كلية المنصور الجامعة

قسم
هندسة اتصالات
المرحلة الاولى

Engineering Drawing

2017 - 2018

الرسم الهندسي

الكورس الاول

Lec. Elaf Sabah Ababbs

1500

Engineering Drawing

Introduction

In this fasting developing society, an engineer plays a vital role. He is rightly called "The Creator" … a man who puts his imaginations into actual practice. He thinks of the problems in his mind and conveys them to others through the language of systematic lines. It is this systematic line which is called engineering drawing. Therefore, an engineer must have knowledge of this language to project his ideas correctly on the paper and then execute the job efficiently and effectively with the help of this drawing.

Since, the modern research work in engineering depends mainly upon engineering drawing, it is therefore, necessary for an engineer to acquire a good working knowledge about the subject in order to express and record the shape, size and other information necessary for the construction of various objects such as buildings, roads, bridges structures machines, etc.

Drawing Instruments

1- Drawing Board
   D_0 (1500X1000) mm, used for paper size A0
   D_1 (1000X700) mm, used for paper size A1
   D_2 (700x500) mm, used for paper size A2
   D_3 (500x350) mm, used for paper size A3

2- T-Square
   T_0 (1500) mm
   T_1 (1000) mm
   T_2 (700) mm
   T_3 (500) mm

3- Set Squares
   a- Thirty-Sixty degree (30^o-60^o) set square
   b- Forty five degree (45^o)set square

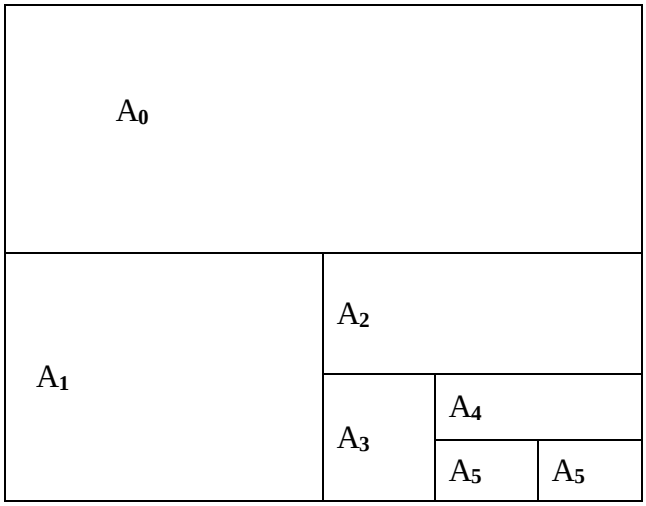
4- Large Size Compass

5- Pencil

Grade of Pencil	Hardness
9H	Hardest
6H, 5H, 4H	Extremely hard
3H	Very hard
2H	Moderately hard
H	Hard
F	Firm
HB	Medium
B	Moderately soft and black
2B	Soft and black
3B	Very soft and black
4B, 5B and 6B	Very soft and very black
7B	softest

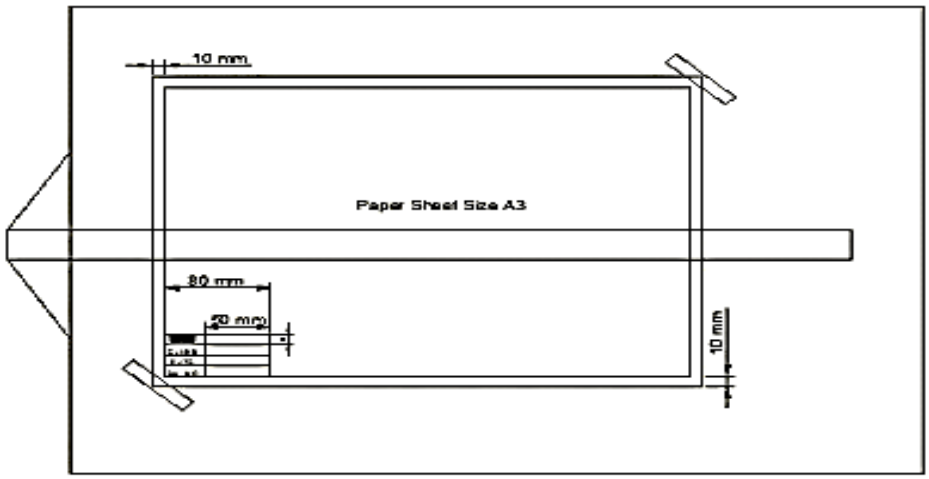
6- Protractor
7- Rubber and Eraser
8- Erasing shield
9- Drawing sheets

S. No.	Designation size in mm Width x length	Trimmed size in mm width x length
(i)	A_0	841 x1189
(ii)	A_1	594 x 841
(iii)	A_2	420 x 594
(iv)	A_3	297 x 420
(v)	A_4	210 x 297
(vi)	A_5	147 x 210



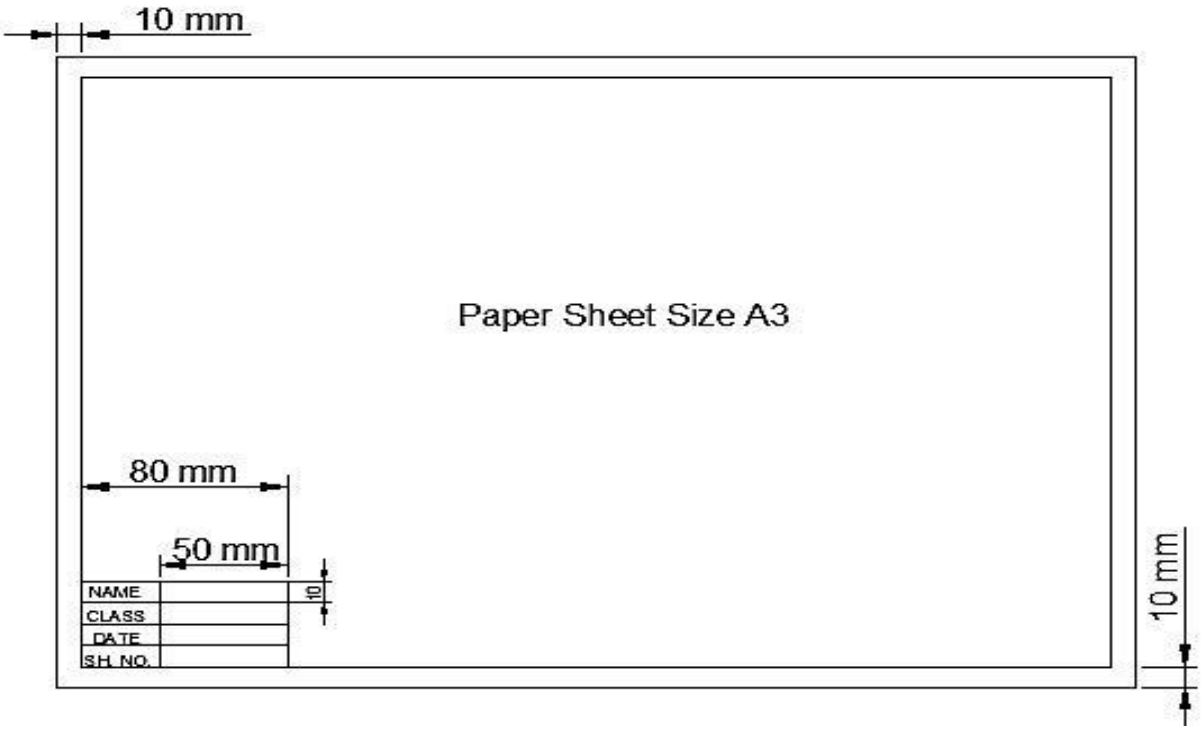
Layout of Drawing Sheet

1- The first step of drawing based on the fixing of the paper sheet on the board at a near distance to the left side as shown below:



2- The clear working space on the drawing sheet is obtained by drawing border lines by a distance 10 mm from the four sides and the lines should be met without intersection of the orthogonal lines.

