CHAPTER ONE
INTRODUCTION TO GRAPHIC COMMUNICATION

Objectives:

At the end of this chapter students should be able to:

- Define graphic communication
- Mention types of drawing
- Explain the difference between different types of drawings
- Mention some of the applications of technical drawings

1.1 Drawing

A drawing is a graphic representation of an object, or a part of it, and is the result of creative thought by an engineer or technician. When one person sketches a rough map in giving direction to another, this is graphic communication. Graphic communication involves using visual materials to relate ideas. Drawings, photographs, slides, transparencies, and sketches are all forms of graphic communication. Any medium that uses a graphic image to aid in conveying a message, instructions, or an idea is involved in graphic communication.

One of the most widely used forms of graphic communication is the drawing.

Technically, it can be defined as “a graphic representation of an idea, a concept or an entity which actually or potentially exists in life. Drawing is one of the oldest forms of communicating, dating back even farther than verbal communication. The drawing itself is a way of communicating all necessary information about an abstract, such as an idea or concept or a graphic representation of some real entity, such as a machine part, house or tools.

There are two basic types of drawings: *Artistic and Technical drawings.*

1.1.1 Artistic Drawings

Artistic Drawings range in scope from the simplest line drawing to the most famous paintings. Regardless of their complexity, artistic drawings are used to express the feelings, beliefs, philosophies, and ideas of the artist.

In order to understand an artistic drawing, it is sometimes necessary to first understand the artist. Artists often take a subtle or abstract approach in communicating through their drawings, which in turn gives rise to various interpretations. (see figure 1.1)

Figure 1.1 Artistic drawings

(Source: Goetsch, Technical drawing 3rd ed. USA: Delmar Publisher Inc., 1994)

1.1.2 Technical Drawings

The technical drawing, on the other hand, is not subtle, or abstract. It does not require an understanding of its creator, only an understanding of technical drawings.

A technical drawing is a means of clearly and concisely communicating all of the information necessary to transform an idea or a concept in to reality. Therefore, a technical drawing often contains more than just a graphic representation of its subject. It also contains dimensions, notes and specifications. (See figure 1.2)

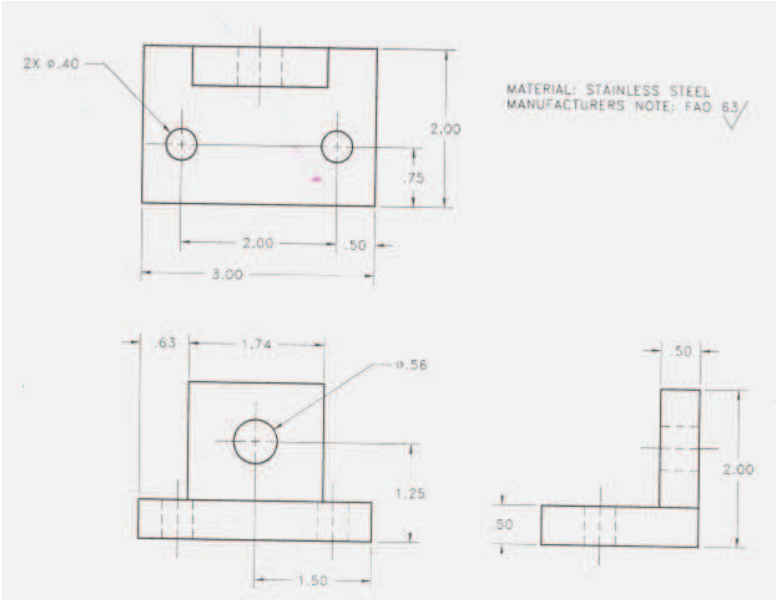


Figure 1.2 Technical Drawings

A. Types of Technical Drawings

Technical drawings are based on the fundamental principles of projections. A *projection* is a drawing or representation of an entity on an imaginary plane or planes. This projection planes serves the same purpose in technical drawing as is served by the movie screen. A projection involves four components

1. The actual object that the drawing or projection represents

2. The eye of the viewer looking at the object
3. The imaginary projection plane
4. Imaginary lines of sight called *Projectors*

The two broad types of projections, both with several sub-classifications, are parallel projection and perspective projection.

Parallel Projection

Parallel Projection is a type of projection where the line of sight or projectors are parallel and are perpendicular to the picture planes. It is subdivided in to the following three categories: *Orthographic, Oblique and Axonometric Projections.*

- *Orthographic projections*: are drawn as multi view drawings, which show flat representations of principal views of the subject.
- *Oblique Projections:* actually show the full size of one view.
- *Axonometric Projections:* are three-dimensional drawings, and are of three different varieties: *Isometric, Dimetric and Trimetric.*

