GHOUSIA INDUSTRIAL TRAINING INSTITUTE

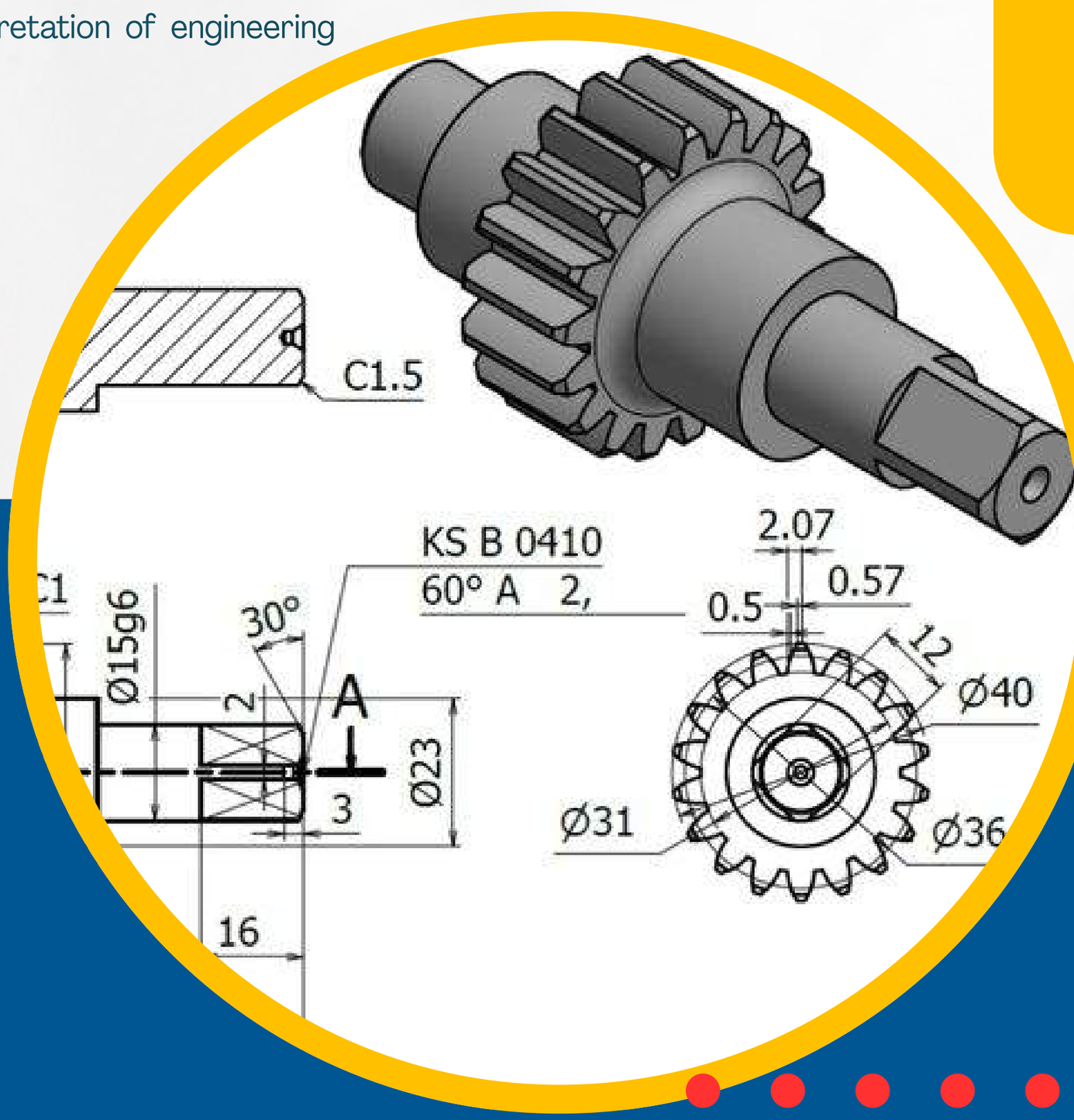
Near Dairy Circle, Hosur Road, Bengaluru-560029, KARNATAKA
Managed By Ghousia Industrial & Engineering Trust
Recognised & Aided by Government of Karnataka & Permanently Affiliated to NCVT, Govt. of India.

ENGINEERING DRAWING

First Year ITI – Fitter/Electrician/Electronics Mechanic/ AC & Regrigeration

Dr.NAVEED
Assistant Professor

This course introduces engineering drawing and drawing instruments, covering basic conventions, standard drawing sheet sizes, layout, and the title block with its position and contents. It explains different types of lines and their applications and develops skill in freehand drawing of geometrical figures, blocks, hand tools, and measuring tools, including transferring measurements from real objects. Students learn the construction of basic geometrical figures such as angles, triangles, circles, rectangles, squares, and parallelograms, along with single-stroke lettering and numbering. The syllabus also includes dimensioning practices and reading of drawings to understand technical details clearly. Overall, the course builds a strong foundation for visualization, accuracy, and interpretation of engineering drawing



080-25536268
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SYLLABUS

1st Year **Group 2 Revised syllabus 2022** **Duration: 1 Year**

2 Year Engineering trades under CTS

CTS Trades Covered: Fitter, Turner, Machinist, Machinist Grinder, Mechanic Machine Tool Maintenance, Operator Advance Machine Tool, TDM (D&M), TDM (J&F), Mechanic Mining Machinery, Textile Mechatronics, Basic Designer & Virtual Verifier, Advanced CNC machining, Aeronautical Structure & Equipment Fitter

S.no.	Syllabus	Time in Hrs
1	Introduction to Engineering Drawing and Drawing Instruments – • Conventions • Sizes and layout of drawing sheets • Title Block, its position and content • Drawing Instruments	2
2	Lines - Types and applications in drawing Free hand drawing of - • Geometrical figures and blocks with dimension • Transferring measurement from the given object to the free hand sketches. • Free hand drawing of hand tools and measuring tools.	6
3	Drawing of Geometrical figures: • Angle, Triangle, Circle, Rectangle, Square, Parallelogram. • Lettering & Numbering - Single Stroke.	4
4	Dimensioning • Types of arrowhead • Leader line with text • Position of dimensioning (Unidirectional, Aligned)	2
5	Concept and reading of Drawing in • Concept of axes plane and quadrant • Concept of Orthographic and Isometric projections • Method of first angle and third angle projections (definition and difference)	14
6	Symbolic representation - • Different symbols used in the related trades.	4
7	Reading of Job drawing of related trades.	8
	Total	**40**

SYLLABUS

1st Year **Group - 19 Revised syllabus 2022** **Duration: 1 Year**

2 Year Engineering trades under CTS

CTS Trades Covered: Electrician, Wireman, Electroplater, Lift & Escalator Mechanic, Electrician Power Distribution

S.no.	Syllabus	Time in Hrs
1	Introduction to Engineering Drawing and Drawing Instruments – • Conventions • Sizes and layout of drawing sheets • Title Block, its position and content • Drawing Instrument	2
2	Free hand drawing of - • Geometrical figures and blocks with dimension • Transferring measurement from the given object to the free hand sketches. • Free hand drawing of hand tools.	6
3	Drawing of Geometrical figures: • Angle, Triangle, Circle, Rectangle, Square, Parallelogram. • Lettering & Numbering - Single Stroke.	4
4	Dimensioning Practice • Types of arrowhead	2
5	Symbolic representation - • Different electrical symbols used in the related trades	4
6	Reading of Electrical Circuit Diagram	14
7	Reading of Electrical Layout drawing	8
	Total	**40**

SYLLABUS

1st Year **Group - 20 Revised syllabus 2022** **Duration: 1 Year**

2 Year Engineering trades under CTS

CTS Trades Covered: Tech. Medical Electronics, Technician Mechatronics, Technician Power Electronics System, Electronics Mechanic, Mechanic Consumer Electronics Appliances, Tech. Electronic System Design & Repair

S.no.	Syllabus	Time in Hrs
1	Introduction to Engineering Drawing and Drawing Instruments – • Conventions • Sizes and layout of drawing sheets • Title Block, its position and content • Drawing Instruments	2
2	Free hand drawing of - • Geometrical figures and blocks with dimension • Transferring measurement from the given object to the free hand sketches. • Free hand drawing of hand tools.	6
3	Drawing of Geometrical figures: • Angle, Triangle, Circle, Rectangle, Square, Parallelogram. • Lettering & Numbering - Single Stroke.	4
4	Symbolic representation - • Different Electronic symbols used in the related trades.	4
5	Reading of Electronic Circuit Diagram	14
6	Reading of Electronic Layout drawing	10
	Total	**40**

Chapter-01 INTRODUCTION

1.1 Engineering Drawing:

Engineering Drawing means making neat and clear drawings of machines, tools, or buildings with correct measurements.

It is like a special language of engineers. Instead of using only words, engineers use drawings to explain how something should be made.

Engineering drawing is a detailed drawing that shows the exact size and shape of an object so that it can be made correctly.

Simple Examples:

- Drawing of a bolt with its length and thickness written.
- Drawing of a table showing height, width, and length.
- Drawing of a house plan showing rooms and doors with measurements.

In short, engineering drawing helps people understand what to make and how to make it before starting the work.

1.2 Types of Engineering Drawing:

Mechanical Engineering Drawing

Mechanical engineering drawing is used to design and manufacture machine parts and equipment. It includes drawings of components such as bolts, nuts, gears, shafts, and engines. These drawings show exact measurements, shapes, materials, and how parts fit together. They help workers manufacture machine parts correctly and accurately.

Civil Engineering Drawing

Civil engineering drawing is used in construction work. It includes drawings of houses, buildings, bridges, roads, and dams. These drawings show plans, room layouts, elevations, and structural details with proper measurements. They guide engineers and builders during construction.

Electrical Engineering Drawing

Electrical engineering drawing is used to show electrical systems and wiring connections. It includes circuit diagrams, wiring diagrams, and single-line diagrams. These drawings show how electrical components like switches, motors, and transformers are connected. They help electricians install and maintain electrical systems.

Electronics Engineering Drawing

Electronics engineering drawing is used to represent electronic circuits and devices. It includes schematic diagrams and PCB layouts. These drawings show electronic components such as resistors, capacitors, transistors, and integrated circuits. They help in designing and assembling electronic equipment.

Exercise-1.1 Conventions:

Conventions in engineering drawing are standard symbols and patterns used to represent different materials in drawings. Instead of writing the name of the material everywhere, engineers use special hatching or shading patterns. These conventions make drawings clear, neat, and easy to understand.

Metals such as steel, cast iron, copper, aluminium, lead, and zinc are shown by thin, equally spaced parallel lines, usually drawn at an angle of 45 degrees. This pattern is mostly used in sectional views to indicate that the object is made of metal.

Glass is represented by a lighter and more open pattern compared to metals. It may include spaced thin lines or simple marks to show that the material is transparent and different from solid materials.

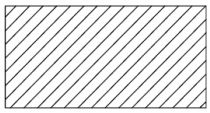
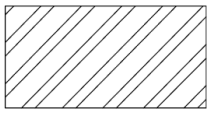
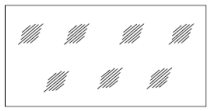
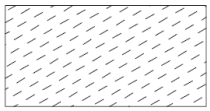
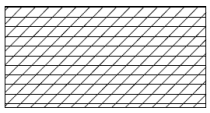
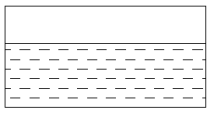
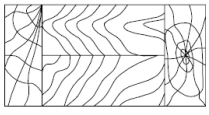
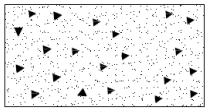
Packing and insulating materials like asbestos, fiber, cork, rubber, felt, and thermocol are shown using cross-hatched or mesh-like patterns. These dense patterns indicate that the material is used for insulation or sealing purposes.

Liquids such as water, oil, petrol, and kerosene are shown by horizontal lines, often with a straight or slightly wavy top line to represent the liquid level inside a container.

Wood is represented by curved lines that look like natural wood grains. This helps to easily identify wooden parts in engineering drawings.

Concrete is shown using small irregular dots and tiny shapes spread across the area. This pattern represents the mixture of cement, sand, and aggregates used in construction.

Thus, conventions help engineers quickly identify different materials in a drawing without writing detailed descriptions.

Metals		Steel, Cast Iron, Copper and its Alloys, Aluminium and its alloy, etc
		Lead, Zinc, Tin, White-metal, etc.
Glass		Glass
Packing and Insulating materials		Porcelain, Stoneware, Marble, Slate etc
		Asbestos, Fibre, Felt, Synthetic resin products, Paper, Cork, Linoleum, Rubber, Leather, Wax, insulating & Filling Materials etc
Liquid		Water, Oil, Petrol, Kerosene etc
Wood		Wood, Plywood etc
Concrete		Concrete

1.3 Different Sizes of Drawing Sheets

Engineering drawing sheets are available in standard sizes as per IS 10811:1983. These sheets are named as A0, A1, A2, A3, A4, and A5. A0 is the largest size, and A5 is the smallest size. Each smaller size is obtained by folding the previous larger sheet into half. The ratio between the length and breadth of these sheets is constant (1 : √2). This makes enlargement and reduction easy without changing proportions.

Standard Trimmed Sizes (in mm)

- A0 – 841 × 1189 mm
  This is the largest size and is used for very big drawings like building plans, layouts, and large assembly drawings.
- A1 – 594 × 841 mm
  Used for medium-sized drawings such as machine assemblies and structural drawings.
- A2 – 420 × 594 mm
  Commonly used for detailed machine part drawings and laboratory work.
- A3 – 297 × 420 mm
  Used for smaller drawings, charts, and classroom work.
- A4 – 210 × 297 mm
  This is the size of normal office paper. It is used for small drawings, assignments, and reports.
- A5 – 148 × 210 mm
  This is the smallest standard drawing sheet and is used for very small sketches and simple drawings.

Untrimmed Sizes

Untrimmed sheets are slightly larger than trimmed sizes. They are cut (trimmed) later to the standard size after drawing work is completed.

Exercise-1.2 Title Block – Position and Content

The title block is an important part of an engineering drawing. It gives basic information about the drawing. It is usually placed at the bottom right corner of the drawing sheet. This position is standard so that anyone can easily find the details of the drawing.