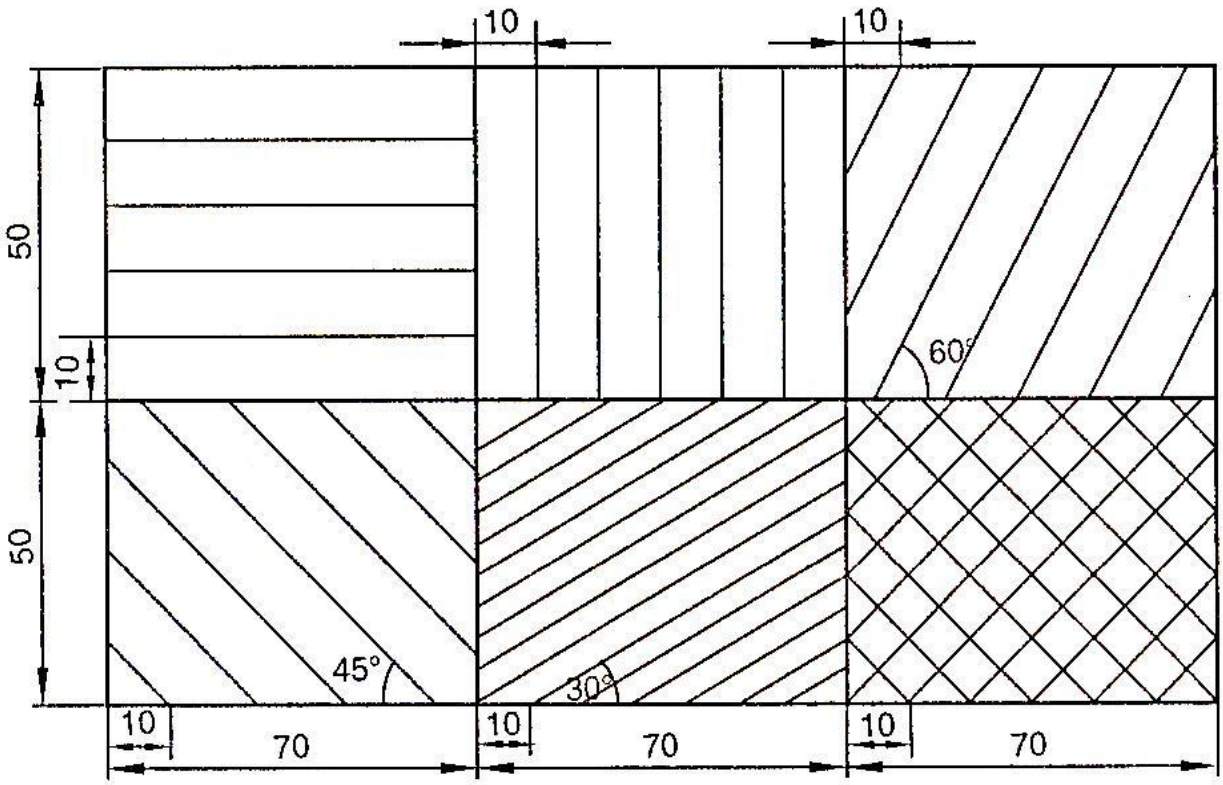
3- The title block is an important feature in drawing, because it gives all the information of the prepared drawing. It is provided as the left hand bottom corner of the sheet. The recommended size (80 x 40) mm as the following detailing:



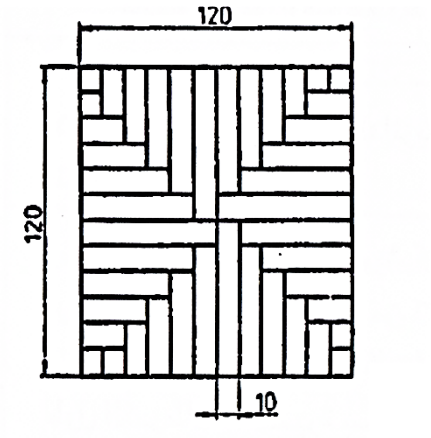
Elementary Basics

The entrance to the engineering drawing must start from the elementary basics and with this step the using of drawing instruments such as T- square, set-squares by drawing the following:

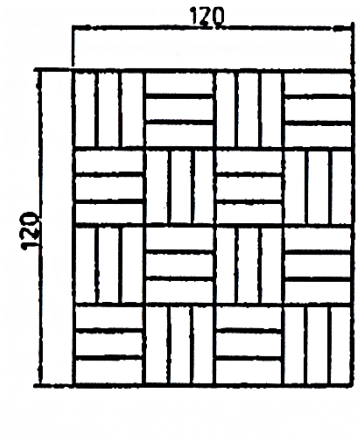
Exercise (1):



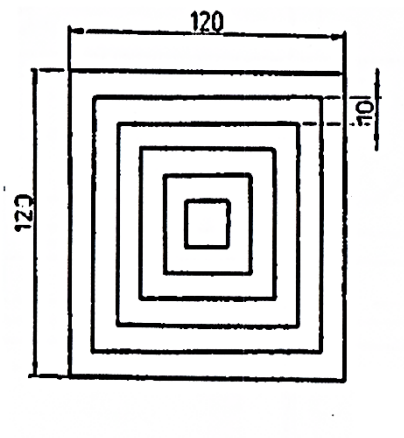
Home work (1):



(a)

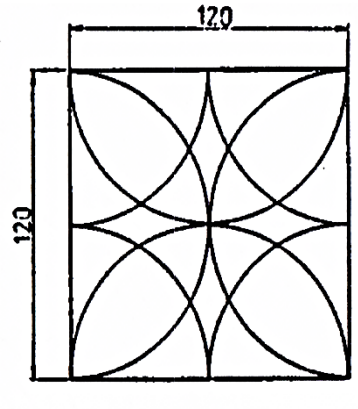


(b)

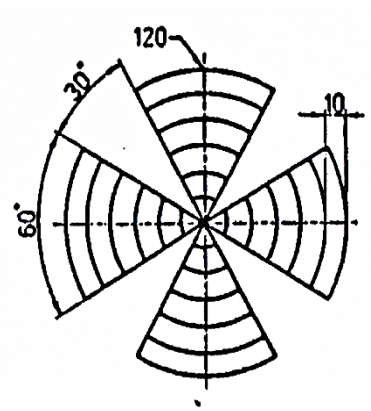


(c)

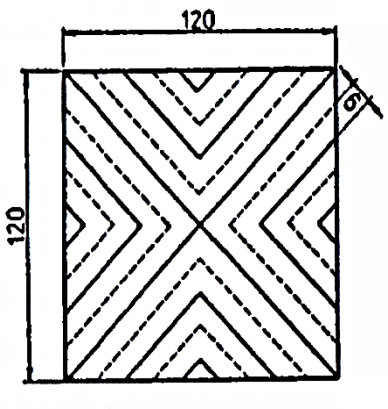
Exercise (2):



(a)

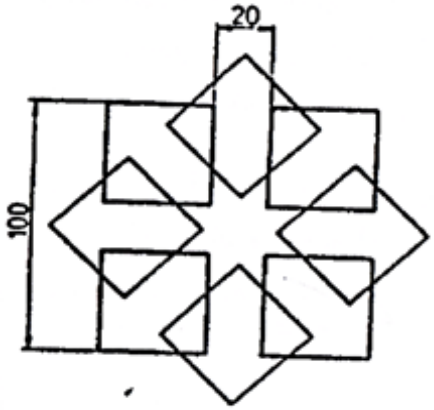


(b)

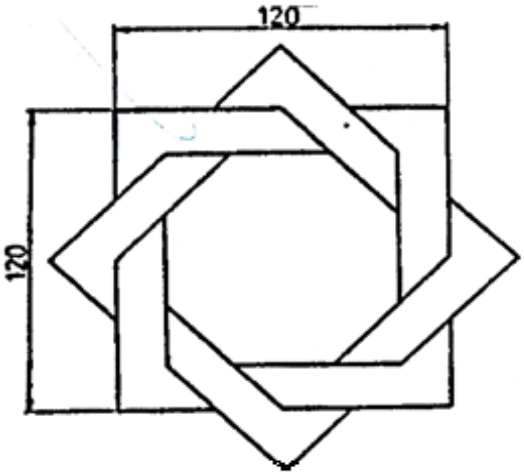


(c)

Home work (2):

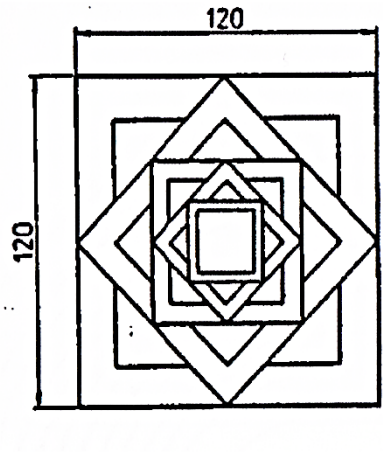


(a)

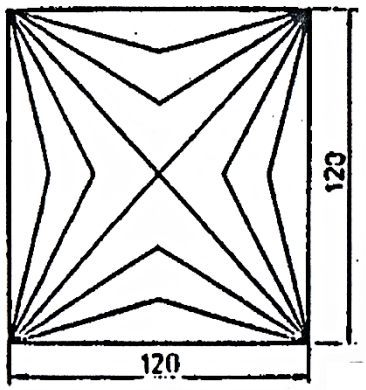


(b)

