details such as the size, shape and position of the object as per the Dimensioning Code 11669 - 1986. Expressing these details in terms of numerical values, lines and symbols is known as dimensioning.

General Rules of Dimensioning:

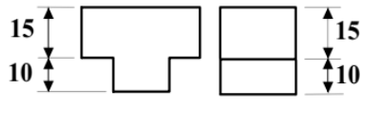
1. Dimension lines are to be drawn maintaining a gap of 12 mm from the object line and a gap of 10 mm between adjacent dimension lines.



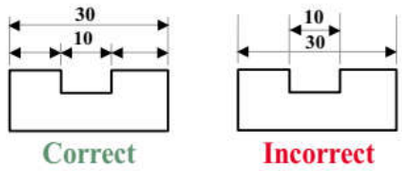
2. Dimension lines should not cross extension lines.



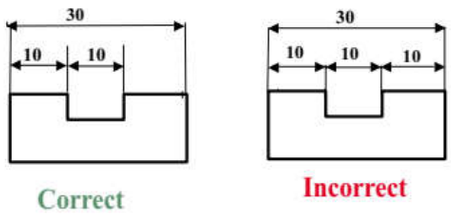
3. A given dimension should be indicated only once. It should not be repeated at another place.



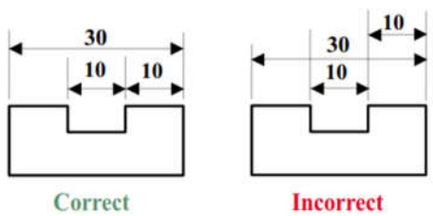
4. The overall dimensions should be placed outside the smaller dimensions.



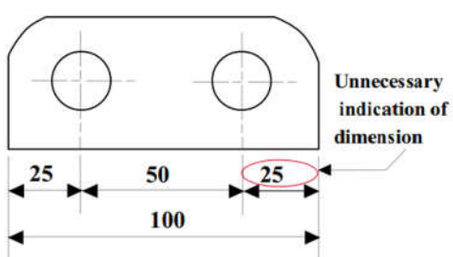
5. When an overall dimension is given, one of the smaller dimensions should not be given unless it is needed for reference.



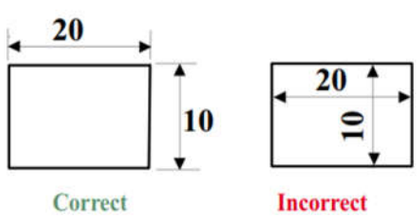
6. The larger dimensions should be placed outside the smaller ones such that the extension lines do not cross the dimension lines.



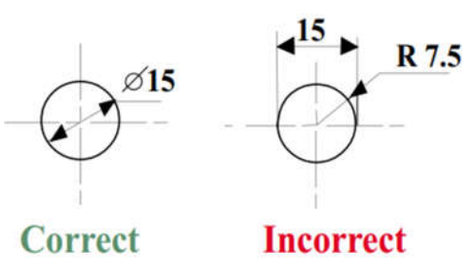
7. No dimensions other than those that are necessary need be given.



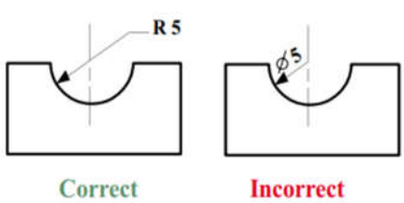
8. Avoid indicating dimensions inside a drawing.



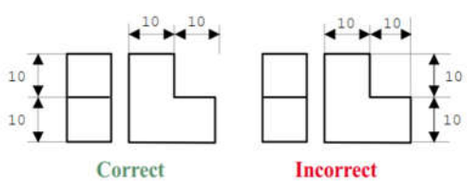
9. Always indicate the diameter of a circle, not its radius. The symbol **Ø** is used before the dimension, except when it is obvious.



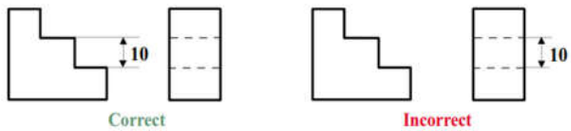
10. The radius of an arc should always be indicated with the abbreviation R placed before the dimension.



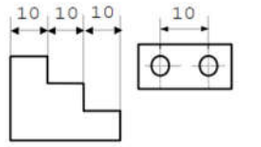
11. Extension lines should not cross each other or dimension lines unless this can be done without making the drawing more complicated.