Layout of Drawing Sheet

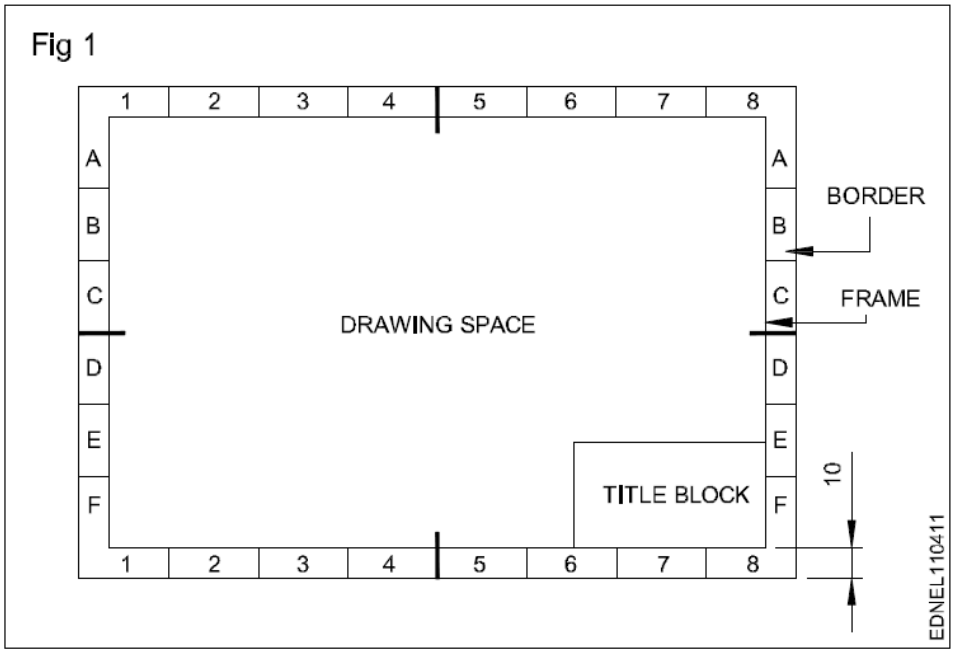
A drawing sheet has margins (borders) on all four sides. Inside the border is the drawing space, where the actual figure or design is drawn. The title block is placed inside the border, at the bottom right side.

What the Title Block Contains

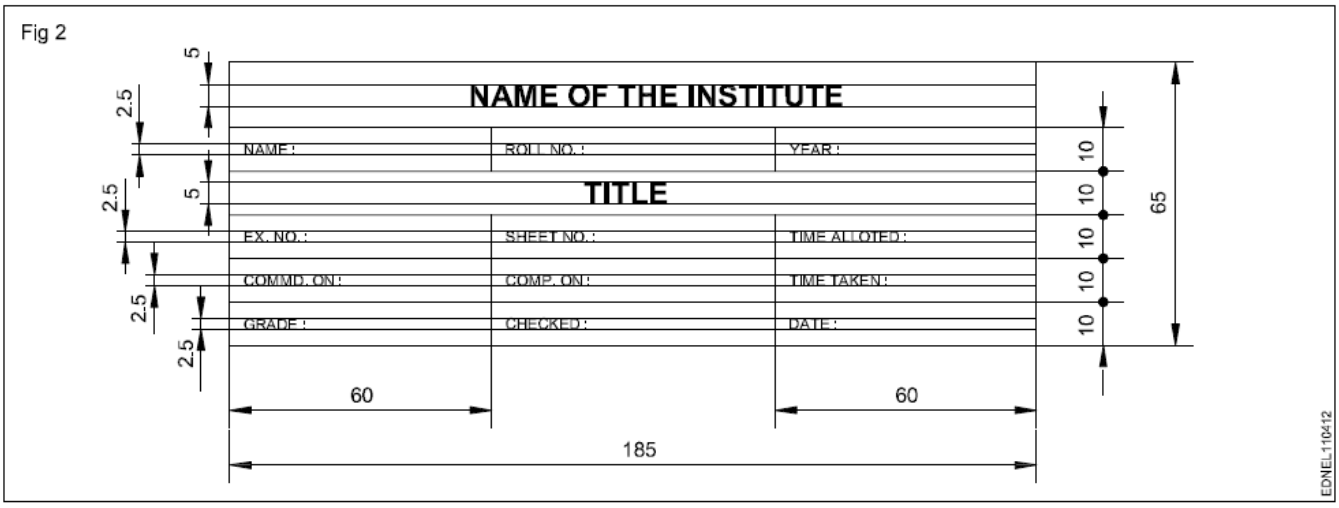
The title block includes important details such as:

- Name of the Institute or Company
- Title of the Drawing
- Drawing Number
- Scale
- Date
- Name of the person who drew it
- Checked by / Approved by
- Sheet number

These details help in identifying and organizing the drawing properly.



Title Block



1.4 Drawing Instruments

Drawing instruments are tools used to make accurate and neat engineering drawings. These instruments help in drawing lines, circles, angles, and measurements correctly.

Drawing board is a flat wooden board used to fix the drawing sheet and provide a smooth surface for drawing.

T-square is used to draw horizontal straight lines. It also helps in guiding other instruments like set squares.

Set squares are triangular tools used to draw vertical lines and specific angles like 30°, 45°, 60°, and 90°.

Compass is used to draw circles and arcs.

Divider is used to measure distances and transfer measurements from one place to another.

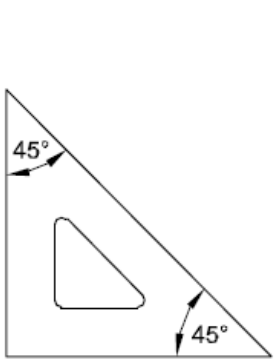
Protractor is used to measure and draw angles.
Scale (Ruler) is used to measure lengths and draw straight lines to a required scale.
Pencils of different grades (H, HB, 2H, etc.) are used for drawing clear and sharp lines.
Eraser and sharpener are used to correct mistakes and maintain pencil sharpness.

Exercise-1.3 Importance of Set Square

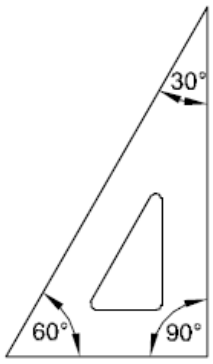
A set square is an important drawing instrument used in engineering drawing to draw accurate vertical lines and standard angles.
It is mainly used to draw 90°, 45°, 30°, and 60° angles. With the help of a T-square, a set square can easily draw vertical and inclined lines. This ensures that the drawing is neat and accurate.
Set squares help in:

- Drawing perpendicular lines
- Drawing parallel lines
- Constructing standard angles
- Making geometrical shapes correctly

There are usually two types of set squares: one with 45°–45°–90° angles and another with 30°–60°–90° angles.



(a) 45° SET SQUARE



(b) 30° - 60° SET SQUARE

1.5 Importance of 2B and 2H Pencils in Engineering Drawing

In engineering drawing, different grades of pencils are used to get proper line quality. 2B and 2H pencils are commonly used because they serve different purposes.
A 2H pencil is hard and produces light, thin lines. It is mainly used for drawing construction lines, guidelines, dimension lines, and projection lines. These lines should be light because they may need to be erased later. The hard lead also keeps a sharp point for a longer time, which helps in making neat and accurate drawings.
A 2B pencil is softer and produces dark, thick lines. It is used for final object lines, visible outlines, borders, and important details. These lines must be dark so that the main shape of the object is clearly visible.

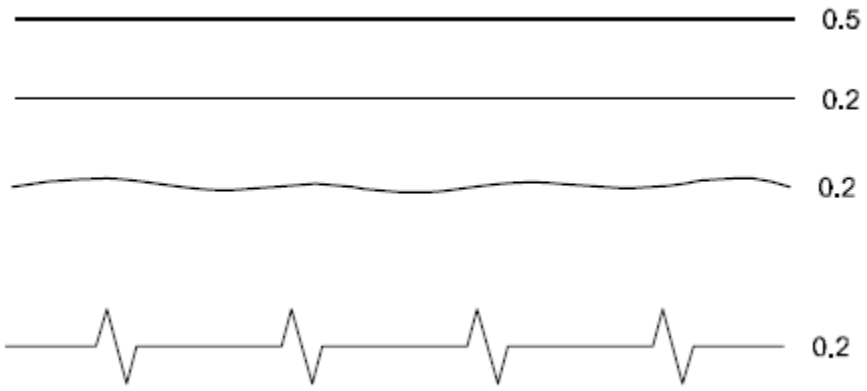
Chapter-02 TYPES OF LINES AND THEIR APPLICATIONS

A line is a continuous mark made on a surface using a pencil or pen. It has length but no thickness.

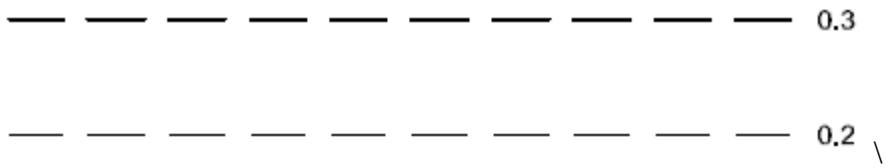
In engineering drawing, a line is used to represent the shape, edges, boundaries, and details of an object. Different types of lines are used to show visible parts, hidden parts, centre lines, and cutting planes.

Exercise-2.1 Types of Lines:

1. Continuous Thick Line
A continuous thick line is a dark, bold line used to show the visible outlines and visible edges of an object. These lines represent the main shape of the object that can be clearly seen. They are the most important lines in a drawing because they define the object.
2. Continuous Thin Line (Straight)
A continuous thin straight line is a light line used for dimension lines, extension lines, projection lines, leader lines, hatching, imaginary lines of intersection, short centre lines, thread lines, and diagonal lines. These lines give additional information but do not represent visible edges.
3. Continuous Thin Freehand Line
A continuous thin freehand line is drawn by hand without instruments. It is used to show the limits of partial views or broken-out sections when only a part of the object is shown.
4. Continuous Thin Line with Zig-Zag
This line is thin and contains zig-zag shapes. It is used to represent long break lines, where a portion of a long object is removed to save space in the drawing.



5. Dashed Thick Line
A dashed thick line consists of thick short dashes. It is used to represent hidden outlines or hidden edges that are not visible from the outside.
6. Dashed Thin Line
A dashed thin line is made of thin short dashes. It is also used to show hidden outlines and hidden edges, but in lighter form.



7. Chain Thick Line

A chain thick line is bold and consists of long and short dashes. It is used to show special surfaces or lines where special requirements or treatments apply.

8. Chain Thin Line

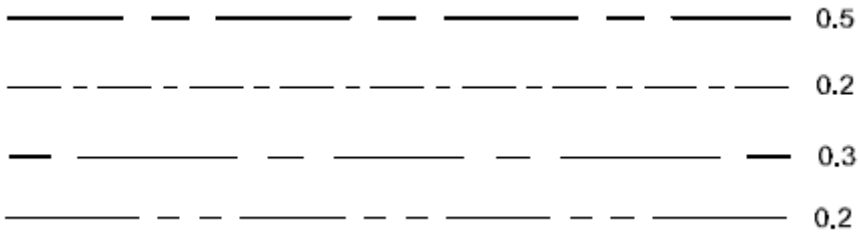
A chain thin line is made of long and short dashes alternately. It is used to show centre lines, lines of symmetry, and paths of motion (trajectories).

9. Chain Thin Line, Thick at Ends

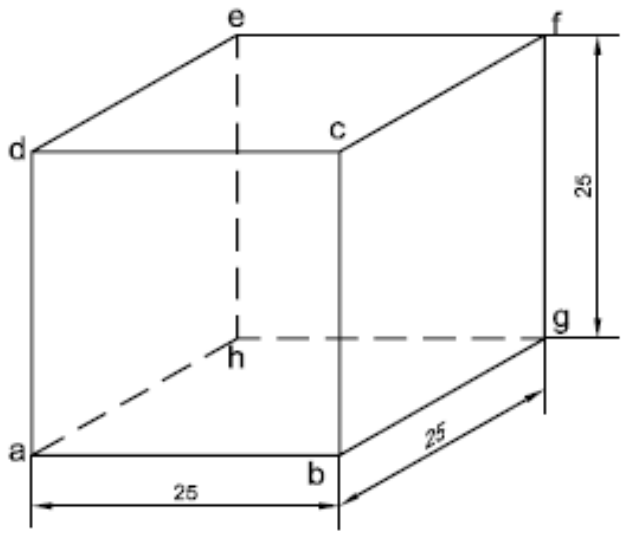
This line is thin but becomes thick at the ends and where direction changes. It is used to indicate cutting planes, showing where the object is cut in sectional views.

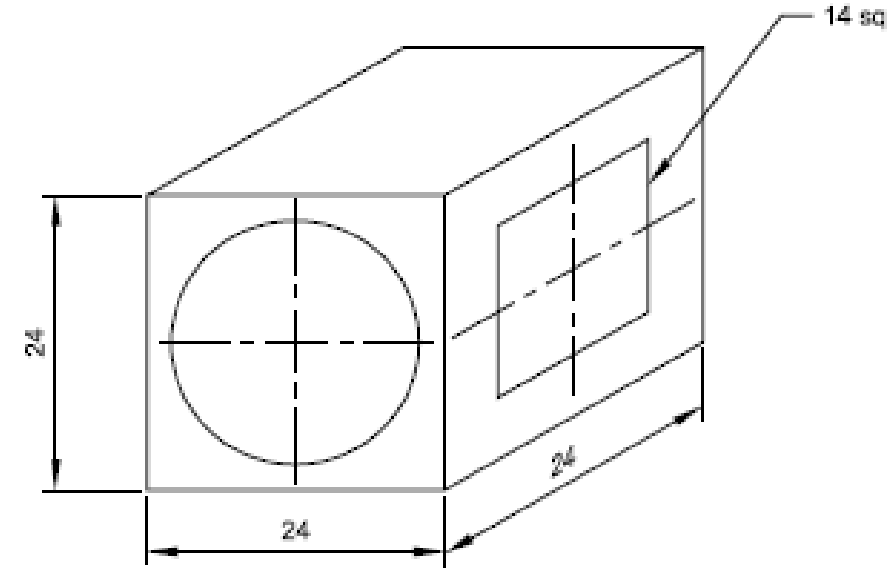
10. Chain Thin Double-Dashed Line

This line consists of thin long dashes with two short dashes in between. It is used to show outlines of adjacent parts, alternative positions of movable parts, centroidal lines, initial outlines before forming, and parts located in front of the cutting plane.



Exercise-2.2 : Draw the following free hand sketches. Indicate the types of lines used.