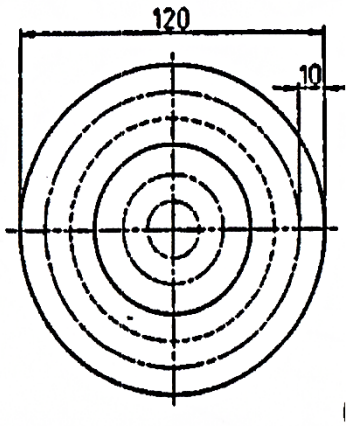
Exercise (3):



(a)

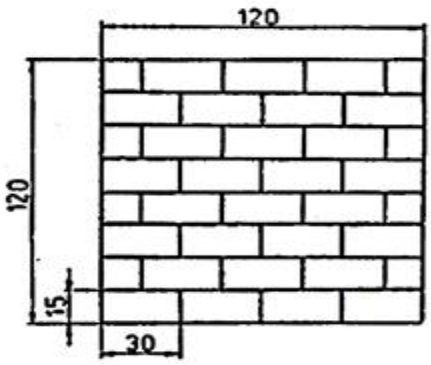


(b)

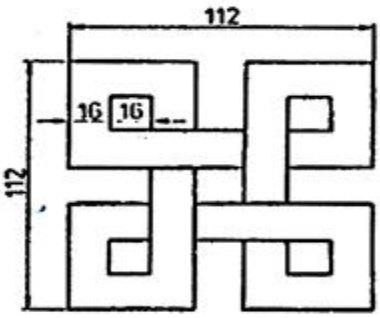


(c)

Home work (3):



(a)



(b)

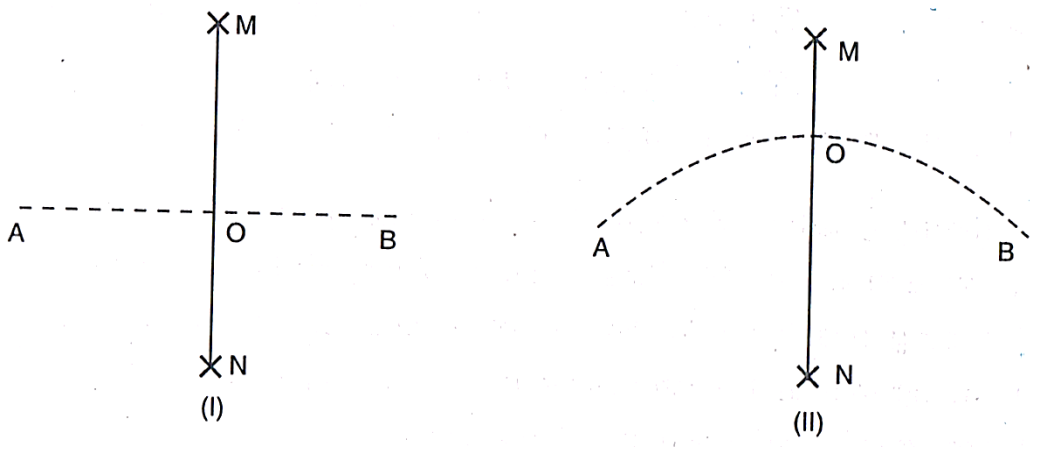
Geometrical Construction and Tangency

In practice, there is a number of geometrical constructions with which an engineer must be familiar with, as they are frequently used in engineering drawing. The methods presented here are the applications of the principles of plane geometry. As the topic of plane geometry is very essential for a course in engineering graphics, so the mathematical proofs are omitted here.

So, this unit is mainly intended for those who have little knowledge regarding the constructions of triangles, circles, regular polygons, etc. also, we will mainly deal with simple problems on geometrical constructions which are mostly based on plane geometry and very essential in the preparation of engineering drawings.

The geometrical constructions are explained in some problems such as:

Problem (1): Bisect a given straight line or an arc.

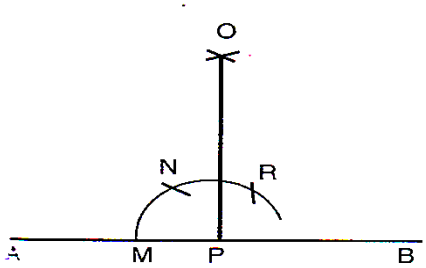


Solution: let the given straight line or an arc be AB.

With A and B as centers and radius is greater than half of AB, draw arcs intersecting each other at M and N respectively.

Join M and N which bisects the given line or arc AB.

Problem (2): Draw a perpendicular to a given line from a given point within it.

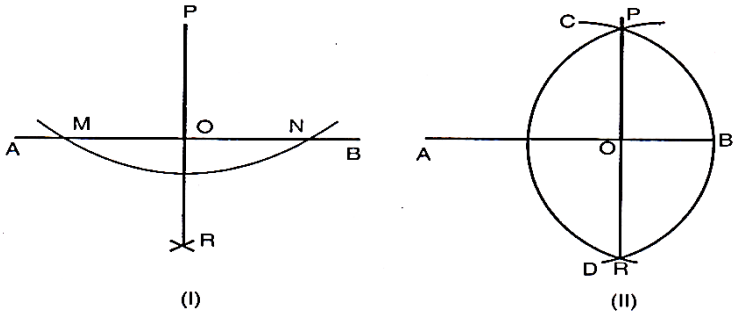


Solution: let P be a given point on a given line AB, with P as center, draw an arc cutting AB at M by taking any suitable radius.

With same as radius, mark two equal subdivisions MN and NR respectively.

With centers N and R and of any suitable radius, draw arcs to intersect at a point O and P. then the line OP is the required perpendicular.

Problem (3): Draw a perpendicular to a given line from a given point outside it.

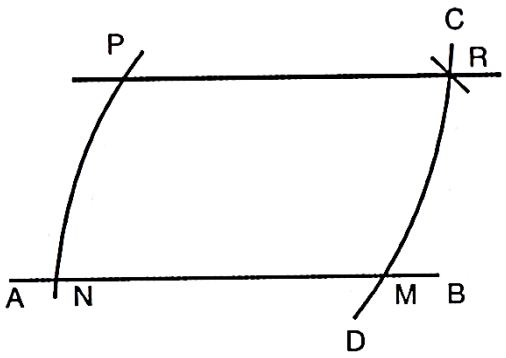


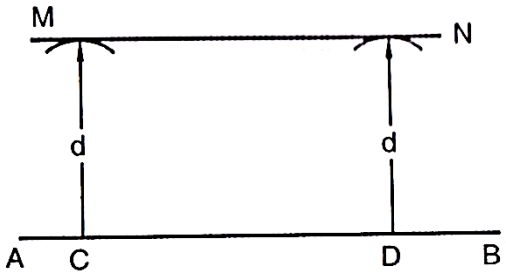
Solution: let P the given point outside the given line AB.

a) When the given point is nearly over the middle of given line see (i).
   With P as center, draw an arc cutting AB at M and N.
   With M and N as centers and radius greater than half of MN, draw arcs intersecting each other at R.
   Join P and R thereby, cutting the line AB at O, then the OP is the required perpendicular.
b) When the given point is nearly over the extremely of the given line see (ii)
   With A as center and radius AP, draw an arc CD.
   With B as center and radius BP, draw another arc cutting the previous arc CD at R.
   Now join P and R thereby cutting the line AB at O. then, the line OP is the required perpendicular.

Problem (4): Draw a line parallel to a given straight line through:

1) A given point. 2) A given distance.



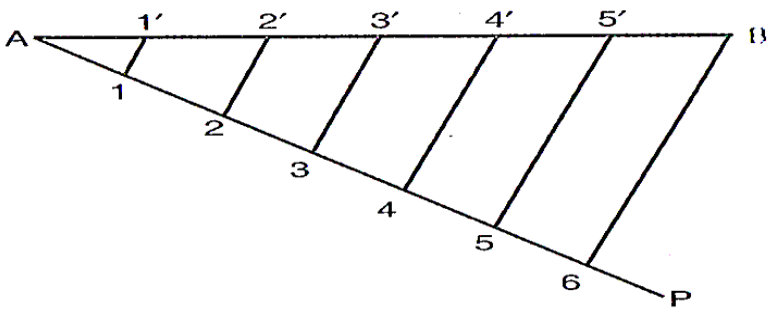


Solution:

1) Let AB a given line and P be the given point, with P as center and any convention radius, draw an arc CD cutting AB at M. with M as center and same radius, draw an arc cutting AB at N. Again, with M as center and the same radius, equal to NP, draw an arc to intersect CD at R. Draw a straight line through P and R. Then the line PR is the required parallel line.

2) Let the given line be AB and 'd' be the given distance take two points C and Don AB at a convenient distance apart. With C and D as centers, draw arcs on one side of AB with 'd' as radius. Draw a line MN just to touch the two arcs. Then the line MN is the required parallel line.

Problem (5): Divide a given straight lineinto any number of equal parts say six.

