ITE 116 INTRODUCTION TO TECHNICAL DRAWING

Technical drawing is a graphic language that is universally accepted. It provides a means by which the shapes and sizes of objects are drawn on paper showing three dimensional views, length, breadth and width.

Aims/objectives of Technical Drawing:-

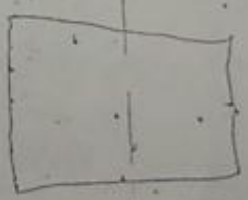
(i) Technical drawing provides a means by which those working in industries such as mechanical engineering, building, architecture or electrical engineering, communicate their ideas of the shape, form, size and dimensions of the objects, articles or materials being produced.

(ii) A knowledge of technical drawing allows you to think of the object being produced in three dimensions - length, breadth and width.

Technical drawing is important as a design tool for communicating ideas among people working on any project in industries, organisations, medical houses etc.

* SOME OF THE THINGS INVOLVED IN ITEM 6.

* Drawing equipment, drawing layout
* Numbering and lettering
* Principle of Construction of common figures
* Construction of angles, triangles, circles tangents, quadrilaterals and polygons using different methods of Construction
* Methods of drawing Circles, i.e. four equal Circles in a Square.
* Bisection of straight lines in to two equal parts or more
* Bisection of angles into number of pieces.
* Further work on plain geometrical Construction etc.



1.0 DRAWING INSTRUMENT/EQUIPMENT AND MATERIAL

Neatness and accuracy are essential in all geometrical and technical drawing and in order to get a very good grade, it is important that the right equipment/instruments is used in the correct manner. In most technical colleges and schools, the instruments or equipments used for class work include the following items:-

(i) Drawing Boards

These are mostly made from plywood with a smooth flat surface and straight edge to allow the T-square to be moved up and down.

(ii) T-Square

The T-square is used in conjunction with the drawing board mainly to draw parallel or horizontal lines and support set squares when drawing vertical lines or angles. The T-square is made up of blade and stock. The stock must be pressed firmly against the edge of the board before drawing any lines. It must never be used for drawing vertical lines. The edge of the blade need special care so that it is kept smooth all the time.

(iii) Drawing paper:-

Drawing papers come in various sizes ranging from A0 - A4. Good quality A2 size drawing paper (594mm x 420mm) should be used for class work and home work. The following are the dimensions of the papers in millimeters:-

A4	210 x 297mm
A3	297 x 420mm
A2	420 x 594mm
A1	594 x 841mm
A0	841 x 1189 mm

(iv) Set-Squares.

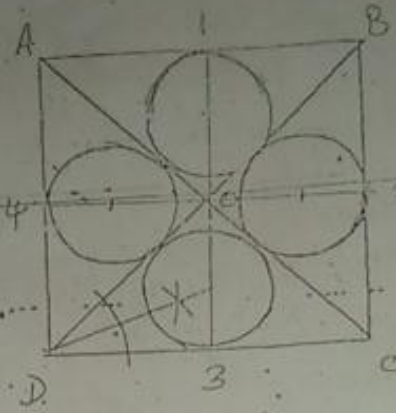
The set-squares come in two types, there is 45° and 30° x 60° separately.

There is also a combined or adjustable set square for a skilled draughtsman.

The set-squares are used in conjunction with a T-square to draw vertical or inclined lines.

(v) Protractor.

This is an instrument used for measuring or drawing angles. In the absence of adjustable set square, protractor is required [illegible]



To inscribe a regular octagon in a given square

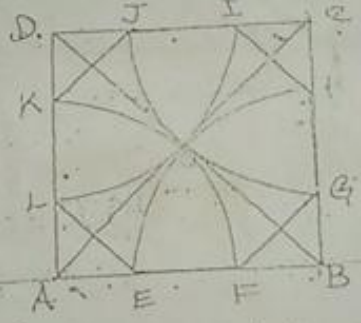
steps:-

(i) Draw the given square ABCD

(ii) Draw the diagonals AC and BD intersecting at centre

(iii) With each vertex as centre and half the diagonal as radius describe arcs concurrently.

(iv) Join EFGHIJKL as the required regular polygon.



To construct a square and any regular polygon given the length of side using the general method.

steps:-

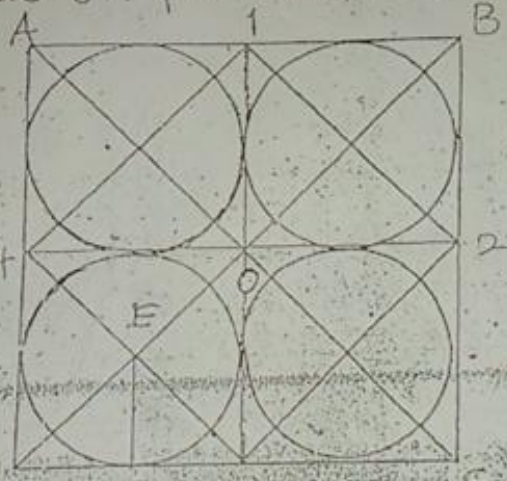
(i) Draw the given side AB and bisect it. Construct a square on AB. Draw a diagonal on the square to cut the bisector of AB at 4. With centres A and B intersect and radius AB draw arcs to intersect at 5. Join 4 to obtain point 6. Take mark 4-5 and step it off to obtain point 7, 8, 9 etc.