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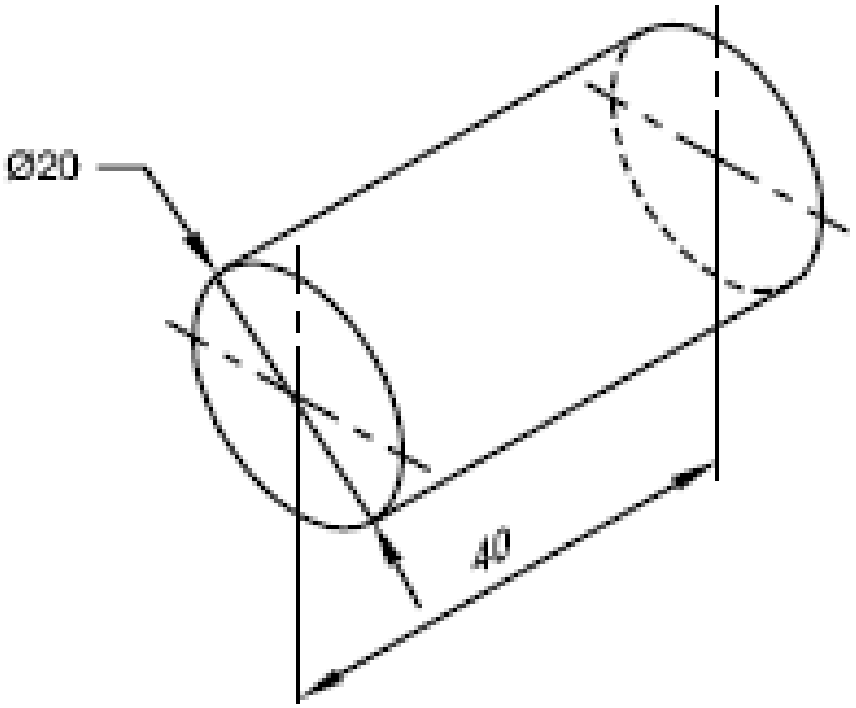
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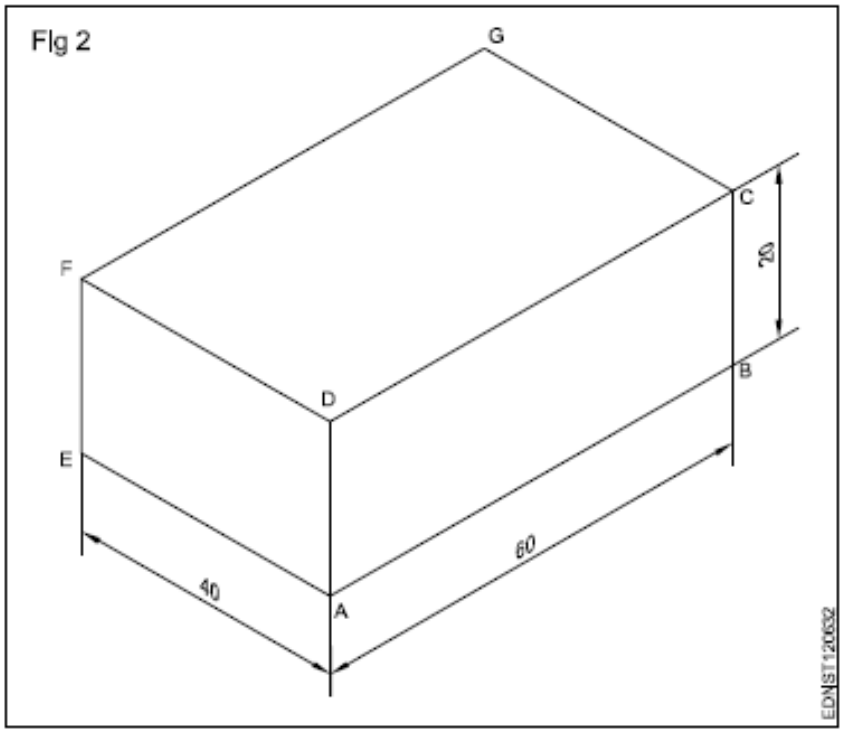
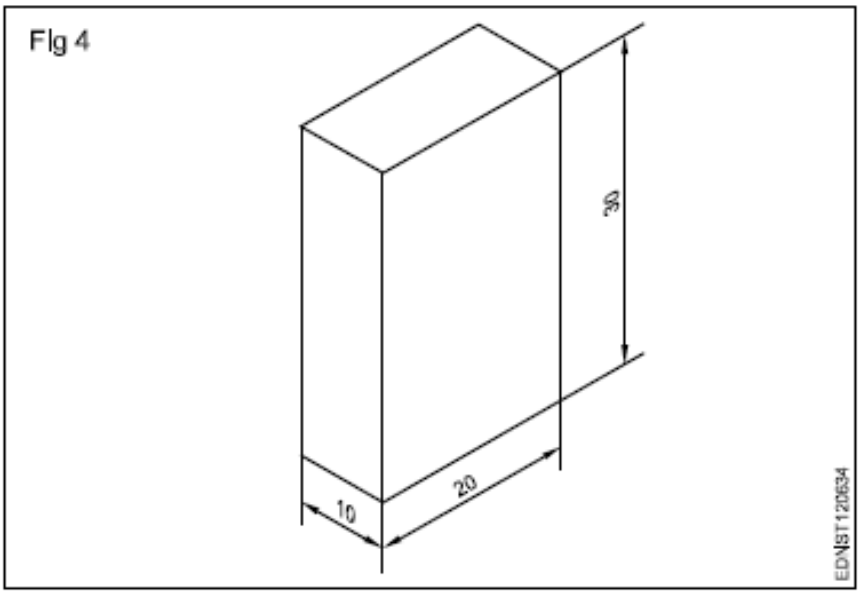
Cuboid (Fig 2)

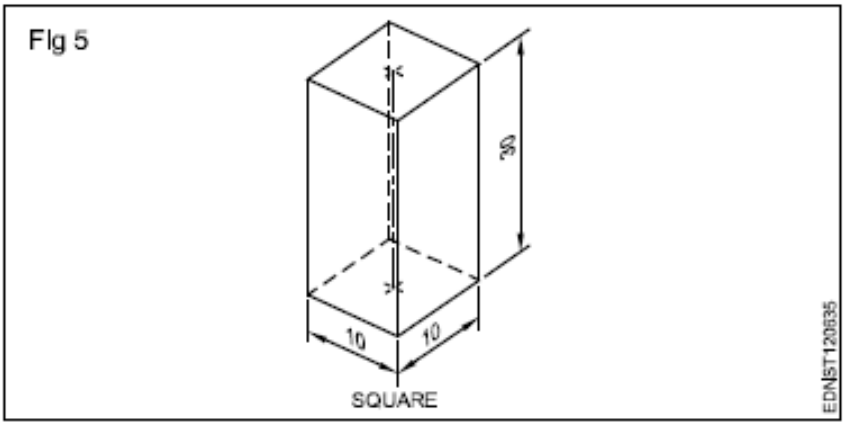
Draw the isometric drawing of a cuboid of base 60 mm x 40 mm and the height of 20 mm. (Fig 2)



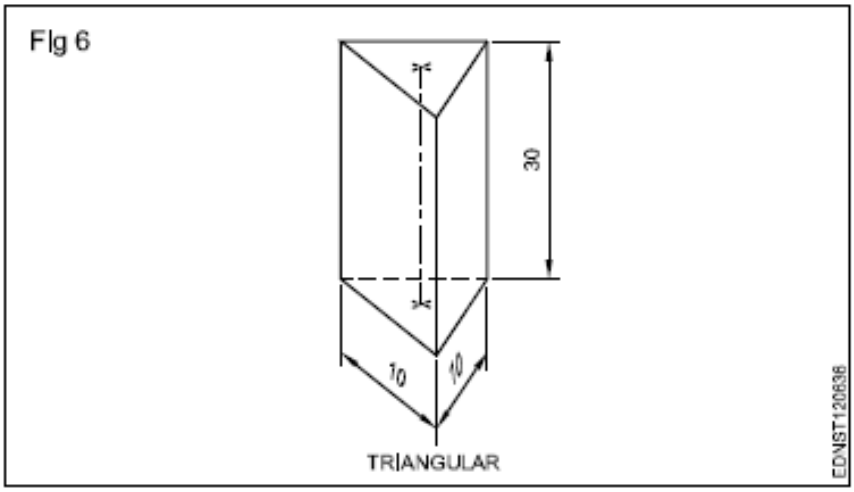
Rectangular prism (Fig 4)



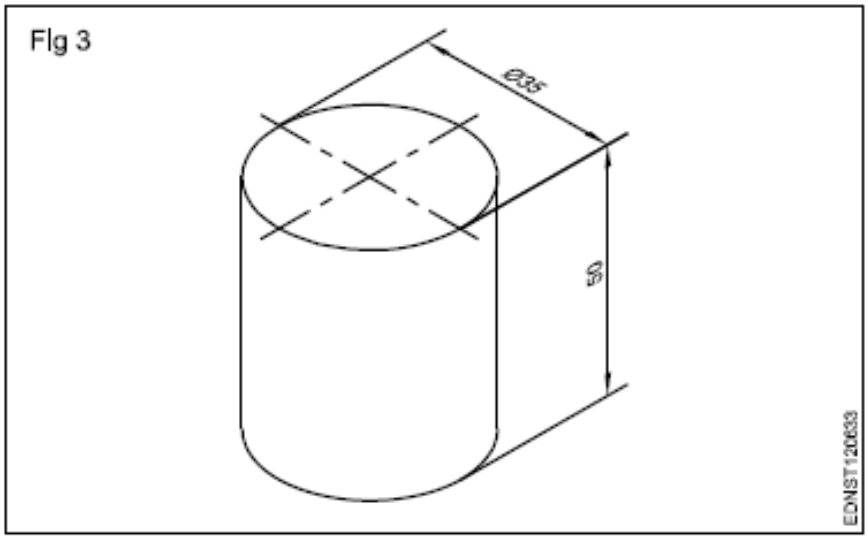
Square Prism (Fig 5)



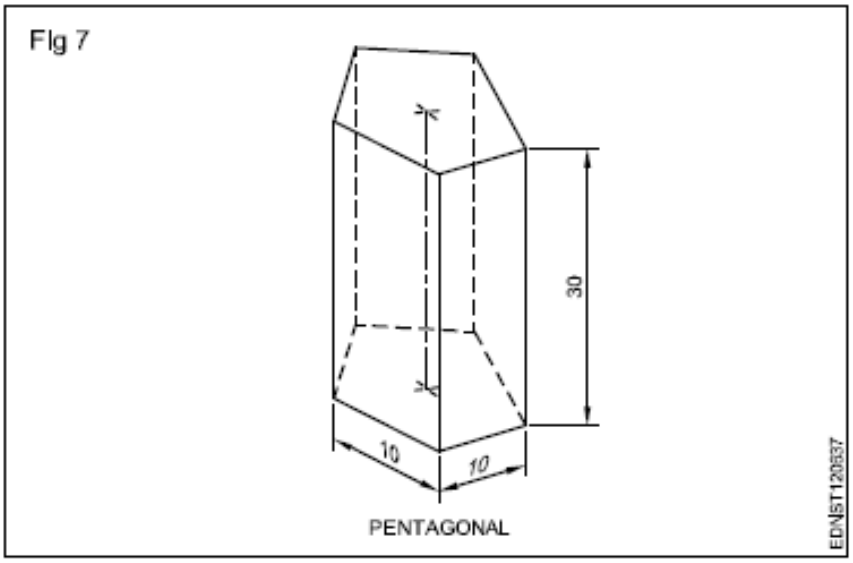
Triangular Prism (Fig 6)



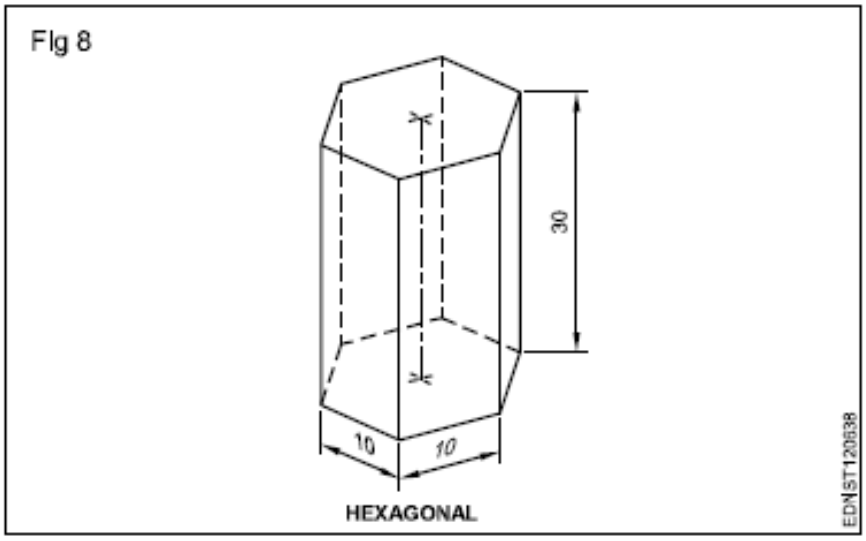
Cylinder (Fig 3)



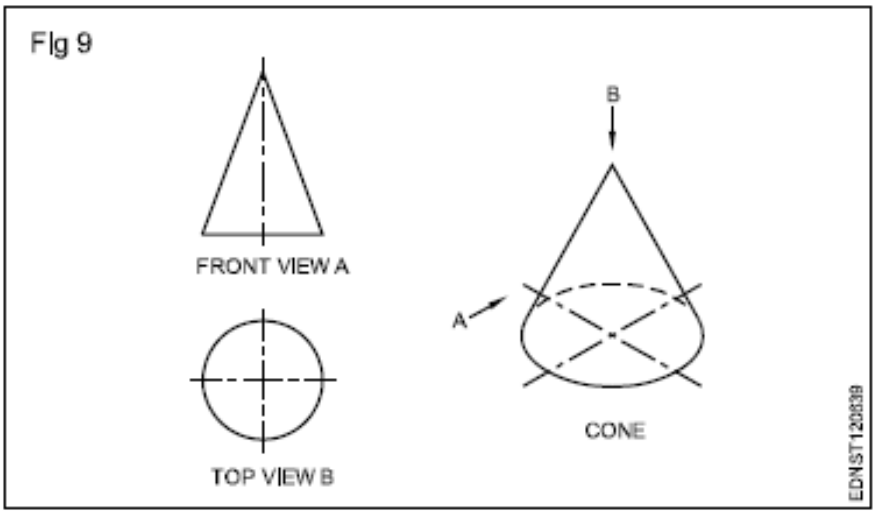
Pentagonal prism (Fig 7)

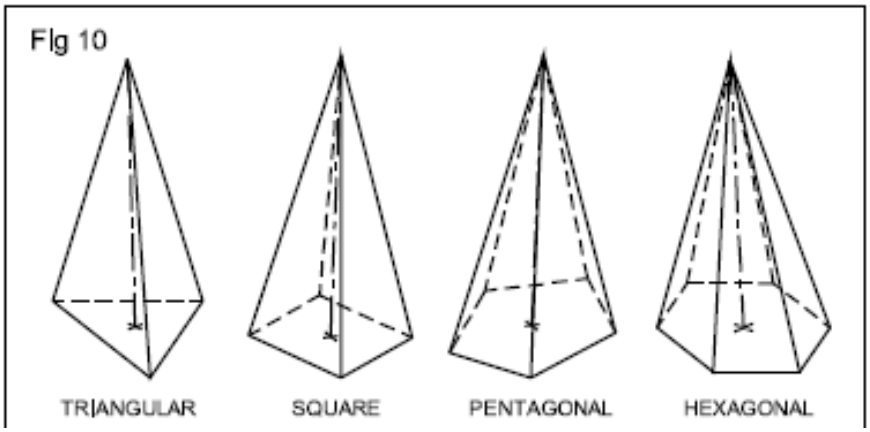


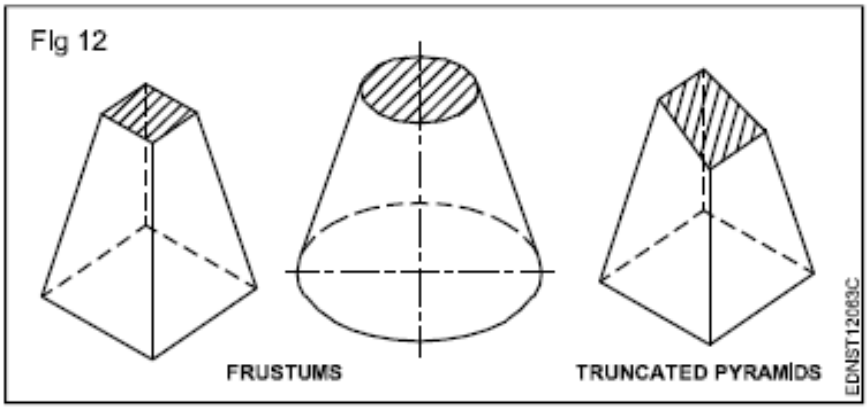
Hexagonal prism (Fig 8)



Cone: When a right-angled triangle revolves about one of its sides forming the right angle, a cone is generated. Cone forming has a circular face and a slant curved surface. (Fig 9)







Exercise- 2.3 : Free hand drawing of hand tools:

Free hand drawing of hand tools means sketching tools like hammer, spanner, screwdriver, plier, and chisel without using drawing instruments. It is done by hand using a pencil to develop observation and sketching skills. In free hand drawing, the correct shape, proportion, and important details of the tool must be shown clearly. Light guidelines are first drawn to maintain proper size and symmetry, and then the final outline is darkened. This method helps students understand the structure and appearance of tools and improves their drawing confidence and accuracy.