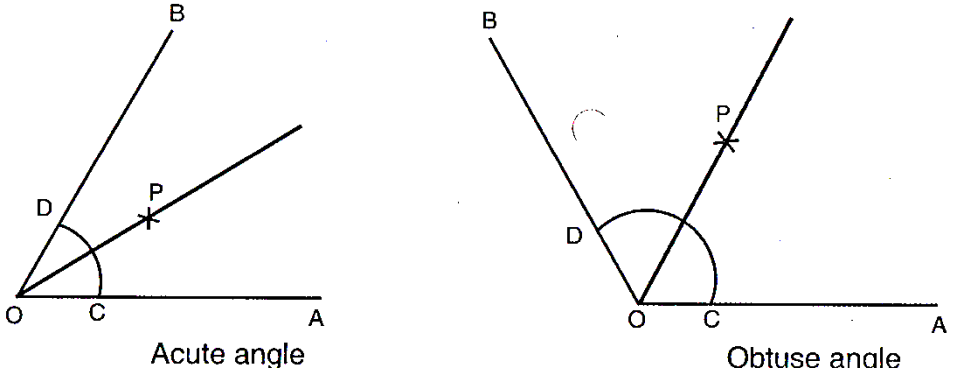


Solution:

Let the given straight line AB; draw a line AP at a given acute angle to AB. From A along AB, cut off six equal parts with a divider of suitable length.

Join B with 6 and draw parallel lines through 1, 2, 3 etc., to B6, meeting thereby1', 2', 3', etc.; thus dividing the line AB into six equal parts.

Problem (6): Bisect a given angle between two given lines.

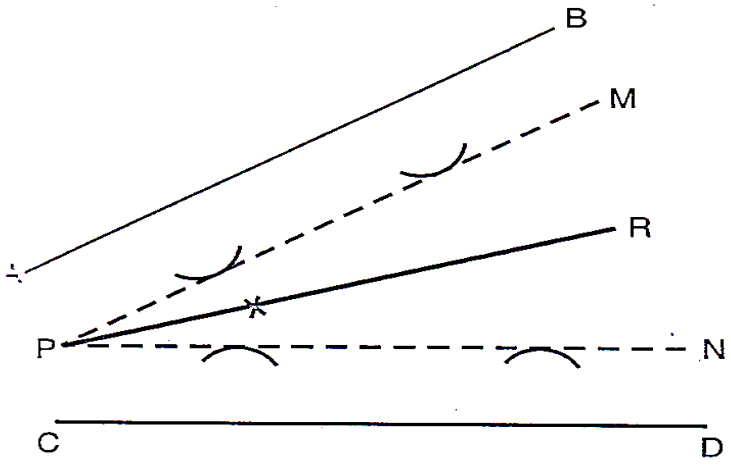


Solution:

Let the given angle be AOB between two given lines OA and OB. With O as center and with any convenient radius, draw an arc cutting OA at C and OB at D.

Now, with C and Das centers and any convenient radius, draw arcs to intersect each other at P. Draw a line through O and P which bisect the given angle AOB.

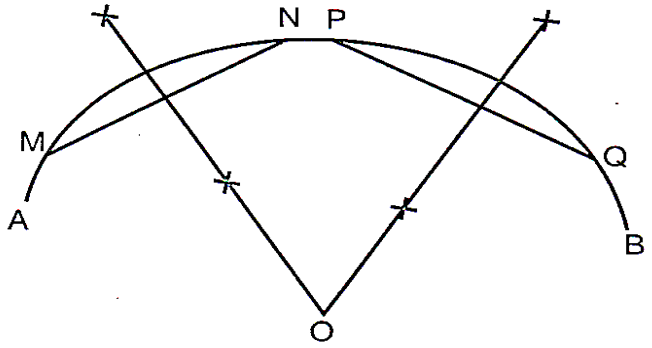
Problem (7): Bisect an angle between two convergent lines without producting them to ontersect.



Solution: let the two convergent lines be AB and CD respectively. Draw two lines PN and PM parallel to CD and AB at equal distances from CD and AB to intersect each other at a point P.

Bisect the angle MPN which will represent the required bisector of two convergent lines.

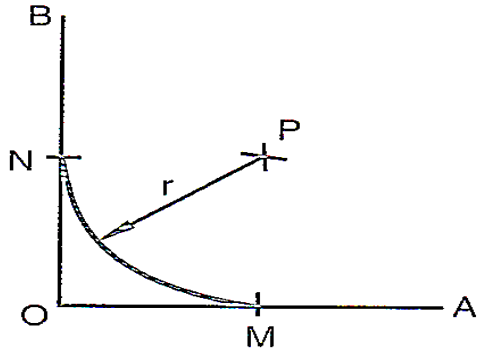
Problem (8): Find the center of a given arc.



Solution:

Let the given arc be AB, select two chords MN and PQ of any suitable lengths on AB. Draw the perpendicular bisectors of MN and PQ meeting at a point O thereby representing the required center of the given arc.

Problem (9): Draw an arc of given radius touching two given straight lines at right angles to each other.



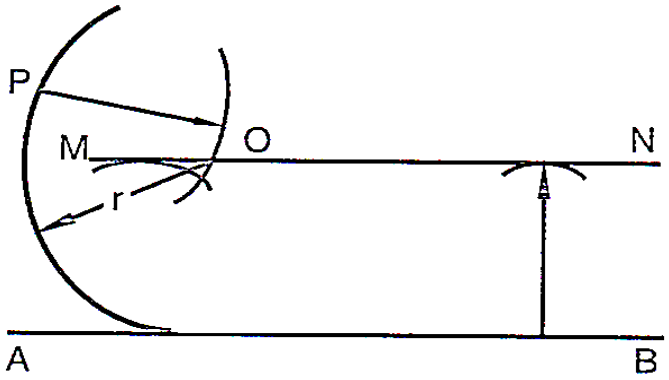
Solution:

Let OA and OB be the given lines and r be the given radius.

With O as center and of radius r, draw arcs cutting OA at M and OB at N. with same radius and M and N as centers, draw arcs to intersect at P.

With P as center and of radius r, draw the required arc MN.

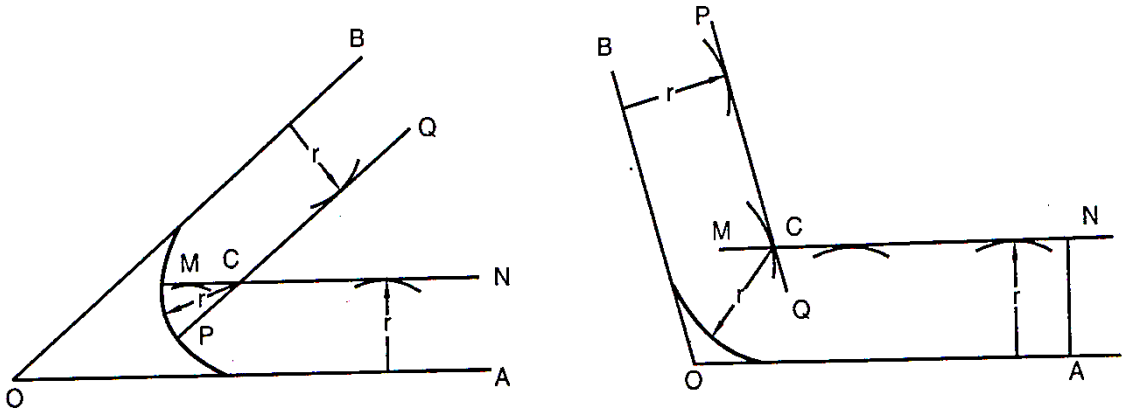
Problem (10): Draw an arc of given radius touching a given straight line and passing through a given point.



Solution:

Let AB be the given line, P be the given point and r be the given radius. Draw a line MN at a distance r and parallel to AB. With P as center and radius equal to r, draw an arc to intersect MN at O. with O as center and radius equal to r, draw the required arc.

Problem (11): Draw an arc of a given radius touching two given lines which subtend any angle between them.