(ii) To draw a pentagon ABCDE as a centre radius AB and

Q. Inscribe four equal circles in a square each to touch two sides and two other circles.

Steps:

(i) Draw the given square
(ii) Draw the diagonals AC and BD
(iii) Through the intersection of the diagonals at O, draw the perpendiculars 1-3 and 2-4
(iv) Draw the diagonals 1-2, 2-3, 3-4 and 4-1
(v) Draw EF perpendicular to the side DC
(vi) With radius EF and the intersections of the four diagonals, draw the four circles.



Q. To inscribe four equal circles in a square, each to touch one side and two other circles.

Steps:-

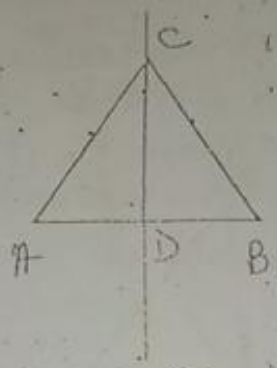
(i) Draw the given square
(ii) Draw the diagonals AC and BD
(iii) Through the intersection of the diagonals at O, draw perpendiculars to sides 1-3; 2-4
(iv) Bisect angle OA3 to give centre E
(v) With centre O and radius OE mark the remaining three centres on the perpendiculars
(vi) With radius E3, on each of the centres draw the four circles.

(3)

To construct an isosceles triangle given the baseline AB and the altitude CD.

Steps:-

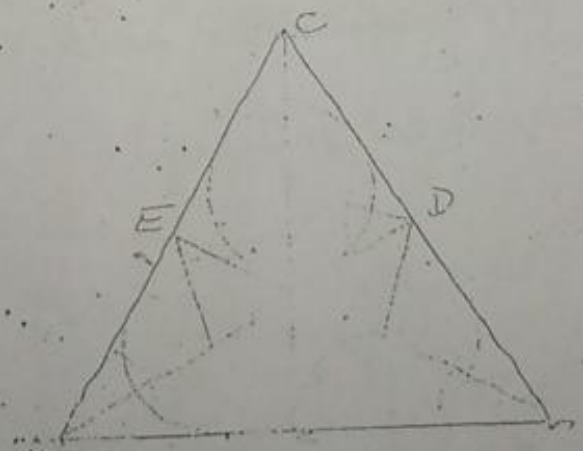
(i) Draw line AB to a convenient length.
(ii) Bisect baseline AB to get the altitude CD.
(iii) Draw CD perpendicular to AB
(iv) Join AC and BC to complete the triangle.



To inscribe three equal circles within an equilateral triangle

Steps:-

(i) Construct the equilateral triangle
(ii) Bisect each of the three angles A, B and C
(iii) Bisect each of the angles AEB, CDA and ADB where these bisectors meet the bisectors of the angles of the triangles are the centres of the circles.



Q1

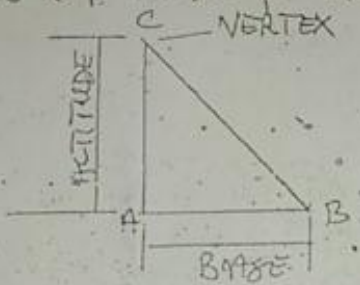
The three angles of any triangle add up to 180°. This means that if two of the three angles are known the third angle can be easily found.

Features of a triangle...

(i) Base :- Any side of the triangle can be considered as the base, and this side is usually drawn horizontally.

(ii) Altitude :- is the perpendicular distance from the base to the vertex

(iii) Vertex :- is the top most point of the triangle.



Construction of Triangles :-

To construct an equilateral triangle given the altitude AB

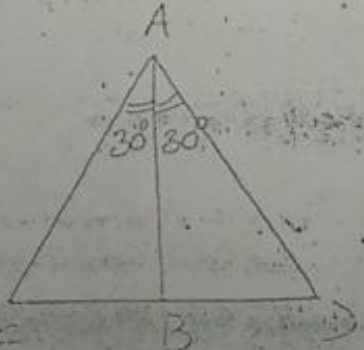
Steps

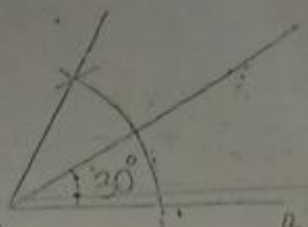
(i) Draw the altitude AB

(ii) On each side of AB construct angles at 30°

(iii) At B draw a perpendicular and produce it to C and D

(iv) ACD is the required triangle





Triangles:-

A triangle is a polane rectilinear figure bounded by three straight lines which form three angles at corners.