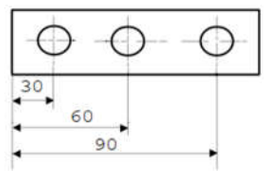


12. Avoid dimensioning of hidden lines if possible.

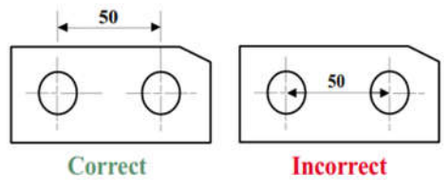


13. Dimensions should be given from the centre lines, finished surfaces, or datum's as applicable to a drawing.

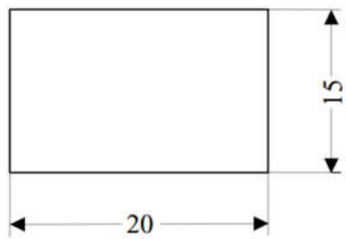




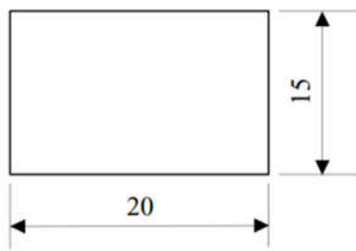
14. The centre line should never be used as a dimension line.



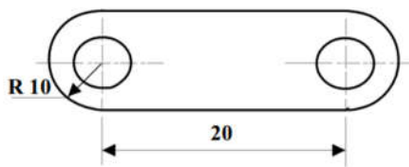
15. In the unidirectional system of dimensioning, all dimensions must be upright and readable when the drawing is viewed in its normal upright position.



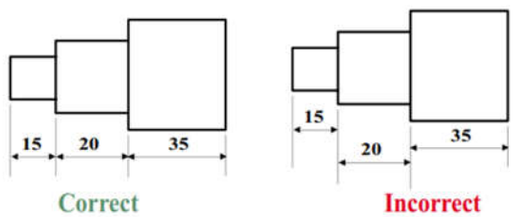
16. In the aligned system, the dimensions must be readable when the drawing is viewed in its normal upright position or from its right hand side.



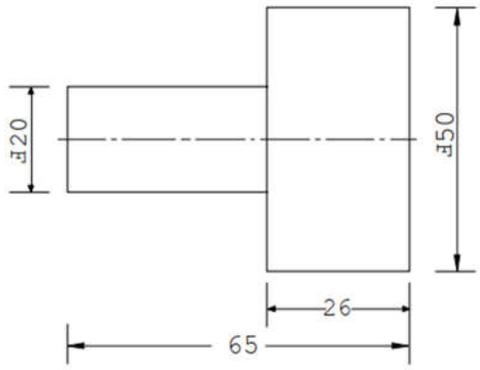
17. In a drawing of a part with circular ends, the centre-to-centre dimension is given instead of an overall dimension.



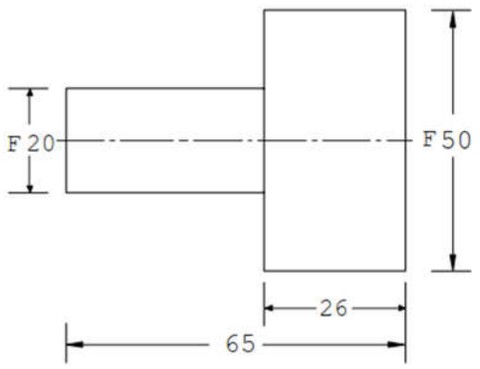
18. When a number of dimensions are indicated on one side of a drawing, they should appear on a continuous line.



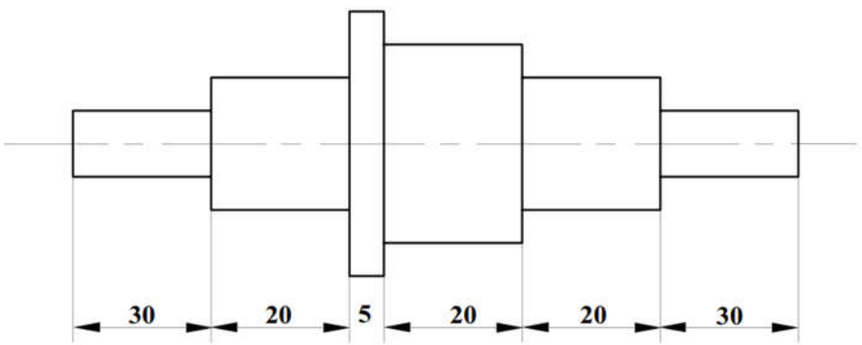
Unidirectional Method:
In this system, the dimensions are indicated in the vertical / upright position so that they can be read easily when the drawing is viewed in its upright position. The numerical values are placed at the centres of the dimension lines.