A file is used to smooth, shape, or remove small amounts of material from metal or wood surfaces. A hacksaw is a hand tool used to cut metal rods, pipes, or sheets. A ball pein hammer is mainly used in metal work for striking chisels and shaping metal. A chisel is used for cutting or shaping metal or wood by striking it with a hammer. A C-clamp is used to hold two objects firmly together during work. A screwdriver is used to tighten or loosen screws.

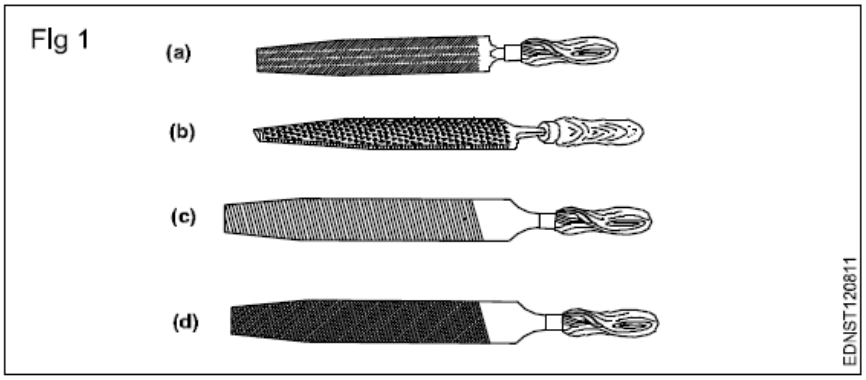
A bench vice is fixed to a workbench and is used to hold workpieces tightly while working on them. A marking knife is used to draw accurate marking lines on wood or metal surfaces. An open end spanner is used to tighten or loosen nuts and bolts. A steel rule is used to measure length accurately. A try square is used to check and draw right angles (90°).

A screwdriver with cross type tips is used for screws that have a cross-shaped head. Screw tips aided screw heads are specially designed screw heads that match specific screwdriver tips for better grip. An instrument screwdriver is a small screwdriver used for delicate repair work in small devices. A screwdriver with interchangeable tips has different removable tips for various screw types. A cutting plier is used to cut wires and small metal pieces.

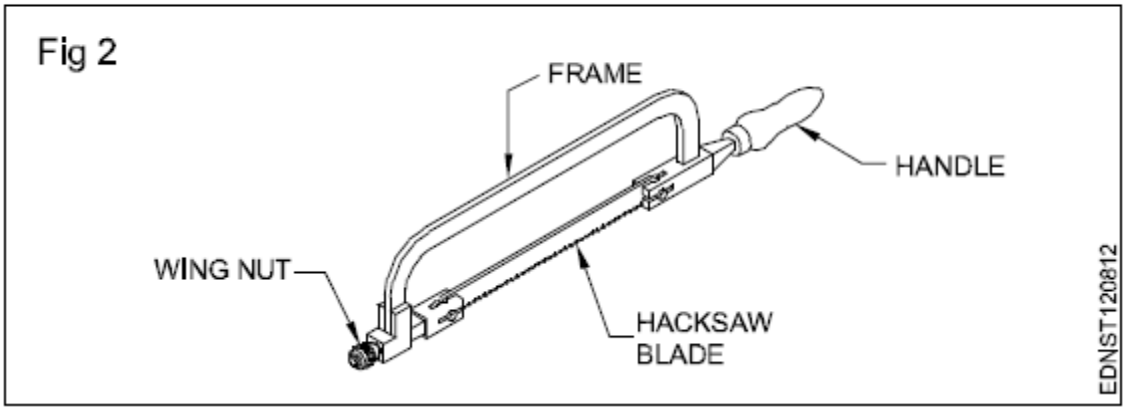
Files (Fig 1)

a Curved cut file b Rasp cut file

c Single cut file d Double cut file

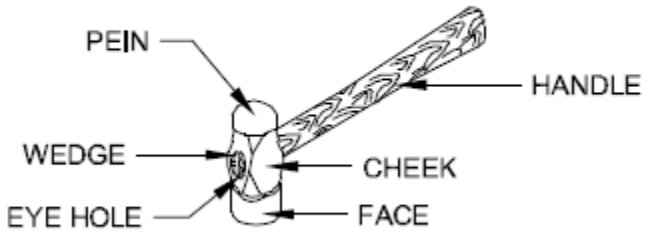


Hacksaw (Fig 2)



Ball pein hammer (Fig 3)

Fig 3



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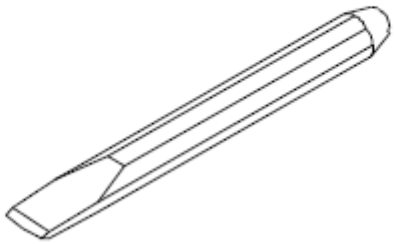
Chisel (Fig 4)

FIg 4



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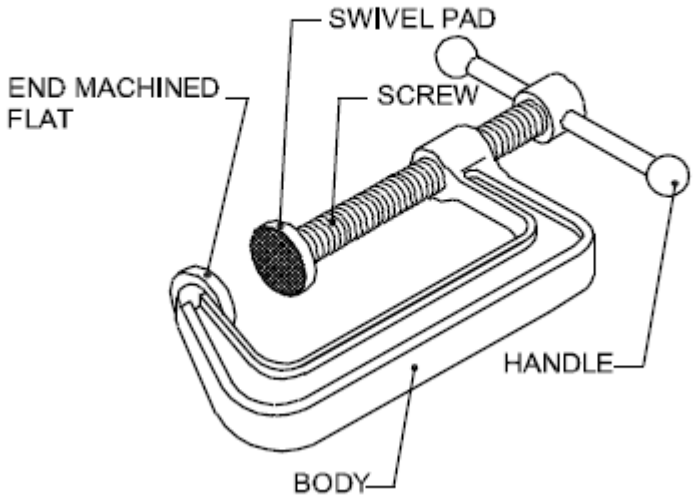
'C' clamp (Fig 5)

Fig 5



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Screw driver (Fig 6)

Flg 6

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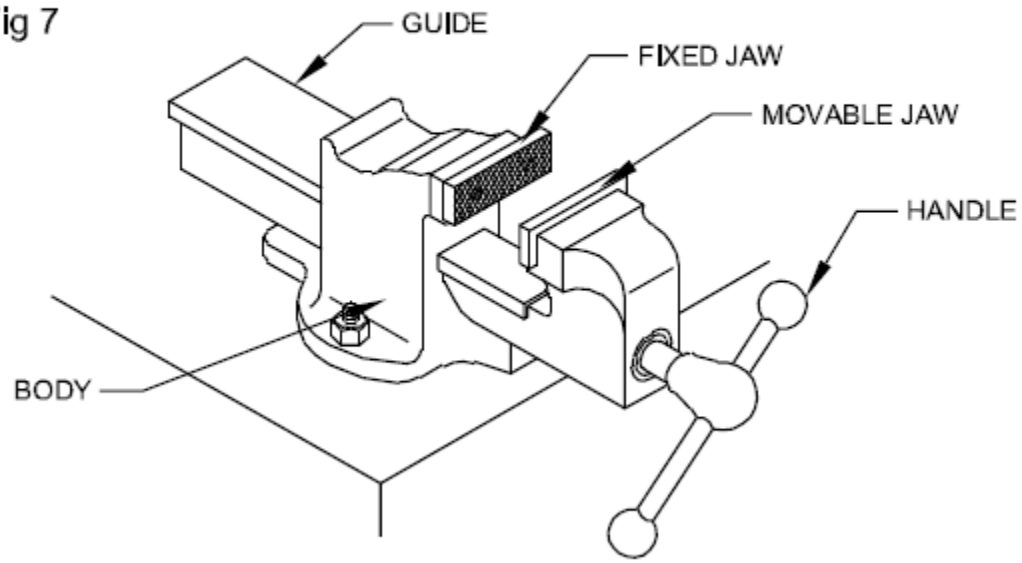
Bench vice (Fig 7)

Fig 7



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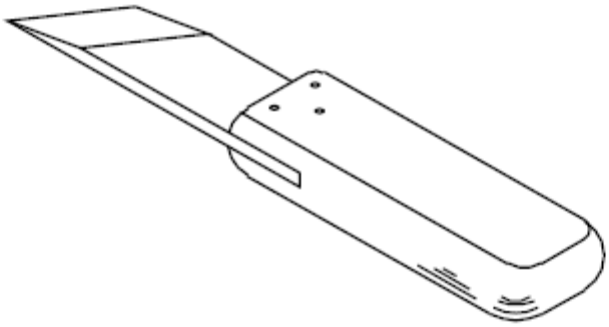
Marking knife (Fig 8)

Flg 8



MARKING KNIFE

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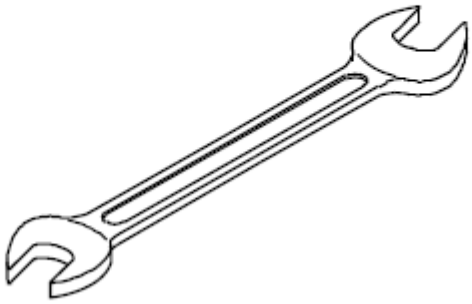
Open end spanner (Fig 9)

Flg 9



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Measuring Tools

Steel rule (Fig 10)

Fig 10

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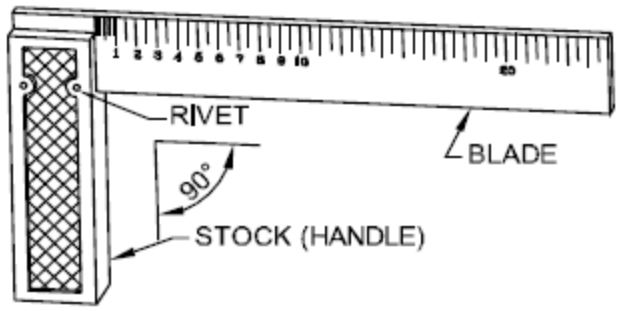
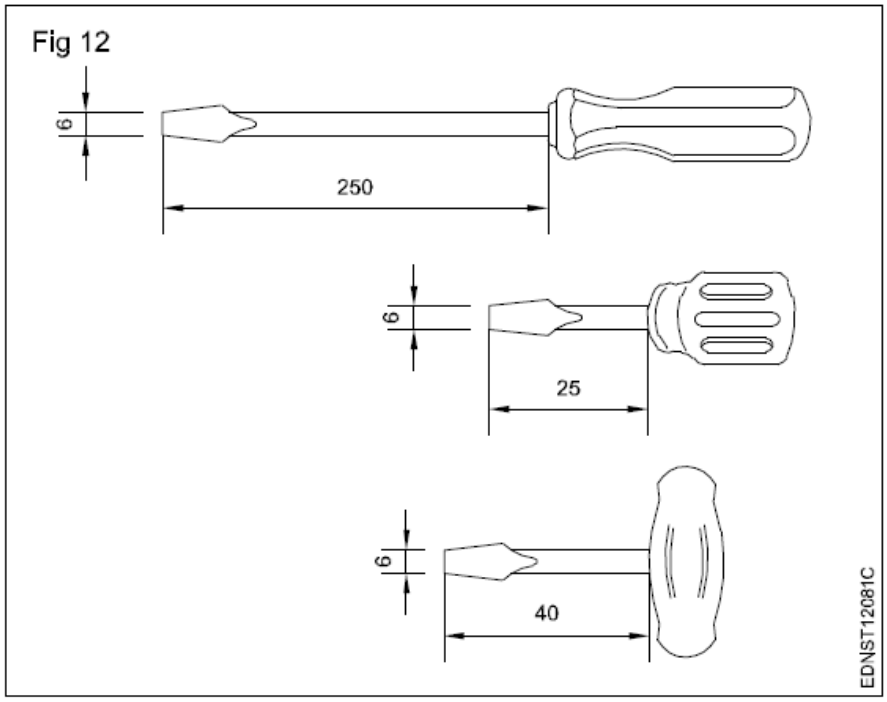
Try square (Fig 11)