Types of triangles:-

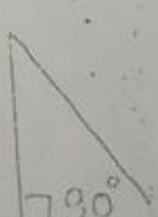
(i) Equilateral triangle:- It has all the three sides equal in length and the three angles the same

(ii) Isosceles triangle:- This has only two sides the same in length and the two angles opposite these sides are also the same

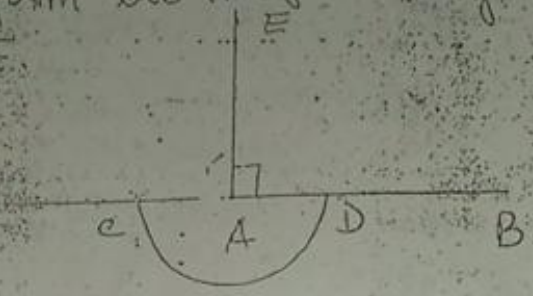
(iii) Scalane triangle:- It has all the three sides unequal and also the three angles are unequal.

(iv) Right angled Triangle:-

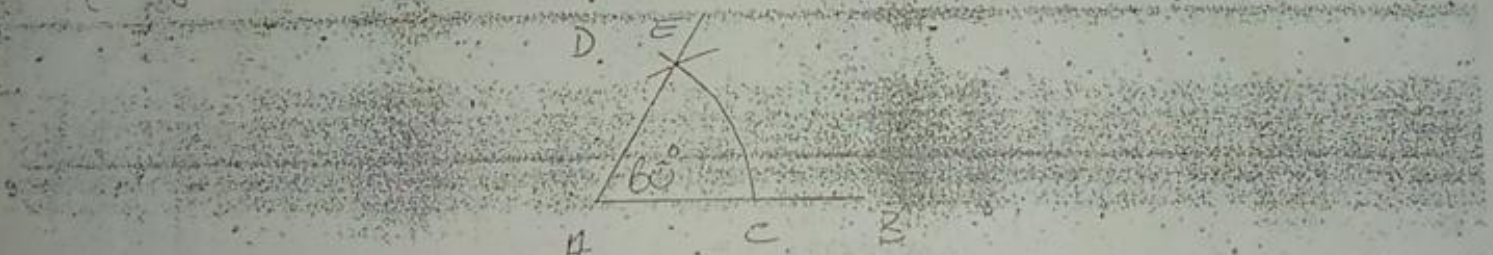
This has one angle = 90°, the side opposite this angle is called the hypotenuse



(i) With Centres C and D and any convenient radius draw ares to Intersect at E.
(ii) Draw a line from A and through the point of intersection of the ares, this is the perpendicular that form the right angle with the line AB at A.



To Construct an angle of 60° using Compass method.
(i) Draw line AB to a Convendent length
(ii) With Centre at A, using any Convenient radius draw an arc CD
(iii) With Centre at C using the same radius describe an arc to cut the first arc CD at E
(iv) Join AE, the angle EAC is the 60° angle required.



To Construct an angle of 30° using Compass Method
Steps:-
(i) Construct an angle of 60° as above
(ii) Bisect this angle
(iii) And this produces the required 30° angle
(iv) With practize angle 90° bisected will give 45°, 40° to 22.5°, 22.5° to 11.25° and 60° to 30° to 15° to 7.5° and so on and so forth.

Angles :-

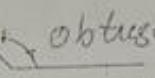
An angle is said to be formed when two lines meet at a point. The unit of angle measured is the degree (°), for example 30°.

A complete revolution (circle) contains 360° and half a revolution contains 180°.

One-quarter of a revolution contains 90°.

Angles are given special names as follows:-

(i) An acute angle :- This is an angle of less than 90°. 

(ii) An obtuse angle :- This is an angle greater than 90°. 

(iii) A reflex angle :- This is an angle greater than 180° but less than 360°

(iv) Complimentary angles :- Two angles which add up to 90°, eg. 30° is compliment of 60° and 60° of 40°

(v) Supplementary angles :- Are two angles which add up to 180°, thus 80° is the supplement of 100°; 120° of 60°.

Construction of angles

(i) To construct an angle of 30° using compass Method.

Steps

(i) Draw line AB to any convenient length.

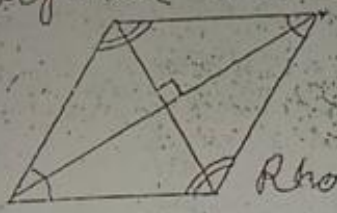
(ii) Extend a construction line outwards from it.

(iii) With A as centre and any convenient radius draw a semi-circle CD.

bisect each other, but not at right angles

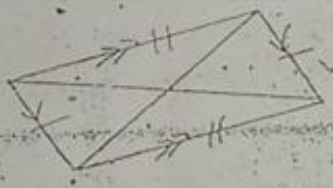
Rectangle

(iii) Rhombus:- is a four sided plane figure in which all the four sides are equal and pairs of opposite angles are equal. Its diagonal bisect each other at right angles.



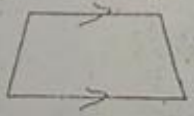
Rhombus

(iv) Parallelogram:- is a four sided plane figure in which pairs of opposite sides are equal and parallel, pairs of opposite angle are equal. its diagonals bisect each other but not at right angles.