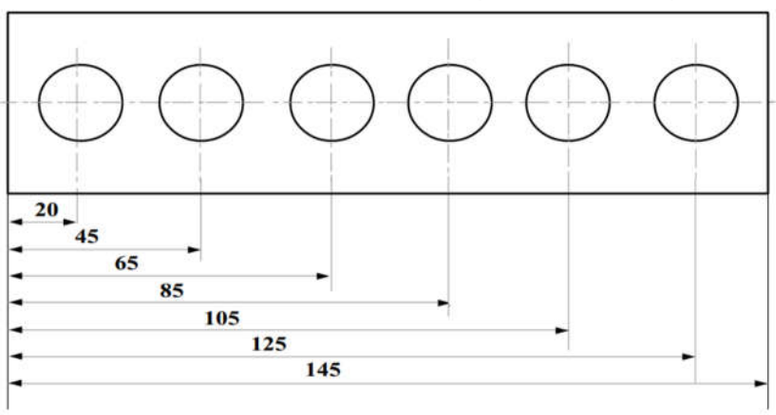
Aligned Dimensioning:
In this system, the dimensions are indicated so as to be perpendicular to the dimension lines. In other words, the horizontal dimensions can be read conveniently when the drawing is viewed normally. Similarly, the vertical dimensions can be read easily from the right side of the sheet.



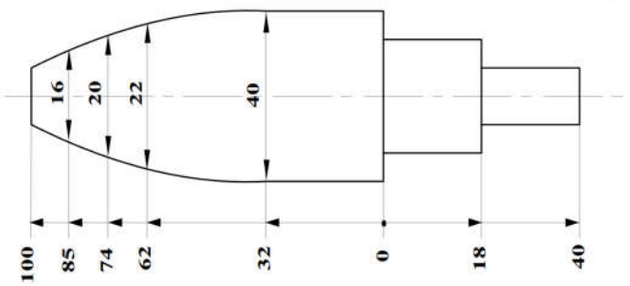
Chain Dimensioning:
When successive dimensions are arranged in a straight line, the method used is called chain dimensioning.



Parallel Dimensioning:
When a number of dimensions are indicated from a common datum, the system is known as parallel dimensioning.



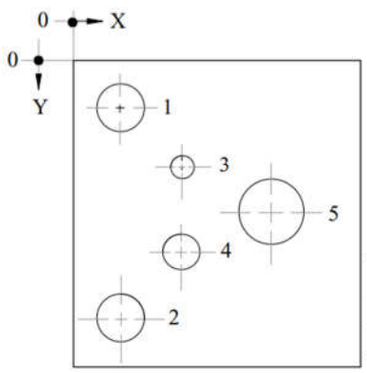
Progressive Dimensioning:
In this method, a dot and a zero sign indicate the datum line. The dimensions are indicated progressively from the datum.



Co-ordinate Dimensioning:

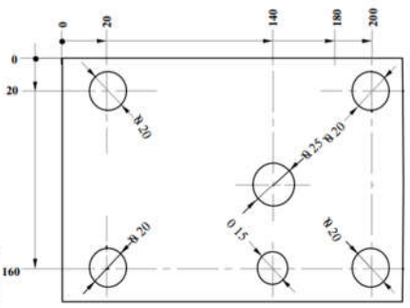
The method of dimensioning shown in the figure is known as co-ordinate dimensioning. For simplicity, the same dimensions can be shown separately in a tabular form as shown in the figure.

Sample: 1



	1	2	3	4	5
X	20	20	60	60	100
Y	20	160	60	120	90
f	20	20	10	15	25

Sample: 2



Geometric Construction

Introduction

This chapter deals with some of the important basic construction techniques frequently used in Engineering Drawing.