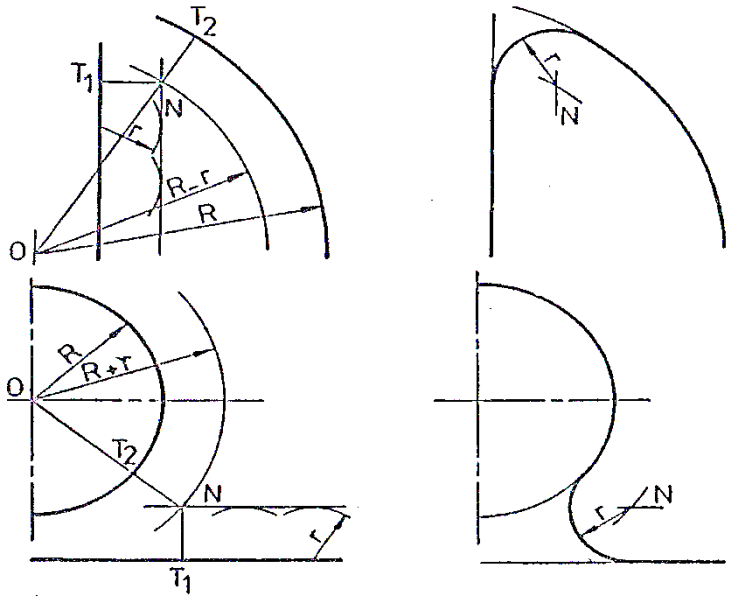
Solution:

Let OA and OB be the two given lines and r be the given radius. Draw two lines MN and PQ parallel to and at a distance of r from OA and OB thereby interesting each other at C. With C as center and radius r, draw the required arc.

Problem (12): Draw an arc with a given radius touching a given straight line and a given arc.

(a)

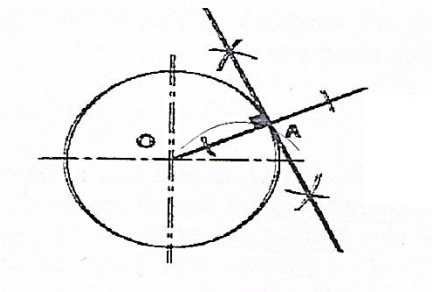
(b)



Solution:

For a given straight line and an arc, Draw a parallel line to the given line at a distance of r. As O center draw an arc at a radius of R+r as the figure (a), or R-r as the figure (b) and N is the tangent point between the arc and the line. From N, draw a perpendicular line to the given line at the tangent point T_1, and join the point N with the arc at T_2. Draw a tangent arc at a radius r from the center N between the two tangent points T_1, T_2.

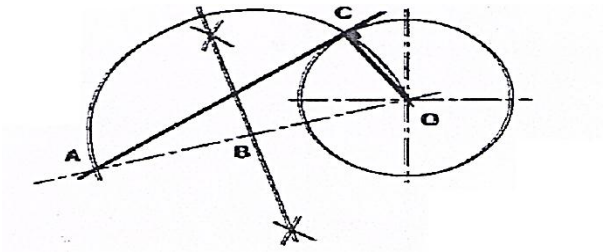
Problem (13): Draw a tangent to a point A on the circumferance of a circle, center O.



Solution:

Join OA and extend the line for a short distance. Erect a perpendicular at point A by the method shown.

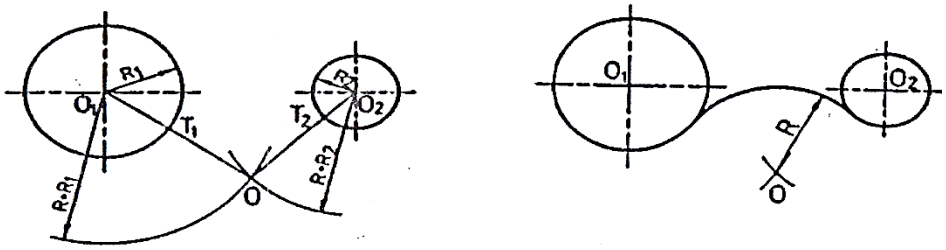
Problem (14): Draw a tangent to a circle from any given point A outside the circle.



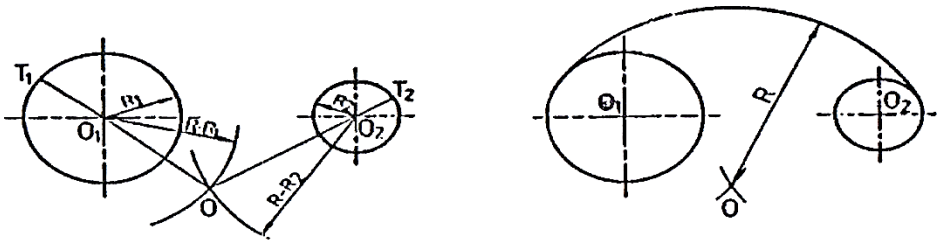
Join A to the center of the circle O. Bisect line AO so that point B is the mid-point of AO. With center B, draw a semi-circle to intersect the given circle at point C. Line AC is the required tangent.

Problem (15): Draw a curve of given radius to touch two circles.

(a)



(b)

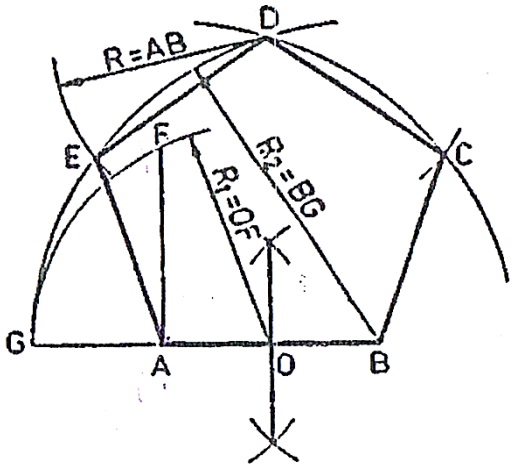


Solution:

Let the center of two circles O_1 and O_2.

1- Draw from the two centers O_1 and O_2 two arcs with and radius $R+R_1$ and $R+R_2$ for obtaining two circles outside the arc as shown in (a), or radius $R-R_1$ and $R-R_2$ for obtaining two circles inside the arc as shown in (b).
2- Join OO_1 and OO_2 to find the two tangent points T_1 and T_2.
3- From the center O, draw the tangential arc with a radius R between the T_1 and T_2.

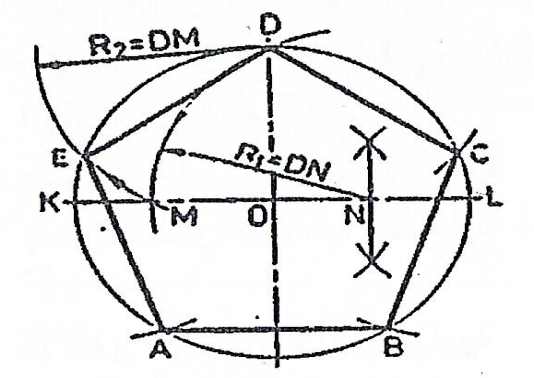
Problem (16): Construct a regular pentagon. The length of one side is given.



Solution: The given line AB

1- Bisect AB at a point O.
2- Draw a perpendicular AF equal to AB.
3- From the center O, draw an arc FG and radius R_1=OF.
4- From A and B draw two arcs with a radius R2=BG to intersect at D.
5- From D draw two arcs and radius R=AB to the previous arcs at C, E.
6- Join the points A, E, D, C, B, A.

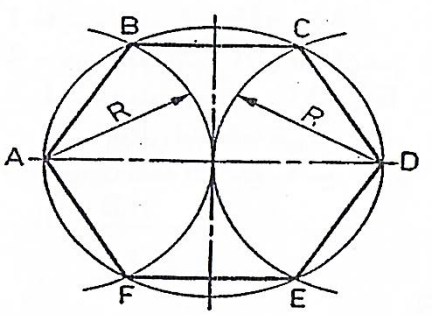
Problem (17): Inscribe a regular pentagon inside a circle.



Solution: The given circle with a radius KL.

1- Bisect the straight line OL at point N.
2- From N, draw an arc and radius R_1=DN.
3- Divide the circle into five equal parts at a distance =DM.
4- Join the points A, E, D, C, B, A.

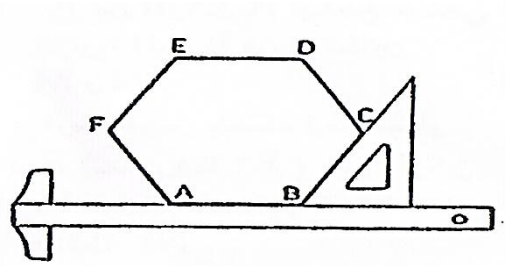
Problem (18): inscribe a regular hexagon in a given circle.



Solution: The given circle with a radius R.

1- From the points A, D, draw two arcs with a radius R to intersect the circle at C, E, B, F.
2- Join A, F, E, D, C, B, A.

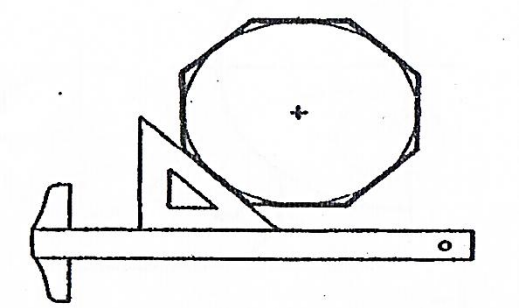
Problem (19): Construct a regular hexagon with a given side length.