Fig 11

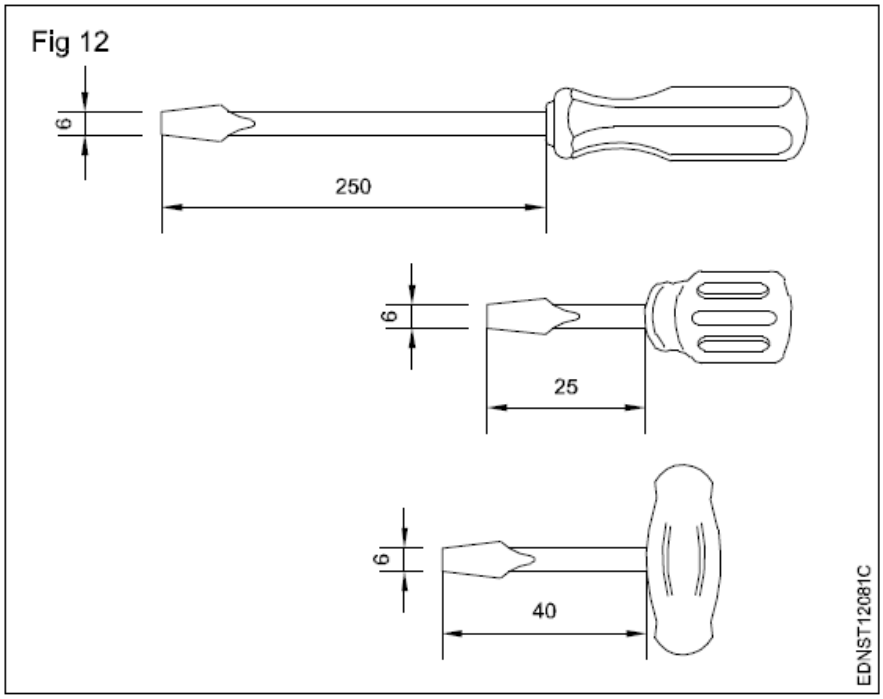


Screw driver (Fig 12)

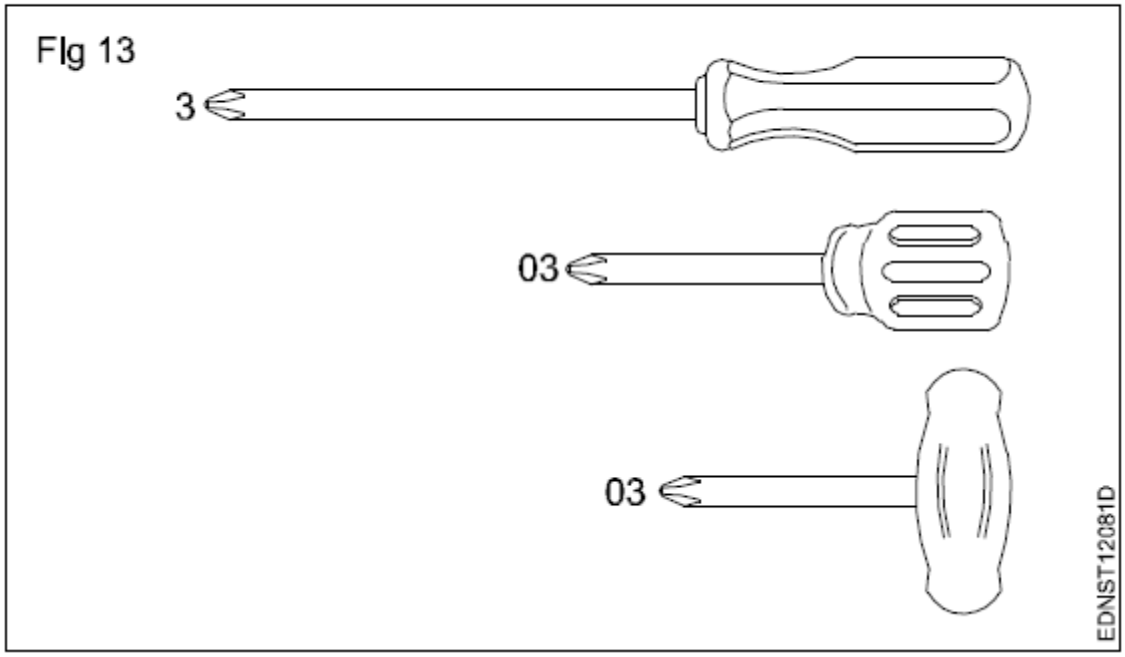
Fig 12



Screw driver (Fig 12)

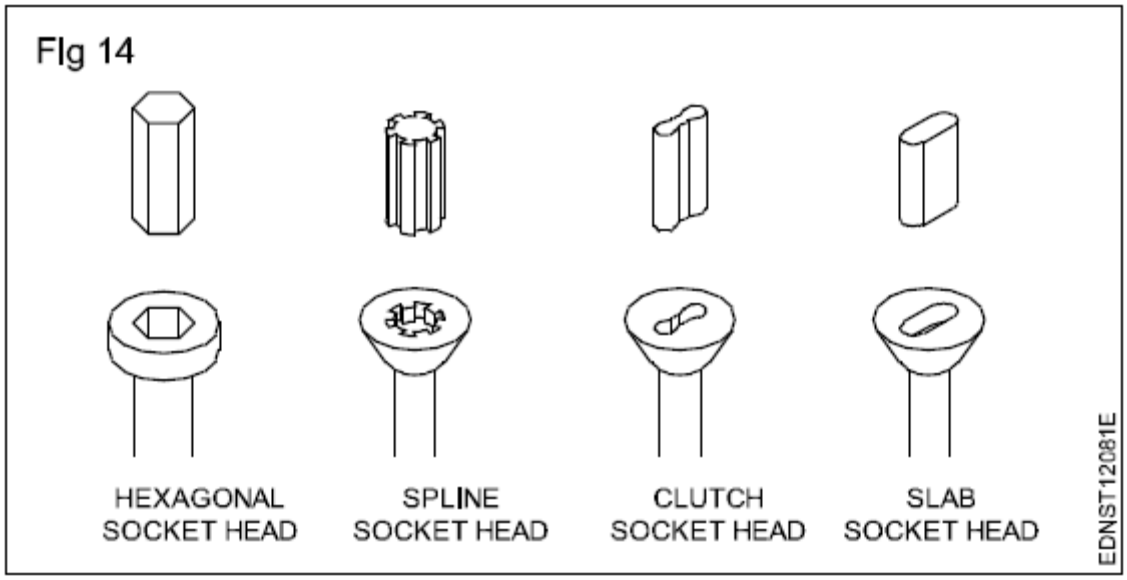


Screw driver with cross type tips (Fig 13)



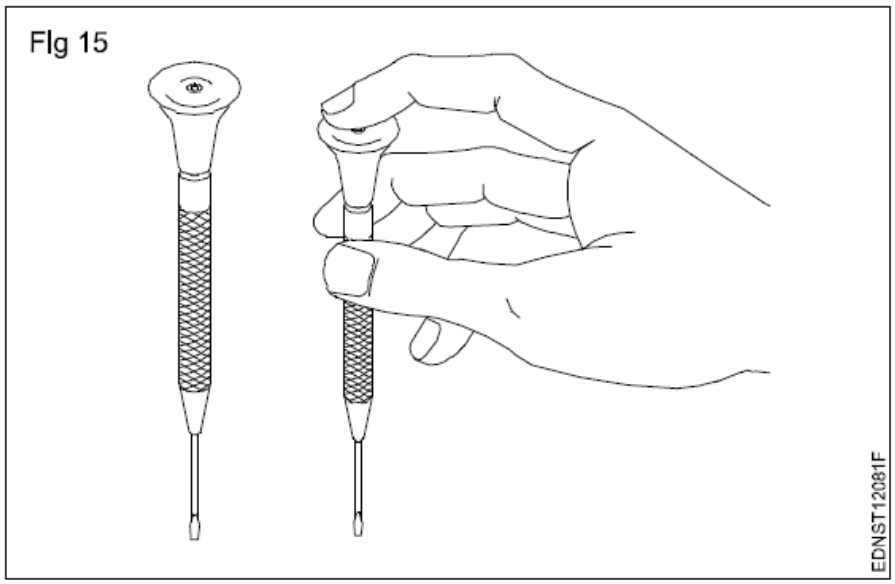
Screw tips aided screw heads (Fig 14)

Flg 14

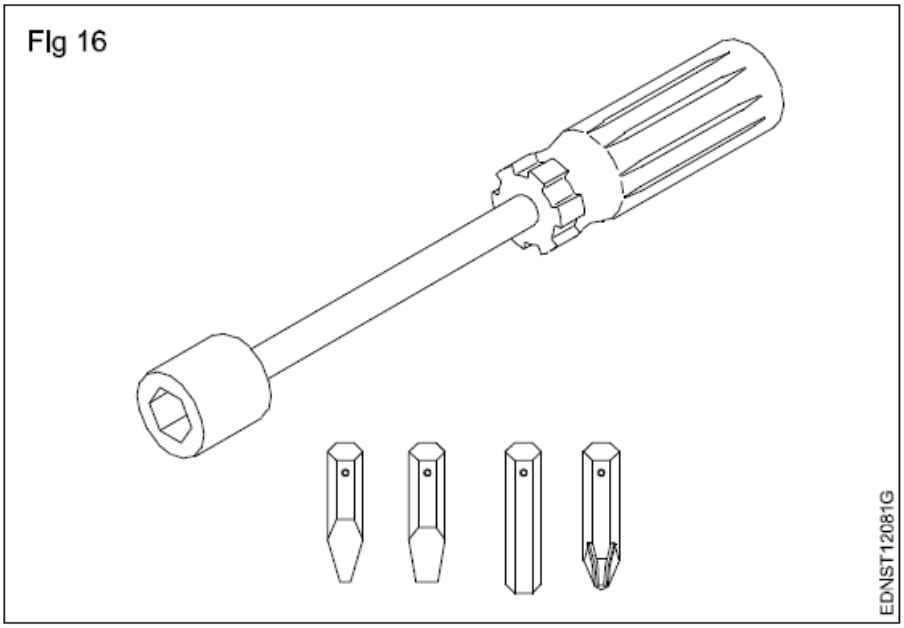


Instrument screw driver (Fig 15)

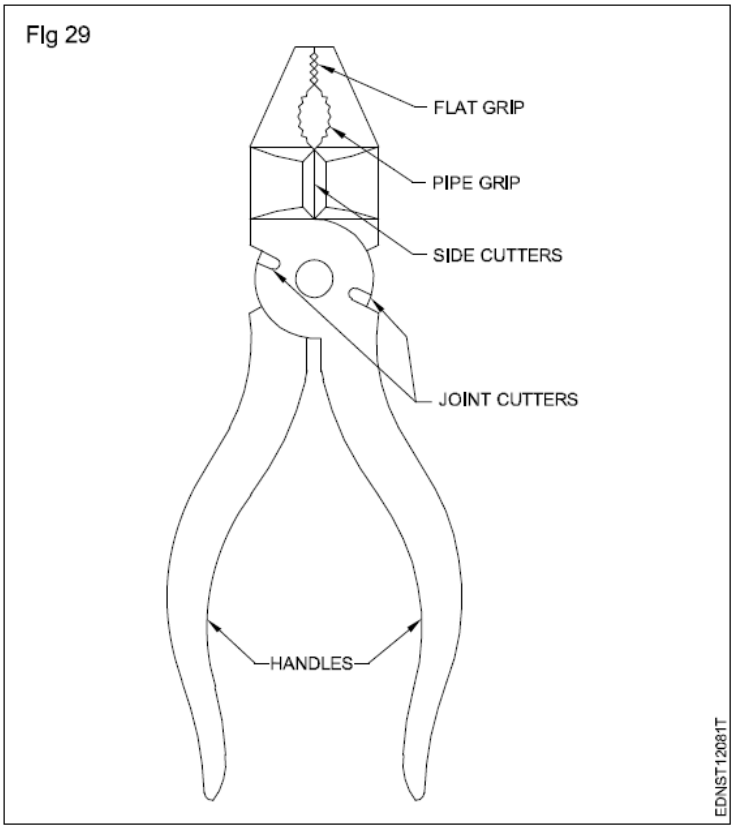
Flg 15



Screw driver interchangable tips (Fig 16)



Cutting plier (Fig 29)



Chapter-03 DRAWING OF GEOMETRICAL FIGURES

3.1 Concept of Angles and Degrees:

An angle is formed when two straight lines meet at a common point. The common meeting point is called the vertex, and the two lines are called the arms of the angle. The opening or amount of turn between the two arms is called the angle.

Angles are measured in degrees (°)**.** A complete circle is divided into 360 equal parts, and each part is called one degree. Therefore, one full rotation around a point is 360°**.** A half rotation forms 180°**,** which is a straight angle. A quarter rotation forms 90°**,** which is a right angle.

When one line rotates around a fixed point from one position to another, the amount of rotation is measured in degrees. For example, if a line turns halfway around a circle, it forms 180°.

In engineering drawing, understanding degrees is very important because angles must be drawn accurately to create correct shapes and designs.

Exercise-3.1 Types of Angles:

Acute Angle

An acute angle is an angle that is less than 90°. It is smaller than a right angle. For example, angles measuring 30°, 45°, or 60° are acute angles. These angles appear sharp and narrow in shape.

Right Angle

A right angle is exactly 90°. It is formed when one line is perpendicular to another line. It looks like the corner of a square or rectangle. Right angles are very common in engineering drawings and buildings.

Obtuse Angle

An obtuse angle is an angle that is more than 90° but less than 180°. It is wider than a right angle but does not form a straight line. For example, 120° or 150° are obtuse angles.

Straight Angle

A straight angle measures exactly 180°. It forms a straight line. When two lines extend in opposite directions from a point, they make a straight angle.

Reflex Angle

A reflex angle is an angle that is more than 180° but less than 360°. It is larger than a straight angle. For example, 210° or 270° are reflex angles.

Adjacent Angles

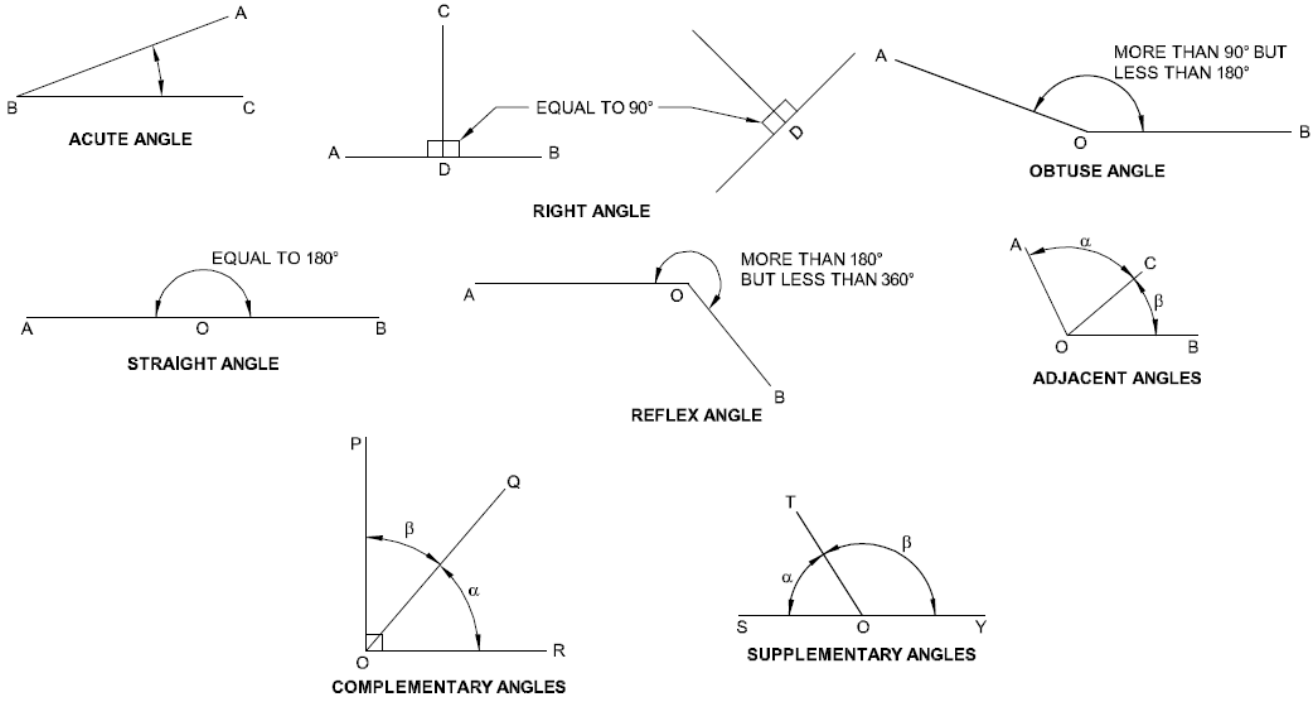
Adjacent angles are two angles that are next to each other and share a common side and a common vertex. They lie side by side without overlapping.