Geometric Terms

Triangle

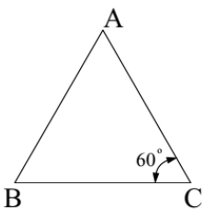
A triangle has three sides; the sum of its angles is equal to 180º.

Equilateral Triangle

An equilateral triangle is a triangle, which has three equal sides.

$$AB = BC = CA$$

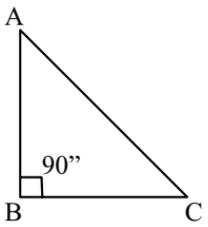
$$\angle ABC = \angle BCA = \angle CAB = 60°$$



Right-Angled Triangle

In a right-angled triangle, the included angle between two of its sides is equal to 90º.

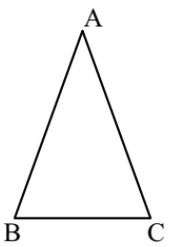
$$\angle ABC = 90º$$



Isosceles Triangle:

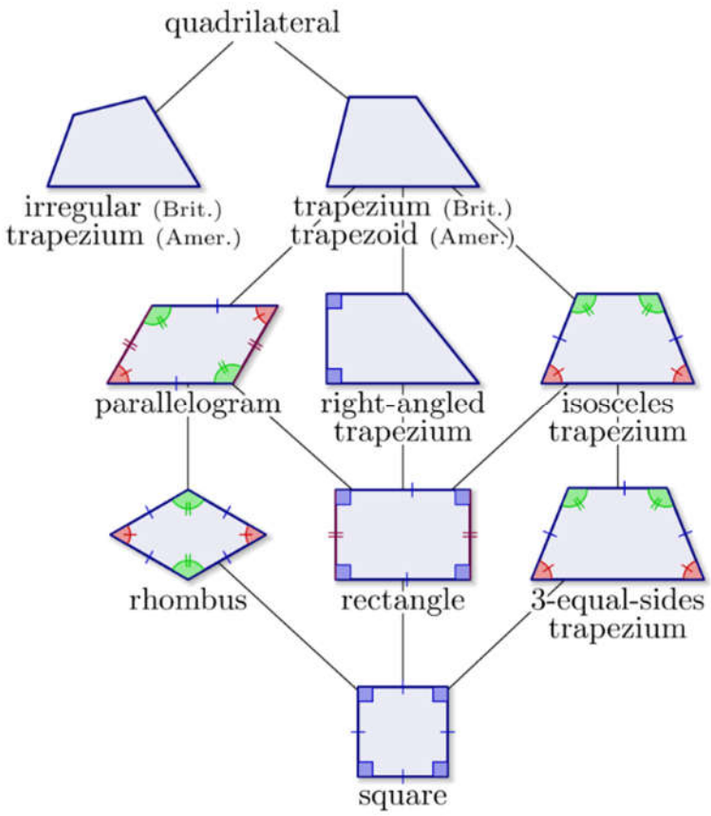
An isosceles triangle is a triangle, which two sides, and two angles are equal.

$$AB=AC \text{ and } \angle ACB=\angle ABC$$



Quadrilateral

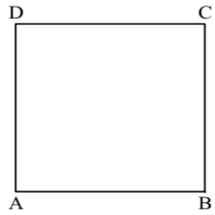
A quadrilateral has four sides; the sum of all its angles is equal to 360º.



Square

When all the sides of a quadrilateral are equal and all its internal angles are right angles, the quadrilateral is called a square.

$$AB = BC = CD = DA$$



Rectangle

When the opposite sides of a quadrilateral are equal and all its internal angles are right angles, the quadrilateral is called a rectangle.

$$AB = CD \text{ and } BC = AD$$

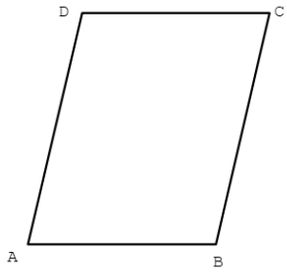
Rhomboid

When the opposite sides and angles of a quadrilateral are equal and none of its angles are right angles, the quadrilateral is called a rhomboid.

$$AB = CD$$

$$BC = AD$$

$$\angle ABC = \angle CDA \text{ and } \angle BCD = \angle DAB$$

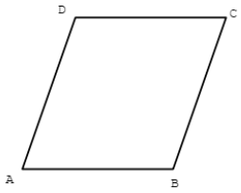


Rhombus

When all the sides of a quadrilateral are equal and none of its internal angles are right angles, but the opposite angles are equal, the quadrilateral is called a rhombus.

$$AB = BC = CD = DA$$

$$\angle ABC = \angle CDA \text{ and } \angle BCD = \angle DAC.$$

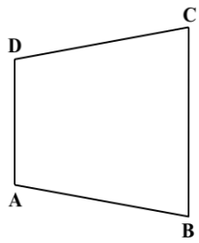


Trapezoid

When two opposite sides of a quadrilateral are equal and the other two opposite sides are parallel, the quadrilateral is called a trapezoid.