Solution: For the given side length

1- By using the T- square and the triangle of (30^o, 60^o, 90^o), draw AF, BC, equal to AB.
2- From the two points C, F, draw CD, FE equal to AB and join DE.

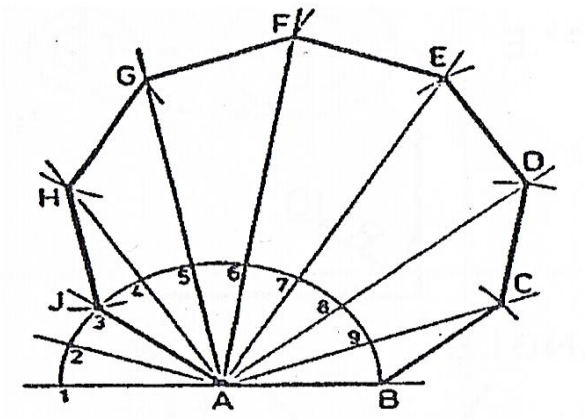
Problem (20): Construct a regular octagon with a given side length.



Solution: The distance of each side of the octagon is given

1- Draw an internal circle and a radius equal to the length of the octagonal side.
2- By using the T-square and the triangle of (45^o), draw the eight sides as a tangent to the internal circle.

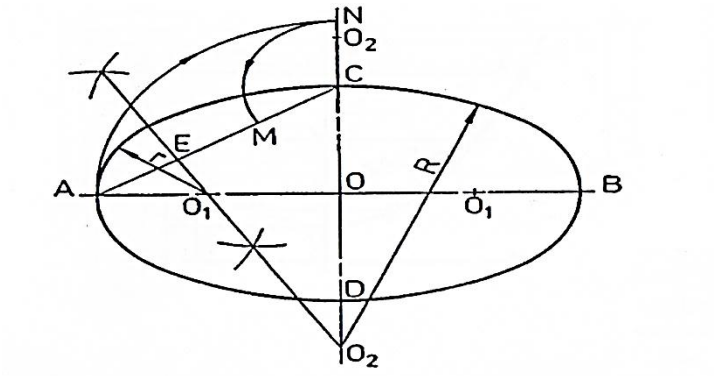
Problem (21): Construct a regular polygon with nine sides



Solution: The given side length AB.

1- Draw semi- circular arcs with a radius
2- Divide the arc into nine equal parts by using the protractor.
3- From the point A, draw ray lines through the points 1, 2, 4, 4,…
4- Draw an arc of a radius AB from the center B to intersect the extension line A9 at point C.
5- Draw an arc of a radius AB from the center C to find the point D.
6- By the same procedure, find the points G, E, F, …. Then join it.

Problem (22): Construct an ellipse by method of four centers



Solution: The length of major axis AB and minor axis CD are given,

1- Draw the two axes AB and CD.
2- From O as center and a radius of OA, draw an arc to intersect the extended line DC at N (AO = NO).
3- From C as center and a radius of CN to intersect AC at M (CM=CN)
4- Make the bisector on the line AM intersect AB at O_1 and CD at O_2
5- Sign the O_1 and O_2 in the other side of the two axes
6- By using the four centers, draw arcs with radius R=O_2C and r =O_1A

Scales

The proportion by which we either reduce or increase the actual size of the object on a drawing is known as drawing to scale or simply scale.

Uses of scales

The following are the main uses of scales in engineering practice:

1- The scales are used to prepare reduced or enlarged size drawings.
2- The scales are used to set off dimensions.
3- The scales are used to measure distances correctly.

Sizes of Scales

1- Full size scale: the scale in which the actual measurements of the object are drawn to same size on the drawing is known as full scale. It is written on the stick as under: 1:1 — drawing made to actual size
2- Reducing scale: the scale in which the actual measurements of the object are reduced to some proportion is known as reducing scale. The standard reducing proportion are:
   1:2 — drawing made to one half of the actual size.
   1:5 — drawing made to one fifth of the actual size.
   1:10 — drawing made to one tenth of the actual size.
   1:20 — drawing made to one twentieth of the actual size.
   1:50 — drawing made to one fiftieth of the actual size.
   1:100 — drawing made to one hundredth of the actual size.
3- Enlarging scale: the scale in which the actual measurements of the object are increased some proportion is known as enlarging scale. The standards proportions are:
   2:1 — drawing made to twice the actual size.
   5:1 — drawing made to five times the actual size.
   10:1 — drawing made to ten times the actual size.

Example :

Construct a simple scale to show meters, when one meter is represented by 2.5 centimeters and long enough up to 6 meters.

Solution: As the drawing need to be reduced,

Representative fraction $= \frac{distance\ on\ sheet}{distance\ of\ object}$

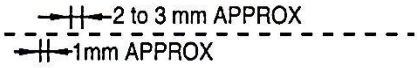
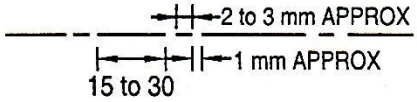
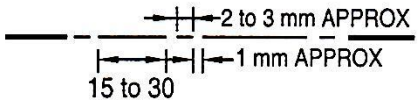
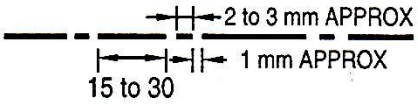
R.F $= \frac{2.5\ cm}{1m} = \frac{2.5\ cm}{100\ cm} = \frac{1}{40}$ also, the scale = 1:40 and

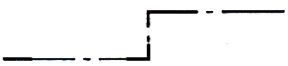
The total length= $\frac{1}{40} * 600cm$=15cm.

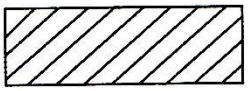
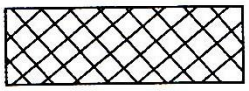
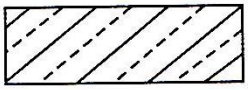
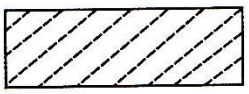
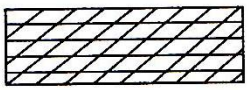
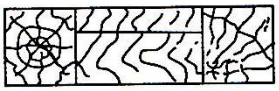
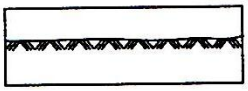
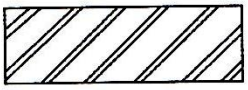
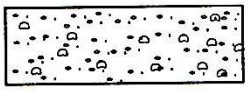
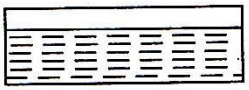
Types of Lines

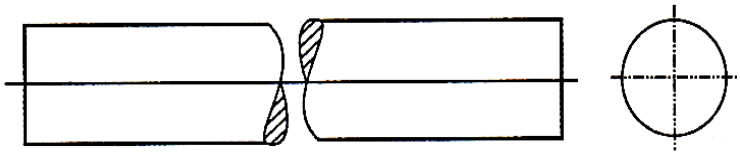
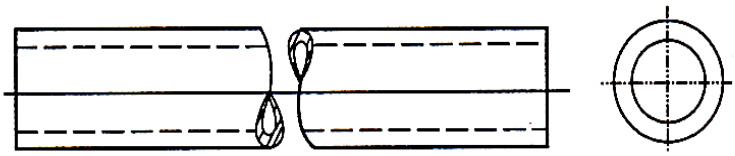
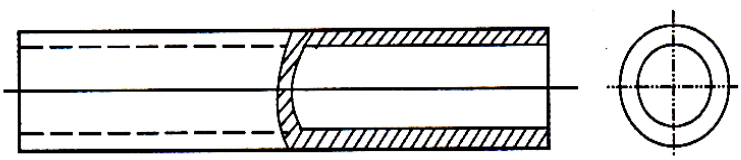
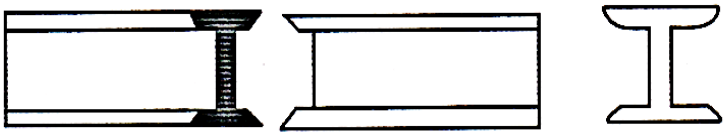
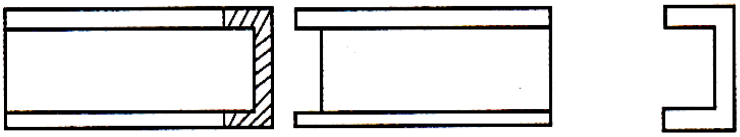
In engineering drawing, the details of various objects are drawn by different types of lines. Each line has a definite purpose and sense of convey. For this, different conventions of lines are used to represent the details of the object accurately on the drawing.