Parallelogram

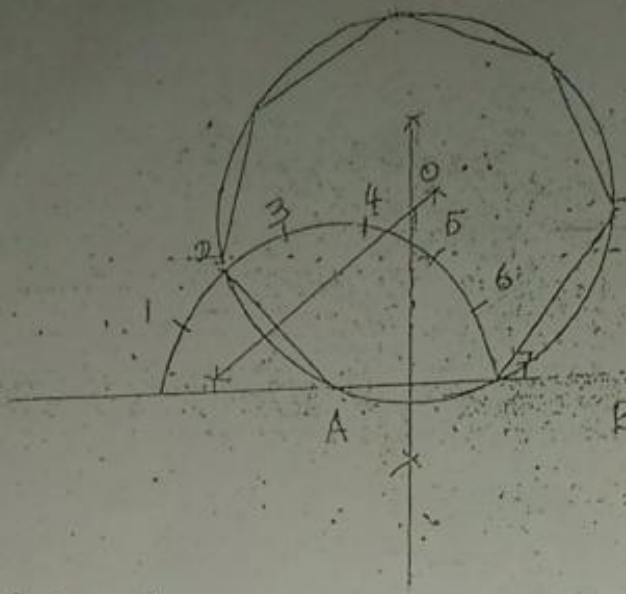
(v) Trapezium:- it is a four sided plane figure in which a pair of opposite sides are parallel and no sides are equal.



Trapezium

(vi) Trapezoid:- it is a four sided plane figure with all the sides unequal and unequal angles.

Trapezoid



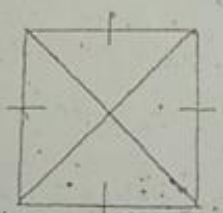
Quadrilaterals:-

A quadrilateral is a plane figure bounded by four straight sides. The four angles so formed add up to 360° or four right angles.

A diagonal is a straight line joining two opposite vertices of a plane figure.

The quadrilaterals are:-

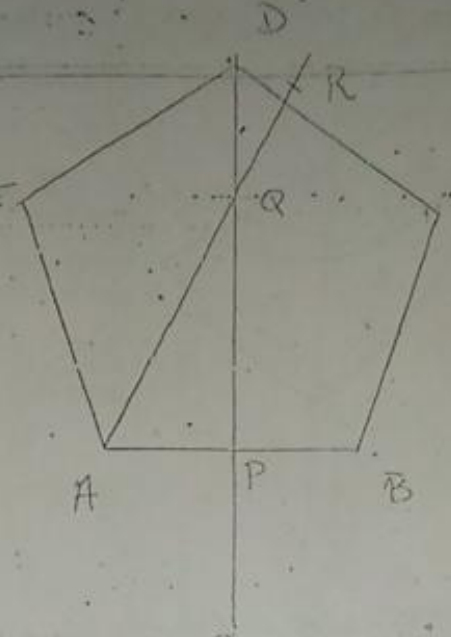
(i) The Square:- The square is a four sided plane figure in which all the four sides are equal and all the four angles are right angles. The diagonals of a square are also equal and they bisect each other at 90°.



Square

(ii) Rectangle:- is a four sided plane figure in which both pairs of opposite sides are equal and parallel, and all the four angles are at right angle. The diagonals

Q5



To construct a regular heptagon using general Method when given the length of side [Trial and Error method]

Steps:-

(i) Draw the given side AB and extend it to the left.

(ii) With centre A and radius AB draw a semicircle and divide it by trial into seven equal parts

(iii) Draw AZ. This is the second side of the required heptagon.

(iv) Bisect AB and AZ. The bisectors intersect at O.

(v) With centre O and radius OA draw a circle and mark off the 5 other sides of the polygon on it.

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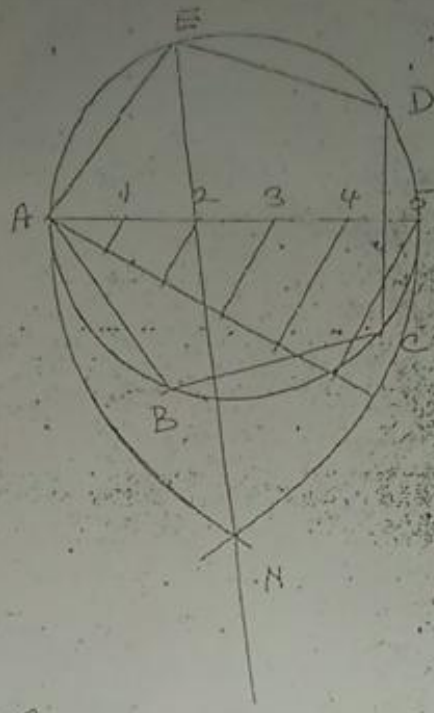
Trial and error method is the semicircle method of constructing polygon of any number of sides.