Complementary Angles

Complementary angles are two angles whose sum is equal to 90°. For example, if one angle is 40° and another is 50°, together they make 90°, so they are complementary angles.

Supplementary Angles

Supplementary angles are two angles whose sum is equal to 180°. For example, if one angle is 110° and another is 70°, together they form 180°, so they are supplementary angles.



Exercise-3.2 Types of Triangles

Equilateral triangle :An equilateral triangle is a triangle in which all three sides are equal in length. Because all sides are equal, all three angles are also equal. Each angle in an equilateral triangle measures 60°. This type of triangle is perfectly balanced on all sides.

Isosceles triangle: An isosceles triangle is a triangle that has two sides equal in length. The angles opposite to those two equal sides are also equal. The third side may be different. This type of triangle looks symmetrical from the middle.

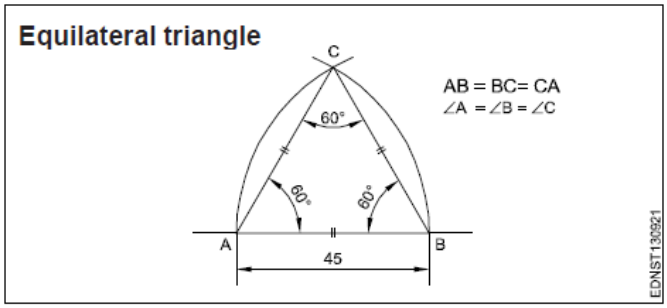
Scalene triangle: A scalene triangle is a triangle in which all three sides are of different lengths. Because all sides are different, all three angles are also different. There is no equal side or equal angle in this triangle.

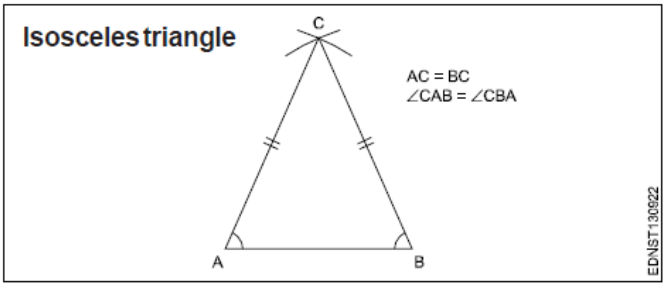
Right-angled triangle: A right-angled triangle is a triangle in which one angle is exactly 90°. The side opposite to the 90° angle is called the hypotenuse, and it is the longest side of the triangle.

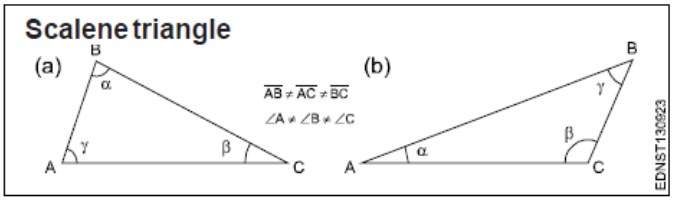
Acute-angled triangle: An acute-angled triangle is a triangle in which all three angles are less than 90°. All the angles are sharp and small.

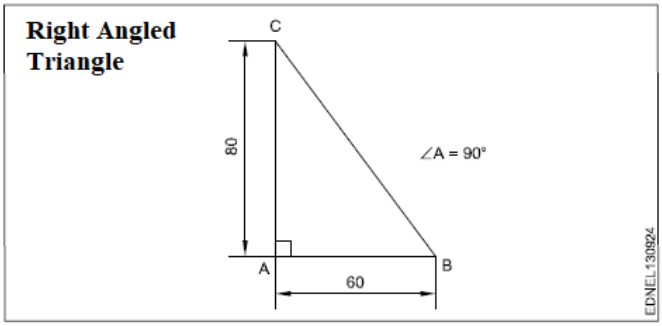
Obtuse-angled triangle: An obtuse-angled triangle is a triangle in which one angle is greater than 90°. The other two angles are always less than 90°.

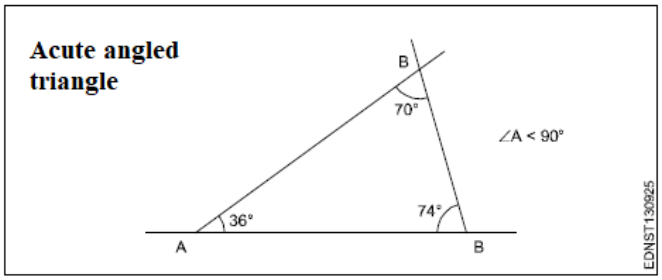
In every triangle, the sum of all three angles is always 180°.

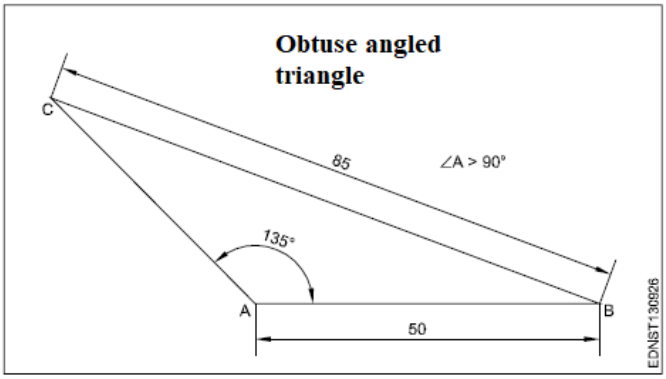

Equilateral triangle
C
AB = BC= CA
∠A = ∠B = ∠C
60°
60°
60°
A
B
45
EDNST130921


Isosceles triangle
C
AC = BC
∠CAB = ∠CBA
A
B
EDNST130922


Scalene triangle
(a)
B
α
γ
β
A
C
AB ≠ AC ≠ BC
∠A ≠ ∠B ≠ ∠C
(b)
B
γ
β
α
A
C
EDNST130923


Right Angled Triangle
C
80
∠A = 90°
A
B
60
EDNEL130924

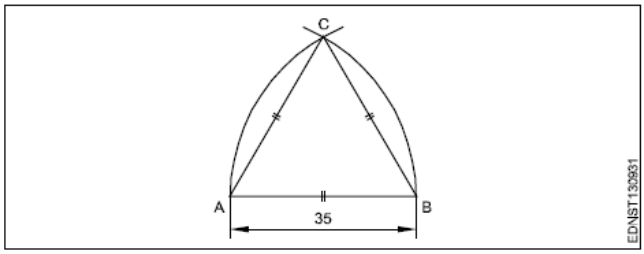




Exercise-3.3 : Problems:

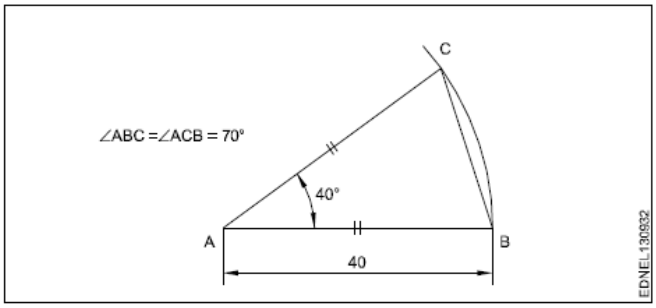
1. Construct an equilateral triangle ABC in which AB = BC = CA = 35 mm using a compass and scale.

Equilateral triangle (Fig 1) AB = BC = CA = 35 mm.



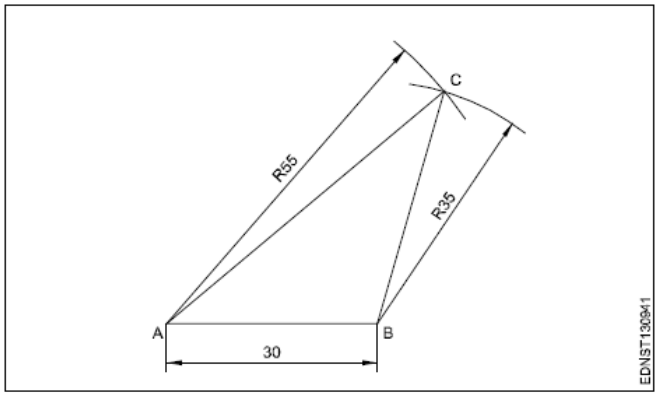
2. Construct an isosceles triangle ABC in which AB = AC = 60 mm and the angle ∠BAC = 40° using a compass and scale

Isosceles triangle : AB = AC = 60 mm & ∠BAC = 40°.



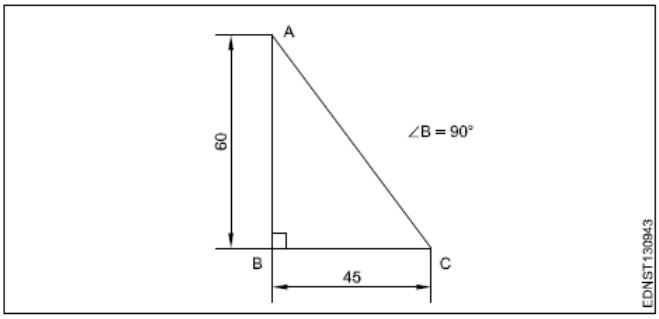
3. Construct a scalene triangle ABC in which AB = 30 mm, AC = 55 mm, and BC = 35 mm using a compass and scale.

Scalene triangle: AB = 30 mm, AC = 55 mm & BC= 35 mm.



4. Construct a right-angled triangle ABC in which AB = 60 mm, BC = 45 mm, and ∠B = 90° using a compass and scale.

Right angled triangle: AB = 60 mm, BC = 45 mm.

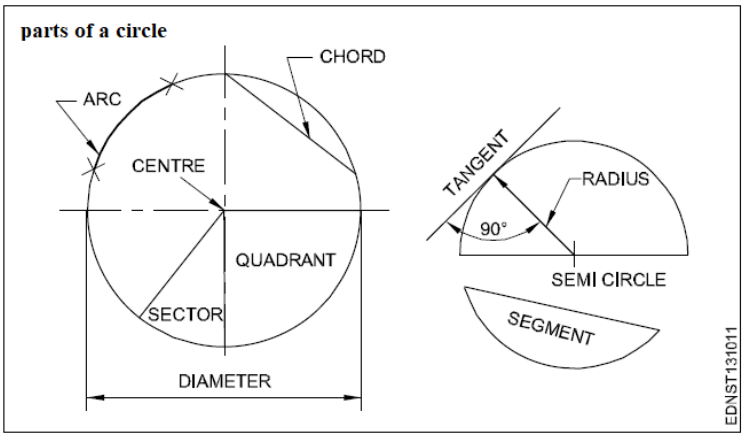


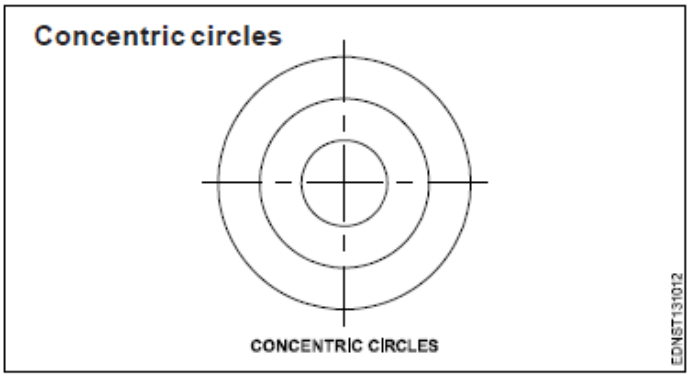
Exercise- 3.4 Elements (Parameters) of a Circle

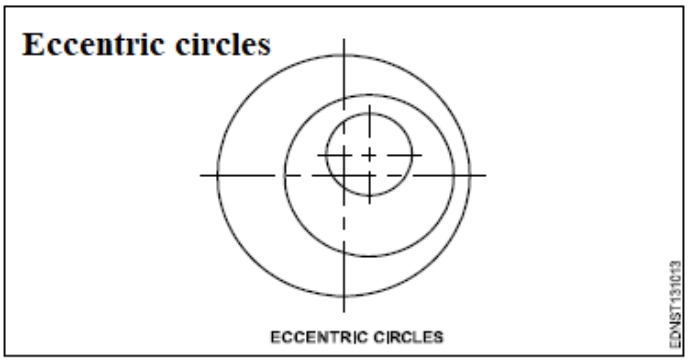
Circle: A circle is a flat shape formed by a curved line in which every point on the boundary is at the same distance from a fixed point called the centre.

Centre: The centre is the fixed point inside the circle from which all points on the circle are equally distant.
Radius: The radius is the distance from the centre to any point on the circle. It is usually written as "R". All radii of a circle are equal.
Diameter: The diameter is a straight line that passes through the centre and joins two points on the circle. It is the longest chord of the circle. The diameter is equal to 2 × radius**.**
Circumference: The **circumference** is the total length of the curved boundary of the circle.

Arc: An arc is a part of the circle's boundary between any two points on the circle.
Chord: A chord is a straight line joining any two points on the circle. The longest chord of a circle is the diameter.
Segment: A segment is the area between a chord and the arc of the circle.
Sector: A sector is the region of a circle formed by two radii and the arc between them.
Quadrant: A quadrant is one-fourth of a circle. It is formed when two radii make a 90° angle at the centre.
Semi-circle: A semi-circle is half of a circle. It is formed when the circle is divided by a diameter.
Tangent: A tangent is a straight line that touches the circle at only one point. It does not cut the circle.
Concentric Circles: Concentric circles are two or more circles that have the same centre but different radii.
Eccentric Circles: Eccentric circles are circles that have different centres.