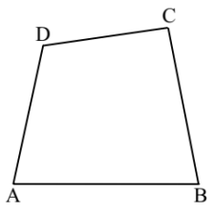
AB = CD

AD || BC



Trapezium

When no side of a quadrilateral is parallel or perpendicular to any of its other sides, the quadrilateral is called a trapezium.

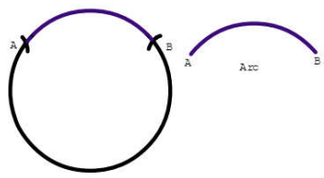


Parts of a Circle

Arc

The part of a circle between any two points on its circumference is called an arc.

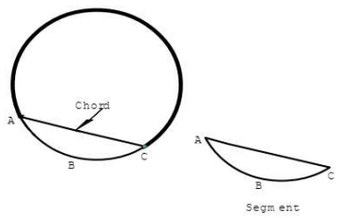
Arc = AB



Segment

The part of a circle bounded by an arc and a chord is called a segment.

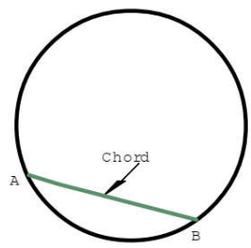
Segment = ABC



Chord

A straight line joining any two points on the circumference of a circle is called a chord.

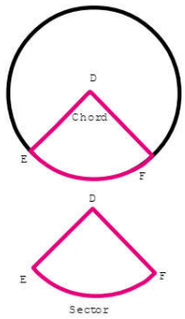
Chord = AB



Sector

The part of circle bounded by two radii and an arc is called a sector.

Sector = DEF



Polygons

Types of Polygons

A plane figure bounded by straight lines is called a polygon. Polygons are classified into two types. They are:

1. Regular Polygon
2. Irregular Polygon

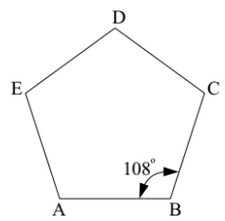
Regular Polygon

A polygon in which all the sides and all the angles are equal is called a regular polygon.

Pentagon:

A regular pentagon has five equal sides. Its angles are equal. The internal angle of a regular polygon of "n" sides= {(2n-4) 90°}/n. The internal angle of a regular pentagon = 108°

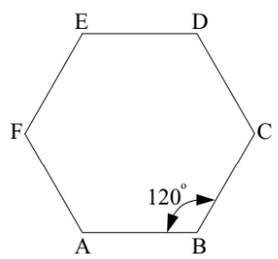
AB = BC = CD = DE = EA



Hexagon:

A regular hexagon has six equal sides. Its angles are equal. The internal angle of a regular hexagon =120°

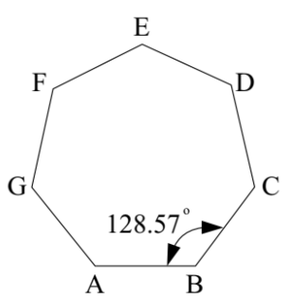
AB = BC = CD = DE = EF = FA



Heptagon:

A regular heptagon has seven equal sides. Its angles are equal. The internal angle of a regular heptagon = 128.57°

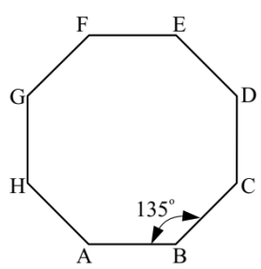
AB = BC = CD = DE = EF = FG = GA



Octagon

A regular octagon has eight equal sides. Its angles are equal. The internal angle of a regular octagon = 135°