To Construct a regular pentagon given the length of the sides

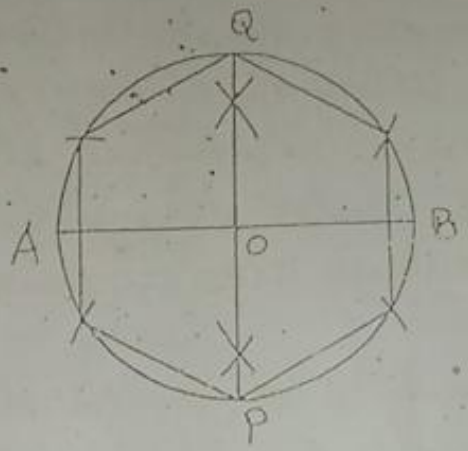
Steps:-

(i) Draw line AB equal to the length of the give side
(ii) Bisect line AB and produce a perpendicular at S
(iii) Mark off PQ equal to AB
(iv) Join AQ and produce to R, making QR equals to AP
(v) With A as centre and radius AR draw an arc to cut the perpendicular bisector at D.
(vi) With A and D as centres, radius AB Make arcs to Intersect at E
(vii) With B and D as centres using the same radius Make arcs to Intersect at C.

(iii) Erect a perpendicular at O to cut the circle at P and Q

(iv) P as centre radius equals to the radius of the circle step off the required points on the circumference of the circle

(v) Join the points to get the required hexagon.



Q2 → To inscribe a regular pentagon in a circle of given diameter

Steps:-

(i) Draw the given circle with centre O

(ii) Produce the diameter AB

(iii) Divide the diameter AB into five(5) equal parts

(iv) With A as centre radius AB describe an arc

(v) With B as centre radius AB describe another arc to intersect the other arc at N

(vi) Join N to 2 and produce to cut the circle at E

(vii) With E as centre radius AE mark out 5 sides on the circumference of the circle.

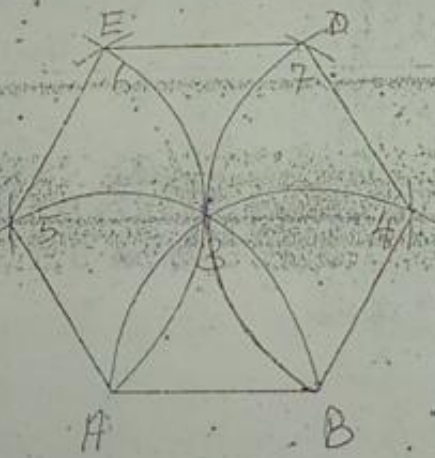
(viii) Join ABCDE for the required pentagon.

$\frac{10-4}{5} \times 90^\circ = \frac{6}{5} \times 90^\circ = 108^\circ$

To Construct a regular hexagon given the length of the side

Steps:-

(i) Draw line AB to the required length.
(ii) With A as centre radius AB describe an arc
(iii) With B as centre using the same radius, i.e AB describe another arc to intersect at point 3.
(iv) With point 3 as centre describe major arcs to intersect the previous arcs at point 4 and 5 respectively
(v) With points 4 and 5 as centres describe arcs to intersect at points 6 and 7.
(vi) Join all the points ABCDEF is the required hexagon



To Inscribe a regular hexagon in a given circle

Steps:-

(i) Draw the given circle from centre O
(ii) Draw line AB, the diameter of the circle

the same, then the polygon is said to be regular.

If the sides or angles are not the same, the polygon is said to be irregular. Example of these polygons are applied are in engineering such is in standard hexagonal bolt or nut.

Common polygons are as follows:-

(i) pentagon 5 sides
(ii) Hexagon 6 sides
(iii) Heptagon 7 sides
(iv) Octagon 8 sides
(v) Nonagon 9 sides
(vi) Decagon 10 sides etc.

The sum of the interior angles of any regular polygon of N sides is calculated by the formular

$$(2(N)-4) \text{ rt } \angle$$

e.g. - pentagon

$$(2(5)-4)\cdot 90^\circ$$

$$(10-4)\cdot 90^\circ$$

$$= 6 \times 90^\circ = 540^\circ$$

For one interior angle of a regular polygon of N sides the formular is $= \frac{(2(N)-4)}{N}$ rt $\angle$

e.g. pentagon $\frac{(2(5)-4)}{N}$ rt $\angle$

To Construct a parallelogram given the lengths of its diagonals and the angle(s) between them.

Steps:-

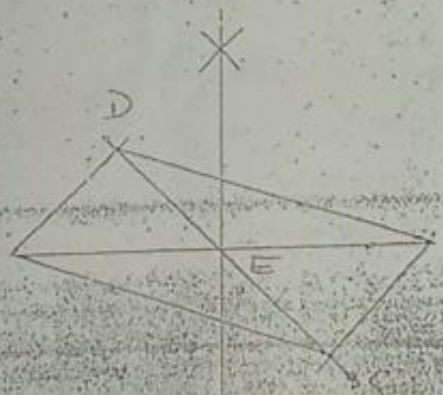
(i) Draw the diagonal AB

(ii) Bisect AB at E; and Construct angle 45° at E and produce it in the opposite direction.

(iii) With Centre at E radius half the minor diagonal describe an are at points C and D

(iv) Join AC, BC, BD and AD

(v) ACBD is the required parallelogram.