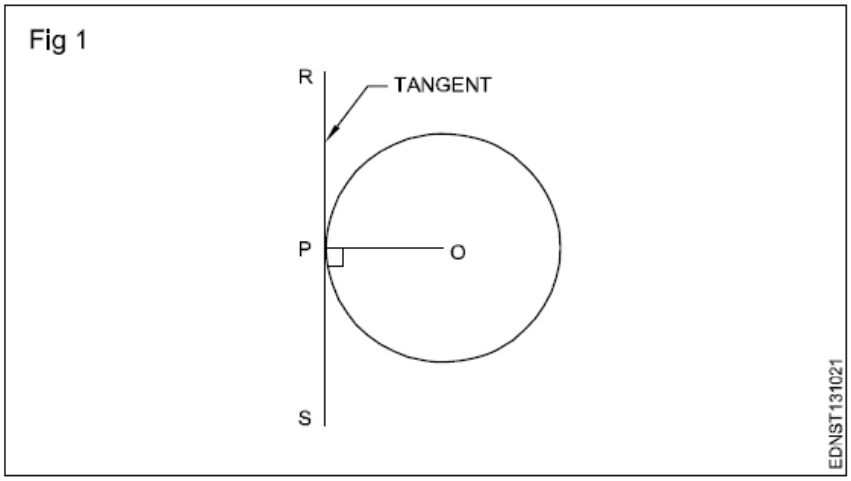






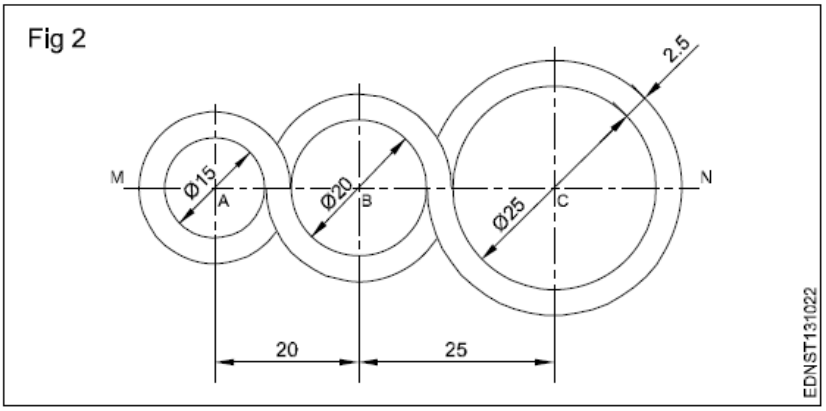
Exercise-3.5: Problems.

1 Draw a tangent to a given circle of ϕ 50 mm at any point `P' on it. (Fig 1)

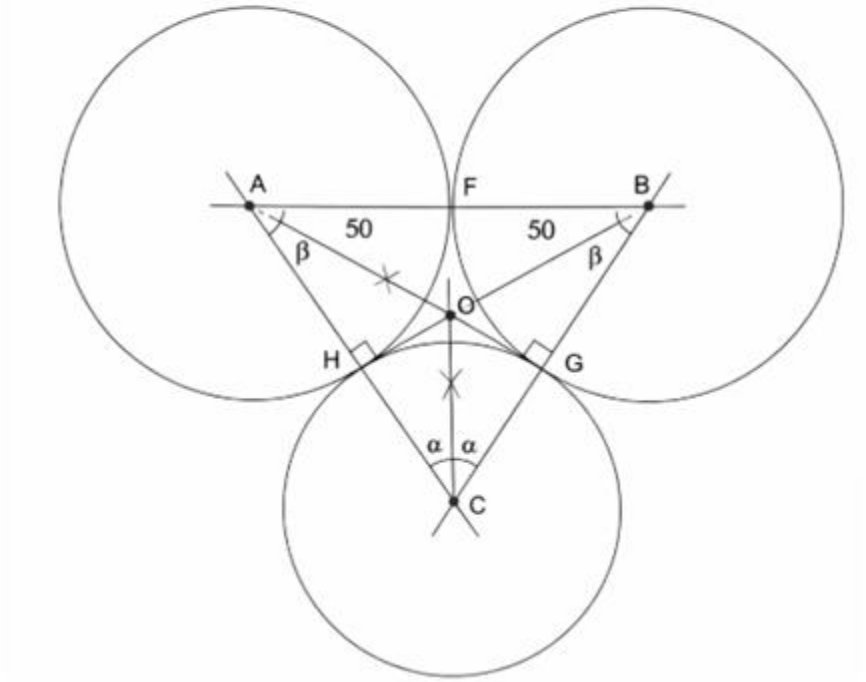


2 Draw a loop of 3 circles pattern. (Fig 2)

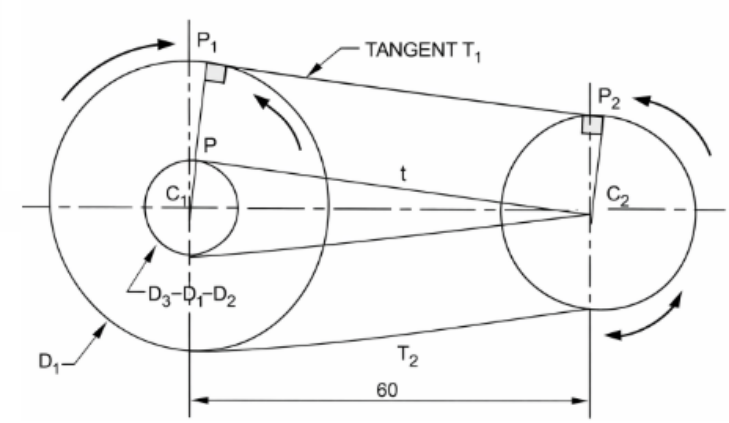
Draw any line MN and mark points A,B and C. So that AB = 20 mm and BC = 25 mm.



3. Construct three circles that are externally tangential to each other if the centres A, B, and C form an equilateral triangle of side 50 mm.



4 Draw external tangents to circles of dia 40 and 30 and centre distance 60 mm. (Fig 4)



Exercise-3.6 Drawing of geometrical figures - Square, rectangle and parallelogram

Quadrilateral (Trapezium):

A quadrilateral is a closed plane figure formed by four sides and four angles. The sum of the interior angles of any quadrilateral is always 360°**.** It has four vertices and two diagonals, which join opposite corners. To construct a quadrilateral, we need a minimum of five measurements, including at least two sides. Common types of quadrilaterals include square, rectangle, and parallelogram.

Square

A square is a four-sided figure in which all four sides are equal in length. All four angles of a square are right angles (90°). The opposite sides are parallel to each other. The diagonals of a square are equal in length and bisect each other at right angles. This means they cut each other into two equal parts and form 90° at the centre.

To draw a square, first draw a base line of the required length. Then draw perpendicular lines at both ends and mark equal lengths on them. Join the top points to complete the square. A square can also be constructed using a 45° set square and compass.

Rectangle

A rectangle is a four-sided figure in which opposite sides are equal and parallel. All four angles are right angles (90°). Unlike a square, the adjacent sides are not necessarily equal. The diagonals of a rectangle are equal, but they do not bisect each other at right angles.

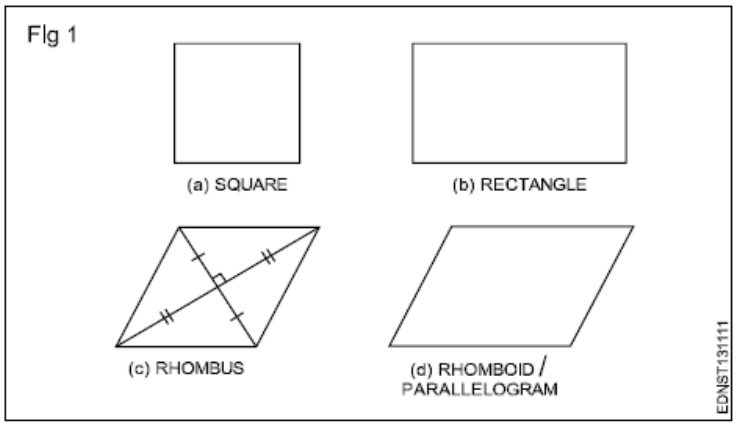
To draw a rectangle, draw a base line equal to the required length. At both ends, draw perpendicular lines and mark the required height. Then join the top points to complete the rectangle.

Parallelogram (Rhomboid)

A parallelogram is a four-sided figure in which opposite sides are equal and parallel. Opposite angles are also equal. The adjacent angles are supplementary (their sum is 180°). The diagonals of a parallelogram bisect each other, but they are not equal in length and do not meet at right angles.

To draw a parallelogram, first draw a base line. From one end, draw a line at a given angle and mark the required length. Then draw a line parallel to the base from the top point, and another

line parallel to the side from the other end of the base. Joining these lines completes the parallelogram.

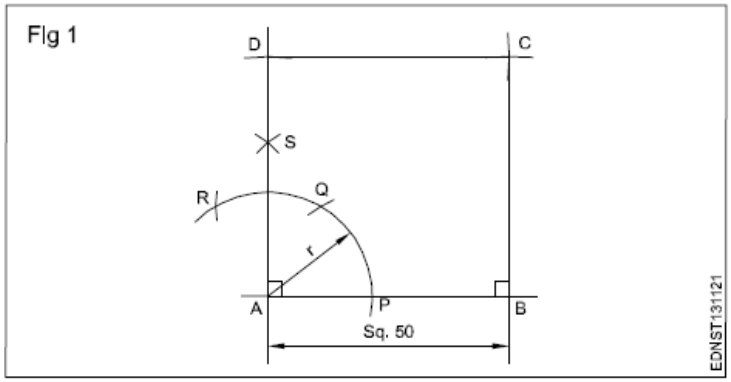


Exercise-3.7: Problems

1. Construct a square ABCD of side 50 mm by erecting perpendiculars at the ends of the base line using a compass and set square.

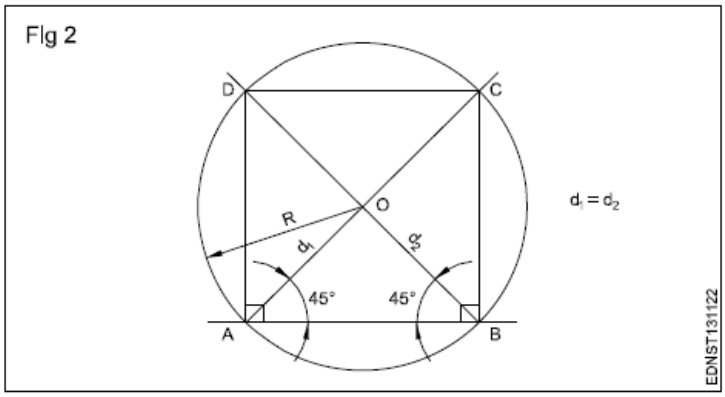
Square

1 **1st method** (Fig 1): A square of side 50 mm by erecting perpendicular.



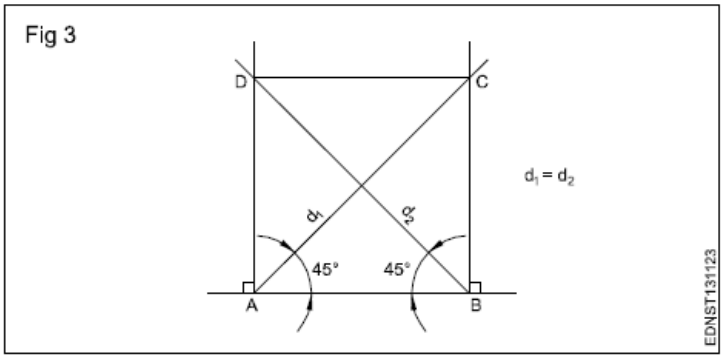
2. Construct a square ABCD of side 60 mm using a 45° set square and compass.

2 2nd method (Fig 2): A square of side 60 mm using 45° setsquare and compass.



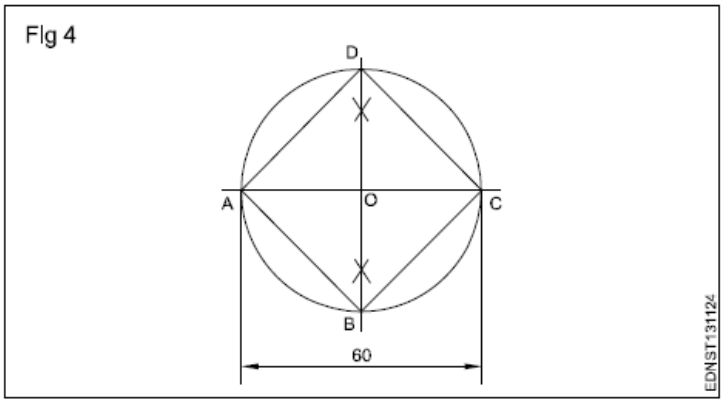
3. Construct a square ABCD of side 60 mm by erecting perpendiculars at the ends of the base and using a 45° set square to complete the figure.

3 3rd method (Fig 3): A square of side 60 mm long by erecting perpendicular and also using 45° setsquare.



4. Construct a square ABCD having its diagonal equal to 60 mm using a compass and scale.

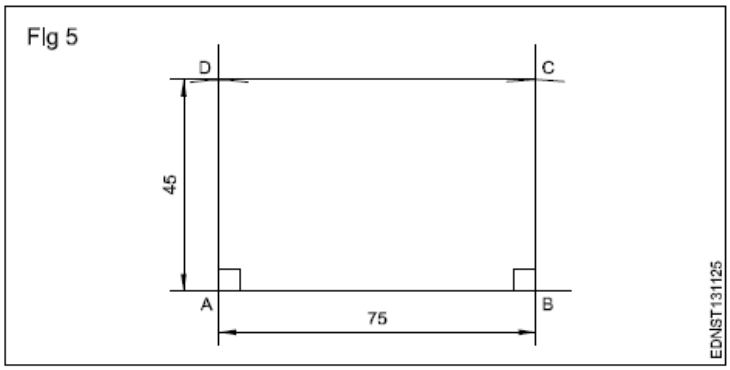
4 Square having diagonal 60 mm (Fig 4)



5. Construct a rectangle ABCD in which side AB = 75 mm and side AD = 45 mm using a set square and compass.

5 Rectangle (Fig 5)

Side AB = 75 mm, side AD = 45 mm using setsquare and compass.