Description and uses of various lines

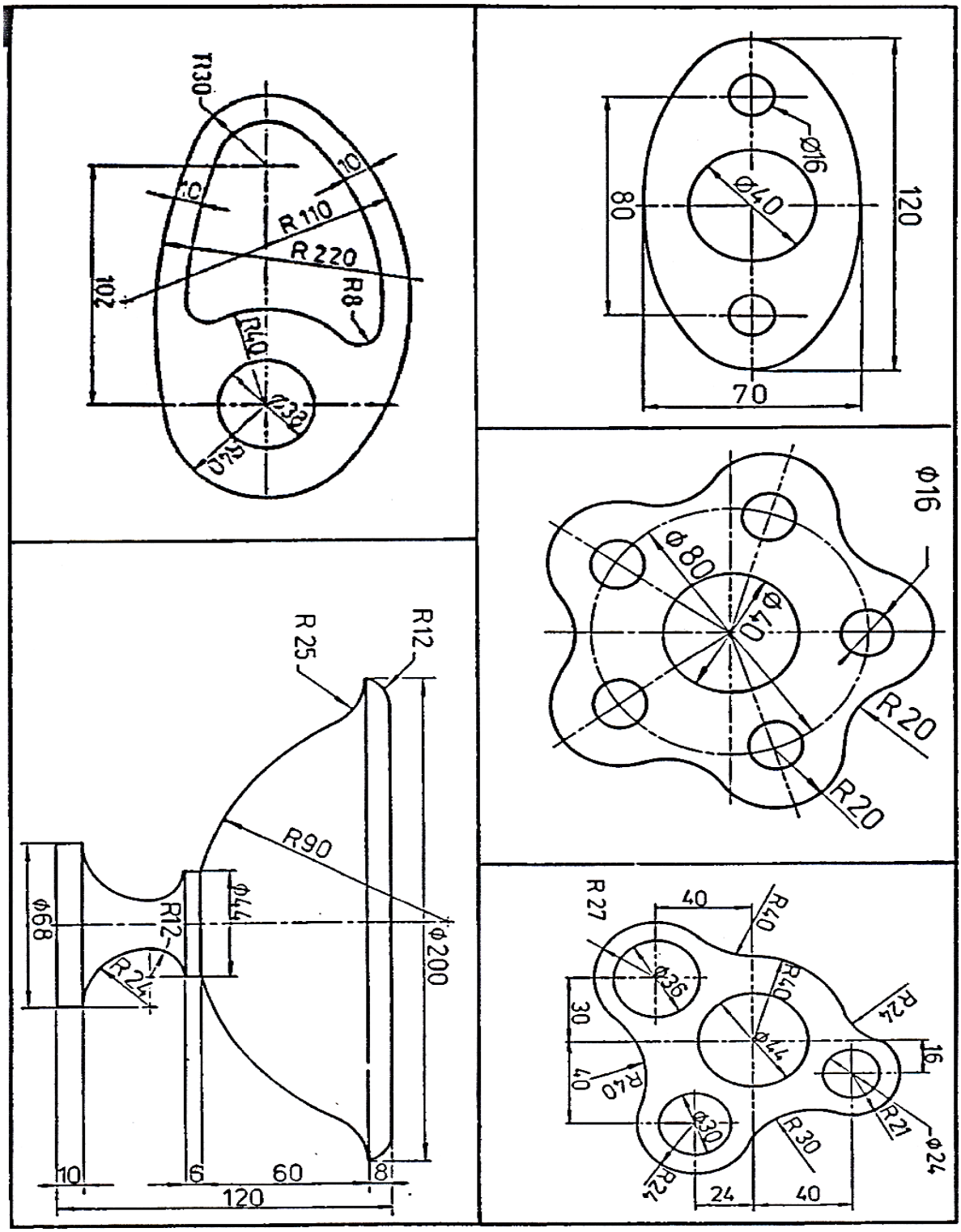
S. NO.	TYPE OF LINE	ILLUSTRATION	APPLICATION
A	CONTINUOUS THICK		VISIBLE OUTLINES
B	CONTINUOUS THIN		DIMENSION LINES, LEADER LINES, EXTENSION LINES, CONSTRUCTION LINES, OUTLINES OF ADJACENT PARTS, HATCHING AND REVOLVED SECTION
C	CONTINUOUS THIN-WAVY		IREGULAR BOUNDAR LINES, SHORT BREAK LINES
D	SHORT DASHES MEDIUM		HIDDEN OUTLINES AND EDGES
E	LONG CHAIN THIN		CENTRE LINES, LOCUS LINES, EXTREME POSITIONS OF THE MOVEABLE PARTS, PITCH CIRCLES AND PARTS SITUATED INFRONT OF THE CUTTING PLANES
F	LONG CHAIN THICK AT ENDS & THIN ELSEWHERE		CUTTING PLANE LINES
G	LONG CHAIN THICK		TO INDICATE SURFACES WHICH ARE TO RECEIVE ADDITIONAL TREATMENT
H	RULED LINE AND SHORT ZIG-ZAG THICK		LONG BREAK LINES

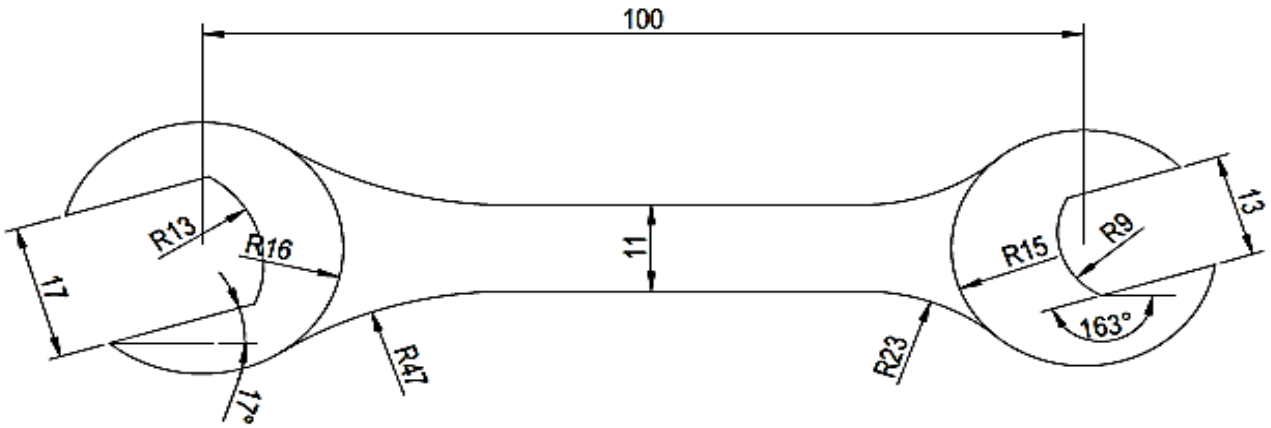
LINE	DESCRIPTION	GENERAL APPLICATION
A	CONTINUOUS THICK	A1 VISIBLE OUTLINE A2 VISIBLE EDGES
B	CONTINUOUS THIN STRAIGHT OR CURVED	B1 IMAGINARY LINES OF INTERSECTION B2 DIMENSION LINES B3 PROJECTION LINES B4 LEADER LINES B5 HATCHING B6 OUTLINES OF REVOLVED SECTIONS IN PLACE B7 SHORT CENTRE LINE
C	CONTINUOUS THIN FREEHAND	C1 LIMITS OF PARTIAL OR INTERRUPTED VIEWS AND SECTIONS, IF THE LIMIT IS NOT A CHAIN THIN
D 	CONTINUOUS THIN (STRAIGHT WITH ZIGZAGS	D1 LINE
E	DASHED THICK	E1 HIDDEN OUTLINES E2 HIDDEN EDGES
F	DASHED THIN	F1 HIDDEN OUTLINES F1 HIDDEN EDGES
G	CHAIN THIN	G1 CENTRE LINES G2 LINES OF SYMMETRY G3 TRAJECTORIES
H 	CHAIN THIN, THICK AT ENDS AND CHANGES OF DIRECTION	H1 CUTTING PLANES
J	CHAIN THICK	J1 INDICATION OF LINES OR SURFACES TO WHICH A SPECIAL REQUIREMENT APPLIES
K	CHAIN THIN DOUBLE-DASHED	K1 INDICATION OF LINES OR SURFACES K2 ALTERNATIVE AND EXTREME POSITIONS OF MOVABLE PARTS K3 CENTROIDAL LINES K4 INITIAL OUTLINES PRIOR TO FORMING K5 PARTS SITUATED IN FRONT OF THE CUTTING PLANE