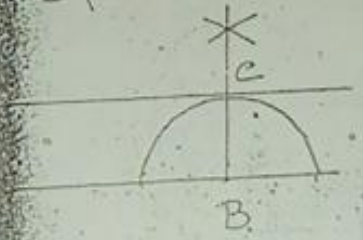


Polygons:-

A polygon is a plane figure bounded by more than four sides (straight sides). If all the sides are of the same length and all the angles are

(7)

centres and radius equals
distance, draw two semi-
circles at A and B to cut the
and D respectively.
touch at points (tangents) the
le two semi-circles to get a st-
C and D line is parallel to AB
ired line.



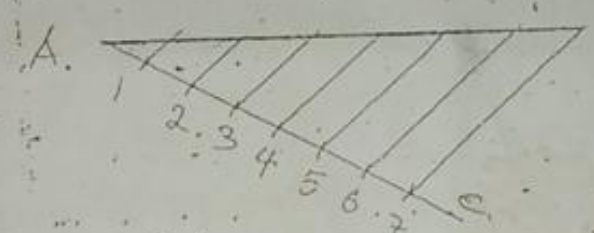
pendicular at a given point

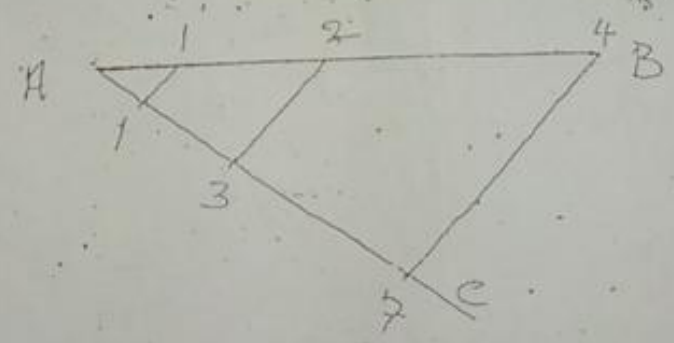
AB.

B to any convenient length and
given point outside the line
and a suitable radius describe
AB at D and E.
D and E describe arcs of the -
Intersect at F.
the required perpendicular

a. Draw the given line AB
b. Draw line AC to any convenient angle to AB.
c. Mark off 7 equal parts along AC using any convenient radius / length...
d. Join the last point that represents 7 to B
e. Draw lines parallel to this line from the other numbers along AC on to AB. AB is now divided into the required number of parts.

To divide the line into a ratio of 1:2:4
Add these numbers added together make 7, divide AB into 7 equal parts then Mark off the division 1, 2 and 4.





(7) 1. Construct a parallel line at a given perpendicular distance from a given straight line AB

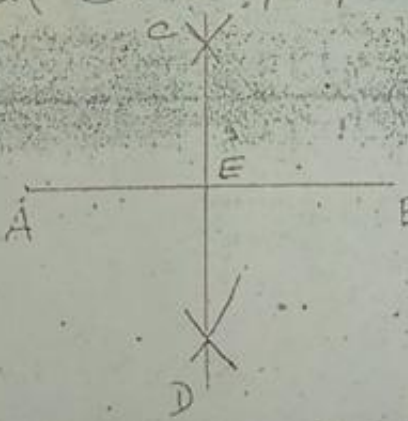
Since no thickness. The figure is therefore two-dimensional.

→ Construction of lines.

(i) To bisect a straight line AB (To bisect means to divide into two equal parts)

steps:-

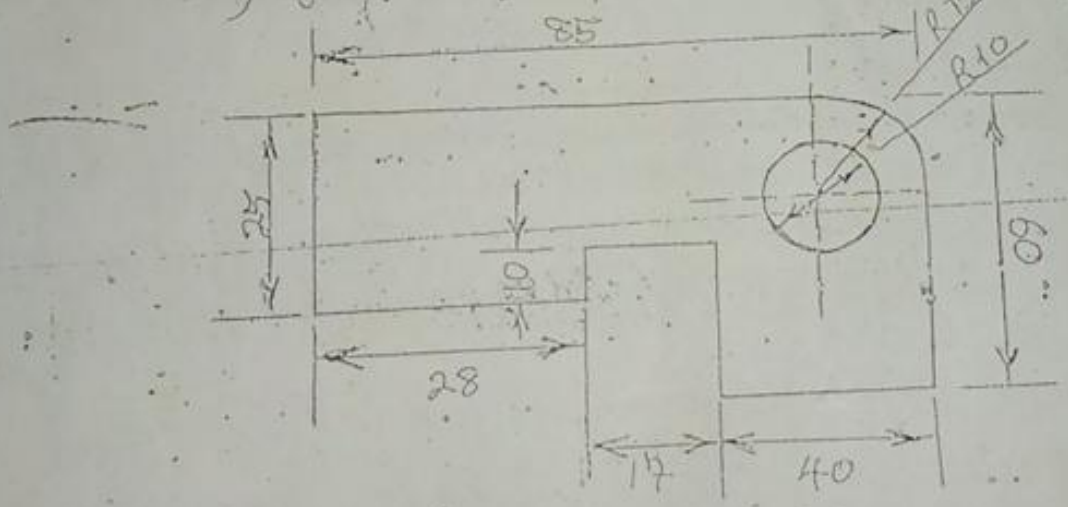
a. Draw line AB to convenient length
b. With centre at A and a radius greater than half AB draw an arcs above and below AB.
c. With centre at B using the same radius draw arcs to cut the previous arcs at E and D.
d. Join E and D. The line CD bisects AB at E and CE is perpendicular to AB at E.