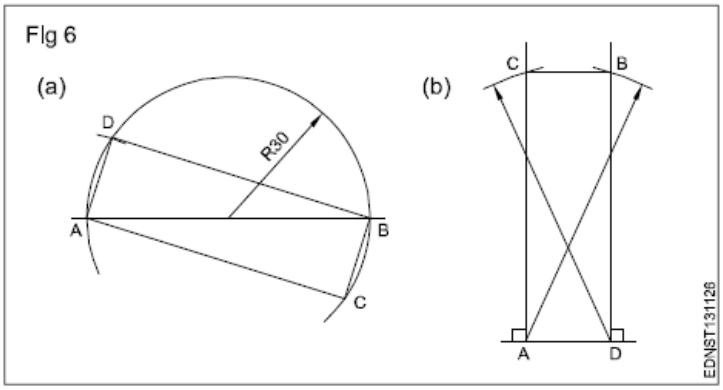


6. Construct a rectangle ADBC in which one side is 20 mm and the diagonal is 60 mm using suitable geometrical methods (Method 1 and Method 2) with compass and set square.

6 Rectangle - Diagonal - 60 mm and one side 20 mm
1st method (Fig 6a)

2nd method (Fig 6b)

ADBC is the required rectangle of side 20 mm and diagonal 60 mm.

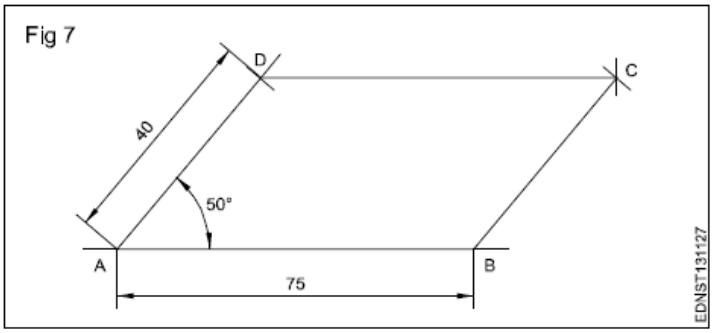


7. Construct a parallelogram ABCD in which the adjacent sides are 75 mm and 40 mm, and the angle between them is 50°, using a compass and scale.

7 Parallelogram (Fig 7)

Sides = 75 mm and 40 mm

Angle between them: 50°

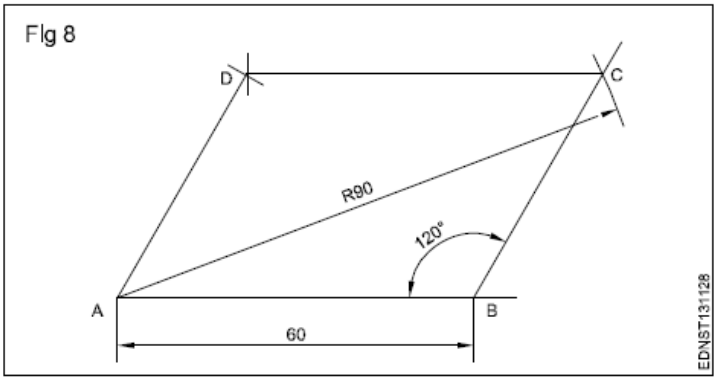


8. Construct a parallelogram ABCD in which side AB = 60 mm, diagonal AC = 90 mm, and angle ∠ABC = 120°, using a compass and scale.

8 Parallelogram (Fig 8)

Parallelogram - Side AB = 60 mm

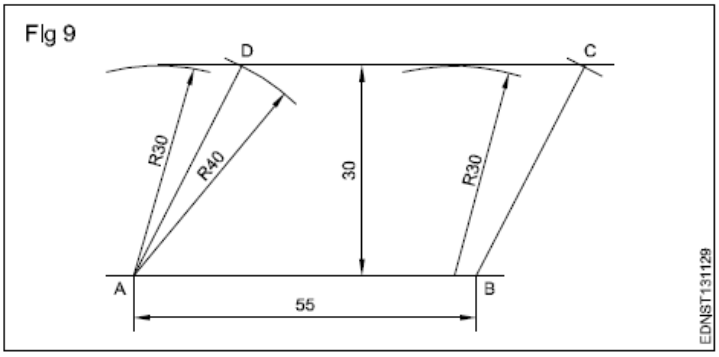
Diagonal AC = 90 mm ∠ABC = 120°



9. Construct a parallelogram ABCD in which AB = 55 mm, BC = 40 mm, and the vertical height of the parallelogram is 30 mm, using a compass and scale.

9 Parallelogram (Fig 9)

Sides AB = 55 mm, BC = 40 mm and vertical height = 30 mm.



3.2 Lettering and numbering - Single stroke:

Lettering and Numbering – Single Stroke and Double Stroke

In engineering drawing, lettering and numbering are used to write titles, dimensions, notes, and other important information. The letters must be clear, neat, and uniform so that the drawing can be easily read and understood. To maintain this uniformity, standard lettering styles are followed.

Single Stroke Lettering:

Single stroke lettering is the most commonly used style in engineering drawing. In this method, each letter is drawn using one uniform line thickness. The thickness of the letter is the same throughout, and it is formed with simple strokes without shading. This style is easy to write,

saves time, and provides clear readability. Therefore, it is widely used for most engineering drawings.

Double Stroke Lettering:

Double stroke lettering is formed by drawing the outline of a letter with two strokes and then filling or thickening the space between them. In this method, the letters appear bolder and more prominent. It takes more time compared to single stroke lettering and is generally used for titles or important headings where emphasis is required.

Standard Heights of Letters:

Letters are written in standard heights such as 2.5 mm, 3.5 mm, 5 mm, 7 mm, 10 mm, and 14 mm. These standard sizes ensure uniformity and proper proportion in engineering drawings.

Thickness of Letters

The thickness of letters is proportional to their height. There are two standard types:

- Type A lettering – thinner lines where d = h/14
- Type B lettering – thicker lines where d = h/10

These standards help maintain clarity and consistency.

Width of Letters

The width of letters is measured in terms of the stroke thickness (d). Some letters like **I** are narrow, while letters like **W** are wide. Most letters have medium width. Proper width and spacing improve neatness and readability.

Spacing of Letters :

In engineering drawing, proper spacing of letters is very important to make the writing clear and easy to read. According to BIS SP:46–2003 standards, correct spacing must be maintained between letters, words, and lines.

Spacing Between Letters

The space between two letters should be uniform and proportional to the thickness of the letter (d). The spacing should be enough so that letters do not touch each other, but not too much that they look separated. Proper spacing makes the word look balanced.

Spacing Between Words

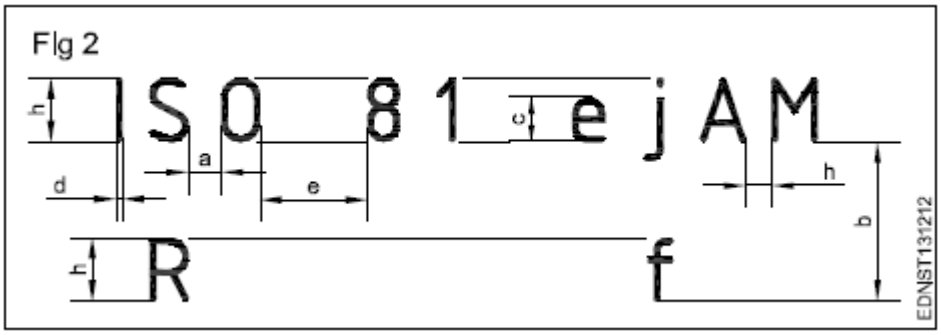
The space between two words should be slightly more than the spacing between letters. This helps to clearly separate one word from another and improves readability.

Spacing Between Lines (Baselines)

The distance between two lines of writing should be sufficient so that letters from one line do not overlap with letters from the line above or below. Proper baseline spacing keeps the text neat and organized.

Exercise-3.8: Height and Proportion

Explain the standard spacing of letters in engineering drawing as shown in Fig. 2. Define and describe the significance of h (height of capital letters), c (height of small letters), d (stroke thickness), a (spacing between letters), e (spacing between words), and b (spacing between baselines). Also explain why proper proportion and spacing are important in lettering.



The height of capital and small letters must follow standard sizes. The proportions of width, height, and spacing are maintained based on the stroke thickness (d).

Correct spacing between letters, words, and lines makes engineering drawing neat, clear, and easy to read. Proper spacing gives a professional appearance to the drawing.

- **h** = height of capital letters
- **a** = space between letters
- **e** = space between words
- **c** = height of small letters
- **b** = space between lines

Exercise-3.9: Single stroke capital letters and numerals:

1. Practice and construct single stroke inclined capital letters and numerals in the ratio 7:5 (and other specified proportions as shown) using standard engineering lettering guidelines with the help of set square.

SINGLE STROKE INCLINED LETTERS

Single stroke inclined letters are slanted letters drawn at a fixed angle (usually 75°) using a set square. Follow these simple steps on your drawing sheet:

Step 1 – Draw Guidelines
First draw two horizontal lines using a T-square:

- Bottom line = baseline
- Top line = letter height line (for example 7 mm or 10 mm depending on required size)

These lines decide the height of all letters.
Step 2 – Draw Inclination Lines
Place a 45° set square on the T-square and adjust it to get a 75° angle (by combining 45° and 30° set squares or using a protractor if needed). Draw light inclined guide lines across the writing area.
These lines guide the slant of letters so all letters tilt equally.
Step 3 – Mark Letter Width
Using a scale, mark equal spacing for each letter width according to proportions. Keep:

- small gap between letters
- larger gap between words

Draw light vertical limit lines to define each letter's width.
Step 4 – Construct Letters
Inside each space:

- Draw letters using single uniform strokes (same thickness).
- Follow the inclined guide lines so all letters slant at the same angle.
- Use straight strokes first, then curves.

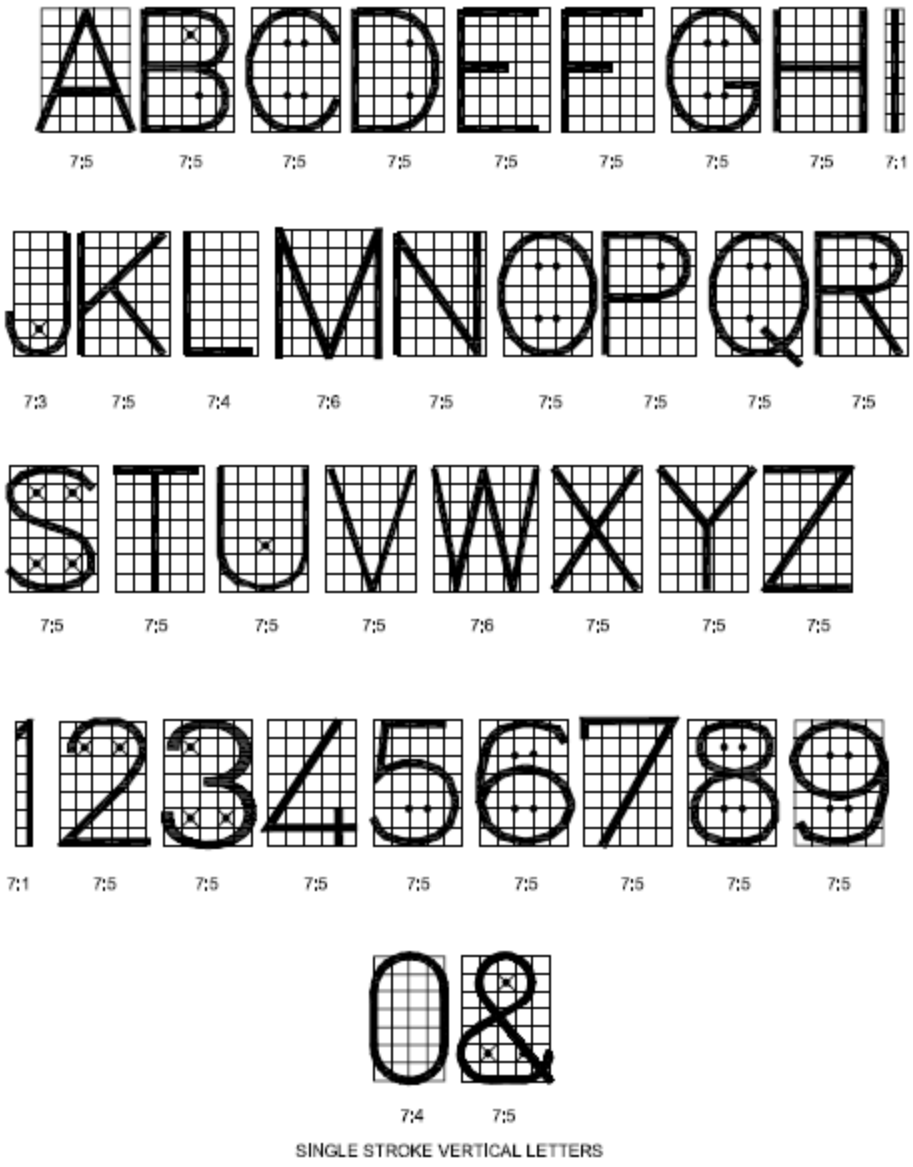
Step 5 – Darken Final Letters
After checking alignment and spacing:

- Darken only the final strokes.
- Erase construction lines and extra guidelines.

Tips for Accuracy

- Keep pencil sharp (use H or 2H for guidelines).
- Maintain equal spacing.
- Do not change slant angle.
- Keep line thickness uniform.

2. Practice and construct single stroke vertical capital letters and numerals in the ratio 7:5 (and other specified proportions as shown) using standard engineering lettering rules and guidelines.



SINGLE STROKE VERTICAL LETTERS

These are single stroke vertical letters**,** which means the letters stand straight (not slanted) and are drawn with uniform line thickness. Follow these simple steps on your drawing sheet:

Step 1 – Draw Horizontal Guidelines

Using a T-square, draw light horizontal lines:

- Bottom line = baseline
- Top line = letter height line

Choose a standard height such as 7 mm or 10 mm. These lines keep all letters equal in height.

Step 2 – Draw Vertical Guidelines

Place a set square against the T-square and draw light vertical lines at regular intervals. These lines help maintain:

- equal letter width
- straight vertical strokes
- proper spacing

Step 3 – Mark Letter Width

Measure and mark the width of each letter lightly according to proportion. Keep:

- small spacing between letters
- slightly larger spacing between words

Step 4 – Construct Letters

Inside each marked space:

- Draw letters using single strokes of uniform thickness.
- Follow vertical guidelines for straight strokes.
- Draw curves carefully within the grid.
- Keep proportions same as shown.

Step 5 – Darken Final Letters

After confirming alignment:

- Darken the final letter lines.
- Erase construction lines and extra guidelines.

Tips for Neat Lettering

- Use H or 2H pencil for guidelines and HB for final letters.
- Keep spacing uniform.
- Maintain same height and width proportion.
- Draw lightly first, then darken.

Note: The dots are only training guides to help you draw correct curves. They are not part of the final letters. Letters are drawn freehand, not with a compass.