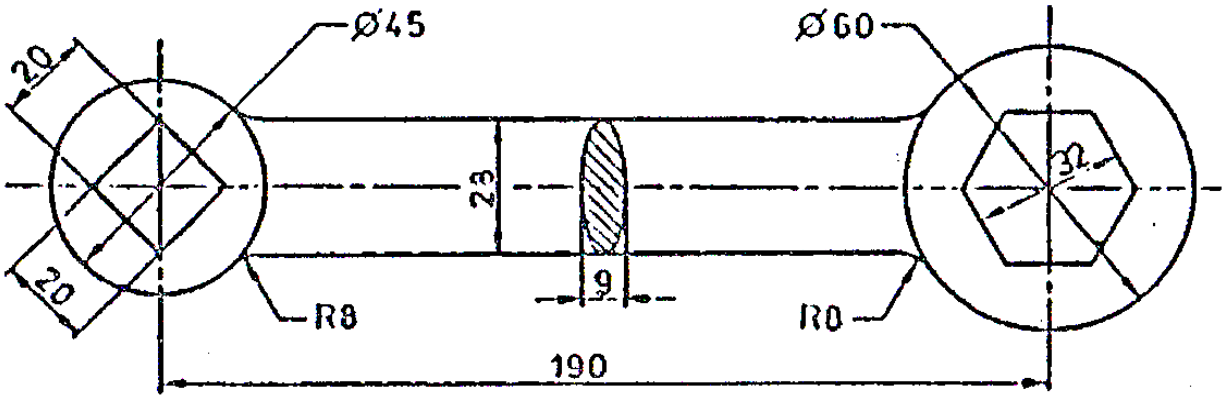
S. NO.	MATERIALS	CONVENTION
1.	STEEL, CAST IRON, COPPER ALUMINIUM AND ITS ALLOYS, ETC.	
2.	LEAD, ZINC, TIN, WHITE METAL, ETC.	
3.	BRASS, BRONZE, GUN METAL, ETC.	
4.	GLASS	
5.	PORCELAIN, STONE WARE, MARBLE, SLATE, ETC.	
6.	ASBESTOS, FELT, PAPER, MICA, CORK, RUBBER, LEATHER WAX, INSULATING MATERIALS	
7.	WOOD, PLYWOOD, ETC.	
8.	EARTH	
9.	BRICK WORK, MASONRY, FIRE BRICKS, ETC.	
10.	CONCRETE	
11.	WATER, OIL, PETROL, KEROSENE, ETC.	

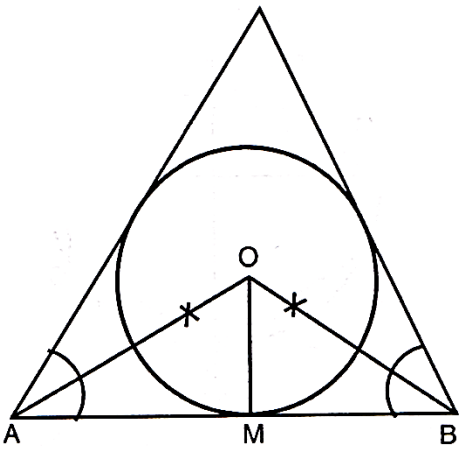
S. NO.	OBJECT	CONVENTION
1.	RECTANGULAR SECTION	
2.	ROUND SECTION	
3.	PIPE OR TUBING	
4.	PIPE OR TUBING	
5.	WOOD RECTANGULAR SECTION	
6.	ROLLED SECTION	
7.	CHANNEL SECTION	

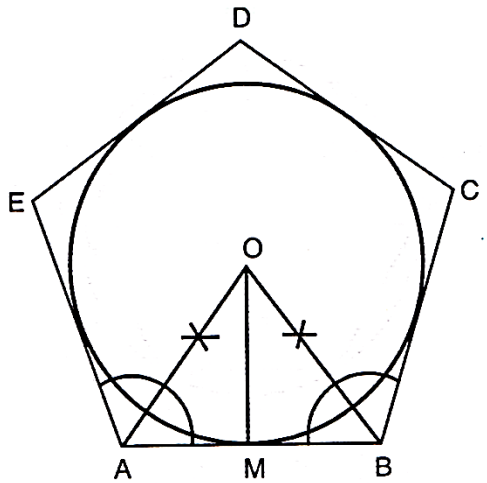
General Home works

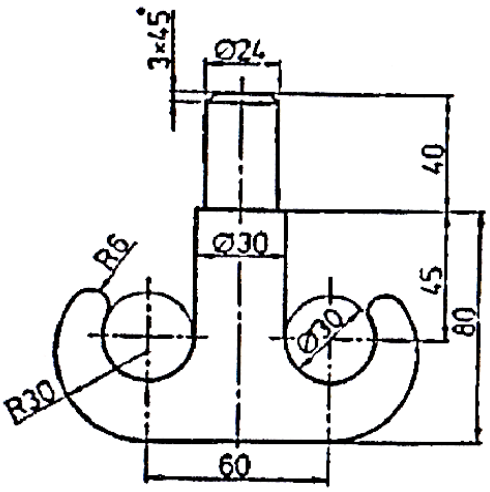


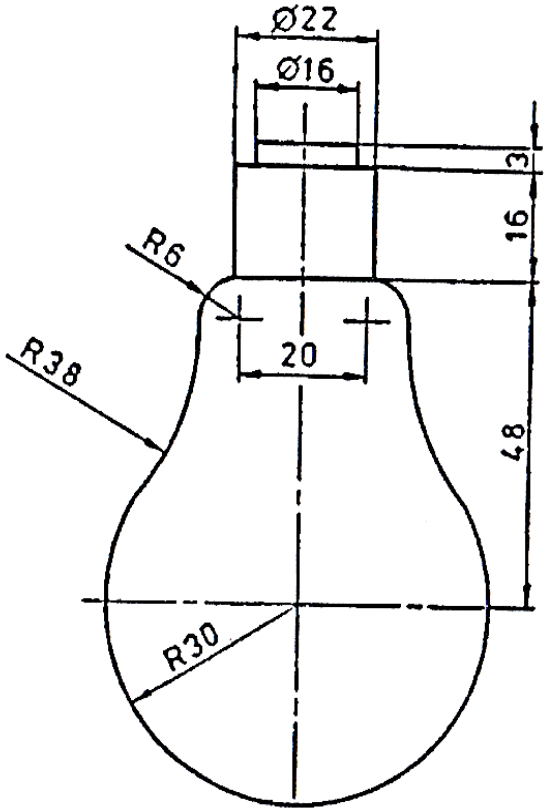

100
R13
R16
17
17°
R47
11
R15
R9
13
163°
R23

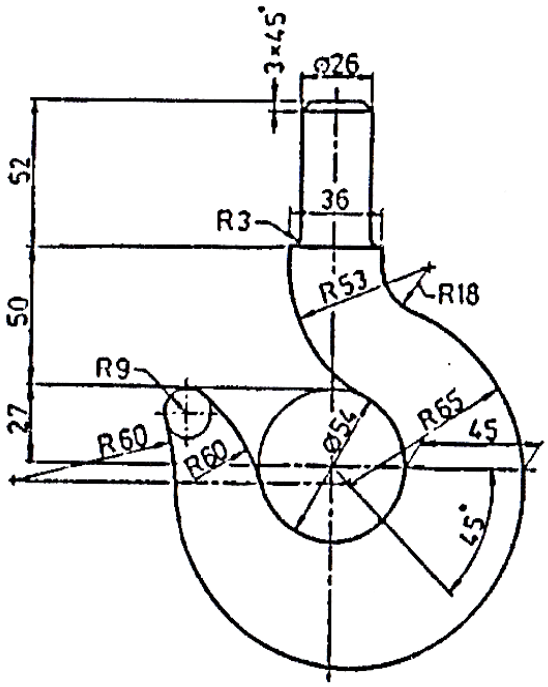

Ø45
Ø60
20
20
23
9
32
R8
R8
190

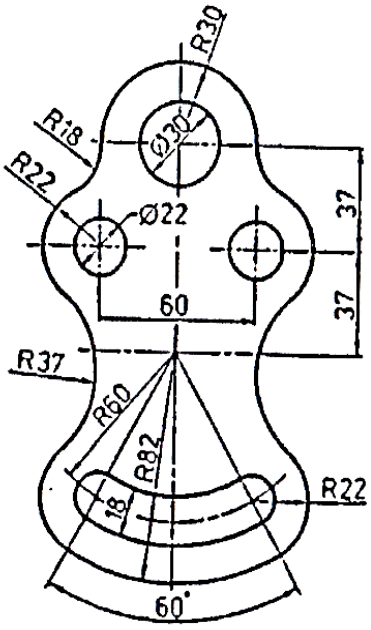

O
A
M
B


D
E
C
O
A
M
B


3×45°
Ø24
40
Ø30
R6
45
80
Ø30
R30
60


Ø22
Ø16
3
16
R6
20
R38
48
R30


3×45°
Ø26
52
36
R3
R53
R18
50
R9
27
R60
R60
Ø54
R65
45
45°


R30
R18
Ø30
R22
Ø22
37
37
60
R37
R60
R82
18
R22
60°