→ (ii) To divide a straight line into a number of equal parts or into a given ratio, say 7 equal parts in the ratio 1:2:4 15

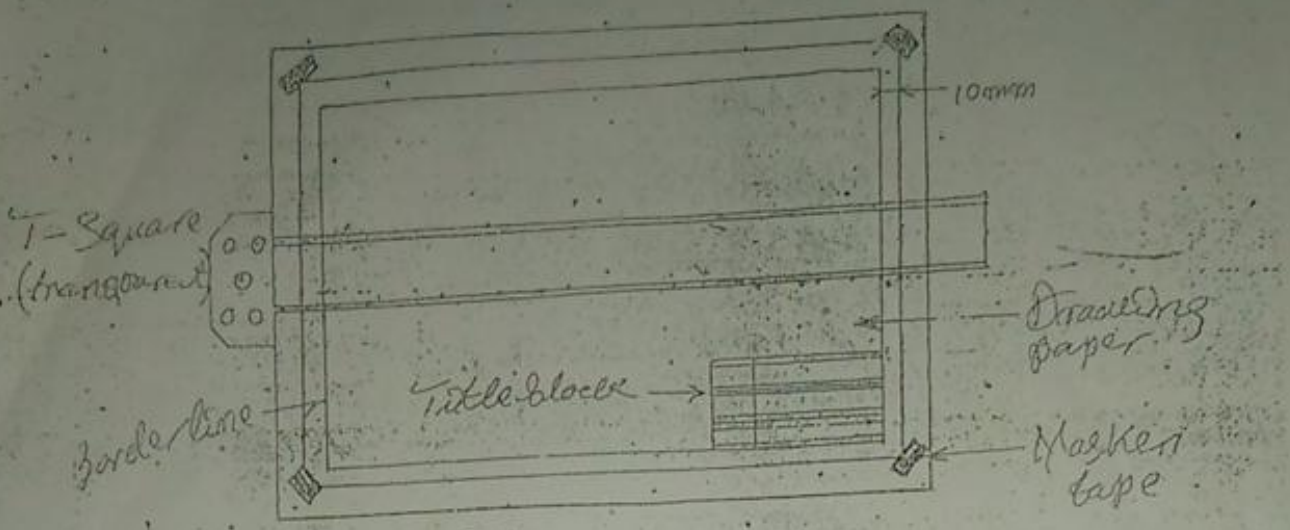
Steps:-

The drawing must contain all of the ne- (9)
cessary measurements or dimensions of the object. They should be clear and easy to read and should not distort the drawing.
- Dimension lines are finer than outlines.
- The lines leading from the point on the drawing to the dimension lines are called projection lines. These should also be fine lines and should be spaced a little from the drawing and have short extensions past dimension lines.
- Dimension lines should have small, sharp, neat arrowheads which exactly touch the projection lines.
- Unless otherwise stated, dimensions are usually given in millimetres (mm).



PLANE GEOMETRICAL DRAWING

Plane geometry is the science of drawing figures on plane surfaces, which by definition



Border line:-
The border line should be at least 10mm from the edges of the drawing paper and must be visibly outlined.

Title Block:-
A title block is usually drawn at the right hand bottom corner of the drawing sheet. It can also be in straight line. Letters and figures should be 4mm - 5mm thick and width within guidelines.

Title block gives general information, the name, matric No., titles, scale, drawing number, date etc. The drawing number for example is an easy way of quickly comparing early drawings and the later ones.

Dimensioning:-
Working drawings are used to provide all the information necessary for somebody to build or to construct an object.

2mm
2mm

dimension. What to note in drawing vertical letters and figures are:-
- Spaces between words must be equal.
- There must be spaces between lines
- All letters and figures must be drawn between parralled guidelines.

Apart from these, we also have Single Stroke lettering

a b c d e f g h i j

Block letters are used Mostly for titles, names, scales, drawing members and date, While Sendpt letters are used for detailed information relating Mainly to processes or constructions

A B C D E F G H I J K L
a b c d e f g h i j k l
1 2 3 4 5 6 7 8 9 0
Vertical letting

A B C D E F G H I J K L
a b c d e f g h i j k l
1 2 3 4 5 6 7 8 9 0
Inclined lettering

Drawing Layout:

In setting the drawing paper on the drawing board the T- Square should be used to set the drawing paper on the drawing board and the Masking tape or clips are used to fasten the drawing paper on the drawing board.

the appearance of a drawing. It is not possible to lay down rules governing the actual size of lettering to be used on a drawing; this must be "sensed" by the student. Obviously a tiny drawing with very large lettering would appear out of proportion.

A balance must be struck to ensure that lettering suits the drawing size and is always clear and legible. Two faint lines should be drawn as required and printing of letters done between them.