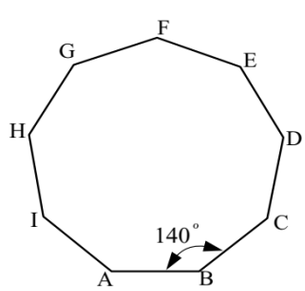
AB=BC=CD=DE=EF=FG=GH=HA



Nonagon

A regular nonagon has nine equal sides. Its angles are equal. The internal angle of a regular nonagon = 140°

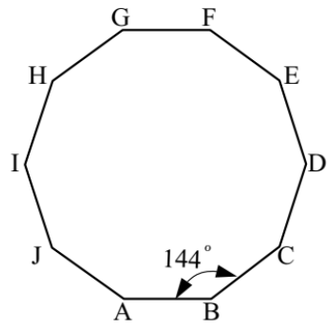
AB=BC=CD=DE=EF=FG=GH=HI=IA



Decagon

A regular decagon has ten equal sides. Its angles are equal. The internal angle of a regular decagon = 144°

AB=BC=CD=DE=EF=FG=GH=HI=IJ=JA



Irregular Polygon

The sides and angles of an irregular polygon are unequal. Hence irregular polygons are not used in engineering drawing.

Orthographic Projection

Introduction

Engineers are mainly involved in the design and development of machines and structures. To design and communicate every detail of a machine /structure, engineers must prepare a drawing that shows the true size and shape of the entire machine or structure. It is difficult to represent a three dimensional object exactly on a sheet of paper by showing a single view.

Hence sets of views from different positions are prepared to define the object completely. Though different methods of projections are available to obtain the views of objects, the orthographic projection is used for most engineering purposes.

What is Projection

The views of an object formed on a transparent plane, by viewing it perpendicularly from the front, top or side of the object are called its projections.

The Front View of an Object:

The view of an object formed on a transparent plane by viewing it perpendicularly from the front of the object is called its front view. It can also be called as "elevation".

Note:

In general, the front view of an object (FV) is taken as the view normal (or perpendicular) to the longest side of the object.

The Top view of an Object:

The view of an object formed on a transparent plane, by looking at it perpendicularly from the top is called the top view of the object.

Note:

1. The top view is usually placed above the front view in the case of third angle projection.
2. The top view is also called "plan" and is placed below the front view in the case of first angle projection.

The Side view of an Object:

The view of an object formed on a transparent plane, by looking at it perpendicularly from the side is called the side view of the object. The view taken from the right hand side of the object is called its "right side view". Similarly the view from the left hand side is the "left side view".

Types of Projection:

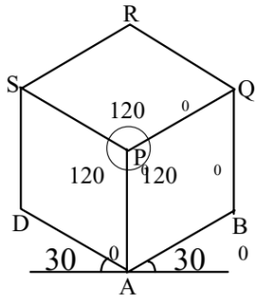
1. Pictorial Projection
2. Orthographic Projection

Pictorial Projection:

1. Isometric Projection
2. Oblique Projection
3. Perspective Projection

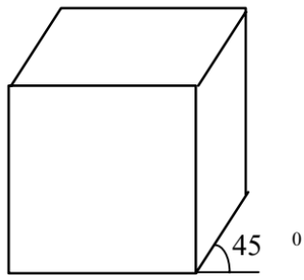
1. Isometric Projection:

"Iso" means equal and "metric projection" means projection to a reduced measure. The tilting angle of the view is 30º to the horizontal.



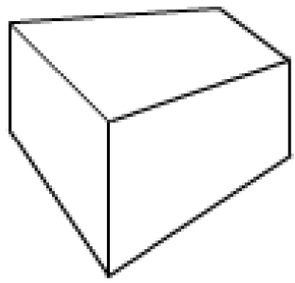
2. Oblique Projection:

Oblique projection is a slanting projection. The tilting angle is either 30º or 45º. Thus an oblique drawing can be drawn directly without using any of the projection techniques.



3. Perspective Projection:

In perspective drawings, the objects are represented more realistically than other drawings. A photograph of a person or object is a perspective of the person or the object. Very often an architect uses photographic representation. Perspective drawings show three-dimensional objects in a single plane as they appear to our eye.



Orthographic Projection:

"Ortho" means right angle and "Ortho-graphic" means right-angled drawing. The projections of an object are perpendicular to the plane on which the projections are` obtained are known as orthographic projections. Imaginary rays of light from an observers eyes viewing an object from an infinite distance will be parallel to each other and perpendicular to the object and the plane on which a projection of the object will be produced.