Neatness of printing earns extra marks in examinations, while indifferent printing often means loss of valuable marks. Capital letters are preferred to the small letters, the latter being limited mostly to symbols or abbreviations.

In printing numerals care must be taken, for instance when printing the figures 2, 4, 6 & 8, the heads of the numerals may vary according to the size of the drawing and the drawing sheet used.

Lettering Styles:-

Letters and figures can be drawn either vertically or inclined. British standards recommended the use of vertical characters for drawing numbers, titles and reference numbers in the title blocks.

The difference between the two types of lettering is that the slaping characters are at an angle of approximately 20° to the right of the vertical, and it is a simple matter to form once the production of vertical letters and figures

(iii) Continuous thick line. This is used for visible outline of an object ———————

(iii) Long and Short thin chain line. This is used for centre lines. — · — · —

(iv) Short thin dashes. This is used for to show the hidden details of an object - - - - -

(v) Long and short chain lines thick at both ends is used for cutting plane —·——·——

(vi) Long break thin line (zigzag line) is used for broken plane i.e. to show the view of a long object

(vii) Arrow head. This is used to indicate the view of an observer (i.e. the direction which the observer should look at) →

Horizontal lines ———

Vertical " |

Inclined " /

Parallel " Two lines maintaining the same distance. Without meeting each other, are referred to as parallel lines

Lettering and Numbering:-

Well-formed, well-spaced lettering with enhance

Lines:-

A line is an extended dot which has a direction and length. It is also a process of joining several points together from one end to the other.

The shortest distance between two given points is a straight line.

The importance of line thickness cannot be overemphasised because variation in the thickness of lines of similar form will convey a different message to skilled draughtsman. For instance a long and short chain thin is used for centre lines and for path lines indicating movement of a part from one position to another. When starting a drawing it is advisable to use faint lines throughout as construction lines (very lightly) so that on completion the main object can now be outlined (darker). Therefore there will be no need to erase construction lines since the main object is drawn out clearly.

Types of Lines:-

(i) Continous thin line. Is used for construction of objects

Smooth curves. Example, flexible rubber type and transparent plastic Mulendar type.

Drawing Clips / Masken tape:

Drawing Clips / Masken tape are used to fasten the paper to the drawing Board to avoid loosening during drawing.

Scales:-

All drawings should be made full size if possible, but where it is not possible due to the size of the object to be drawn, then the drawing should be made in proportion; that is to a uniform scale. The scale should be stated on the drawing as a ratio or representative fraction, for instance scale 1:2; this means that the drawing is half of the full size.

When components are drawn larger than full size; it is scale to 2:1. It is advisable to use scale Multipliers and divisors using 2, 5 and 10:

The following are the commonly used representative fraction of scales.

(a)
1:1 Full size
1:2 Half full size (1/2)
1:5 one-fifth full size (1/5)
1:10 one tenth full size (1/10)

(b)
2:1 Double the full size
5:1 Five times full size
10:1 Ten times full size.

(x) Brushes / Hand Kerchief :-

A light brush or clean Hand Kerchief should be used to keep the drawing paper clean, that is when any part of the drawing is erased, the dust or dirt or particles on the drawing paper can be wiped away neatly.

(xi) Templates :-

These are Instruments used for drawing small circles or arcs when there is problem of radii to be drawn on a drawing. It is easier, convinient and quicker to use radius templates rather than compasses. This is made from transparent plastic material.

(xii) French / Irregular Curves :-

When plotting a series of points along the desired path, the french curve should be used in order to join the points together. This will make it possible to have neat curves, for example when plotting the points of an ellipse, archimedian spiral, parabola, hyperbola and other geometrical curves.

The french curves provide

justable (depending on the user). Compass pencil should be of H or HB grades sharpened to a conical point to ensure uniformity of line and to avoid blurring the paper.

(viii) Dividers:-

These are used to transfer measurements or dimensions from the scale ruler to the drawing. A pair of dividers has a needle point inserted in each leg and is available in a variety of sizes and designs similar to a pair of compass. Another type of compass has a spring between the two needle points for adjustments.

(ix) Eraser / Cleaner:-

This is used for cleaning / erasing excess work done. When any part of drawing is not required, then it should be erased after the drawing. The eraser usually comes in two forms (hard and soft erasers). The soft eraser erases greatly. While the hard ones make the drawings dirty after erasing. The softer eraser is therefore recommended for use in drawings.

angles other than 30, 45° and 60°.

Protractor is semi-circular in shape and made up of transparent plastic materials with graduation of 0°–180° around its curve.

(vi) Pencils:-

Pencils come in grades. Selecting good quality pencils helps a lot in getting a neat work. The pencils are graded by number and letter according to the hardness and softness. As a guide H-grades are hard while B-grades are soft.

Hard pencils are graded from 2H–6H and are mostly blue in colour. Soft pencils- B, 6B and 7B and so on are mostly orange in colour while medium pencils are graded HB.

2H pencil is generally used for drawing and H or HB for lettering and dimensioning or used for drawing circles and arcs in compasses.

(vii) Compasses:-

A pair of compass is used to draw circles and arcs. The compasses are ad-