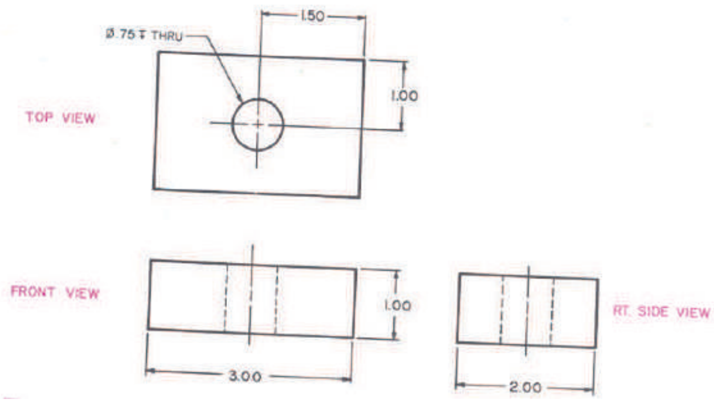


Figure 1.3 Orthographic multi view drawing

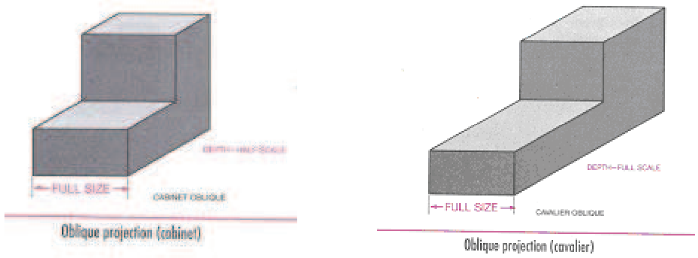


Figure 1.4 Oblique drawing

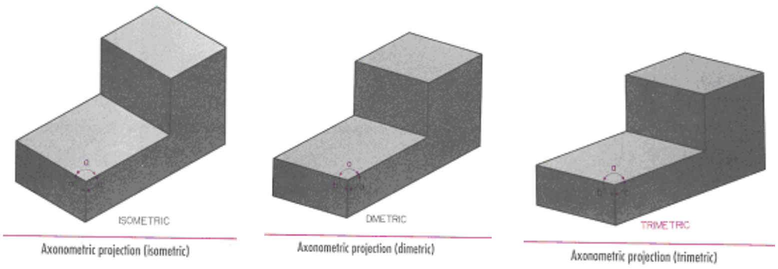


Figure 1.5 Axonometric drawing

Perspective Projection

Perspective projections are drawings which attempt to replicate what the human eye actually sees when it views an object. There are three types of perspective projections: *One-point, Two-point and Three-point Projections.*

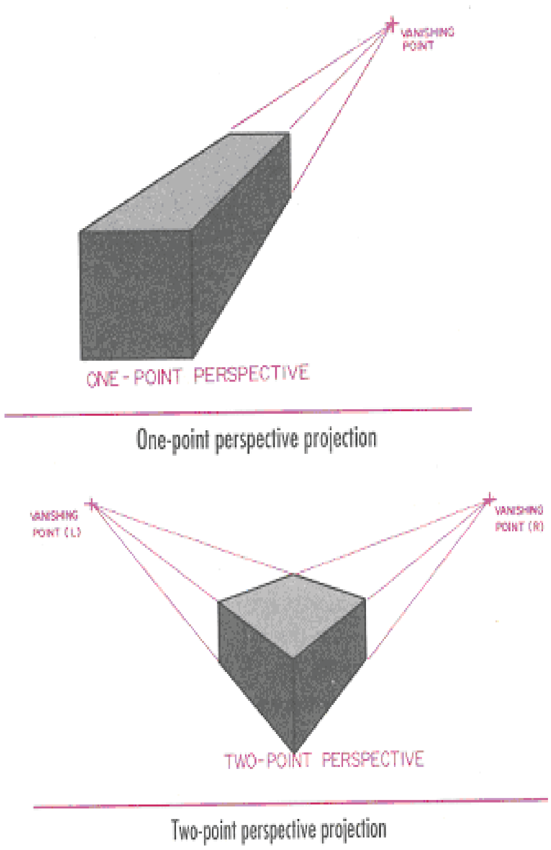


Figure 1.6 Perspective drawing

B. Purpose of Technical Drawings

To appreciate the need for technical drawings, one must understand the design process. The design process is an orderly, systematic procedure used in accomplishing a needed design.

Any product that is to be manufactured, fabricated, assembled, constructed, built, or subjected to any other types of conversion process must first be designed. For example, a house must be designed before it can be built.

C. Application of Technical Drawing

Technical drawings are used in many different applications. They are needed in any setting, which involves design, and in any subsequent forms of conversion process. The most common applications of technical drawings can be found in the fields of manufacturing, engineering and construction.

For instance, Surveyors, civil engineers, sanitarians use technical drawings to document such works as the layout of a new subdivisions, or the marking of the boundaries for a piece of property. Contractors and construction personnel use technical drawings as their blue prints in converting architectural and engineering designs in to reality.

Figure 1.7 Technical drawing (architectural)

Review questions

1. Discuss the different types of drawing
2. Explain the different application of technical drawing
3. What is graphic communication?

CHAPTER TWO

DRAWING EQUIPMENTS AND THEIR USE

Objectives:

At the end of this chapter students should be able to:

- List the main drawing equipments
- Discuss the use of different drawing equipments

2.1 Introduction

To record information on paper instruments and equipments are needed. Engineering drawing is entirely a graphic language hence instruments are essentially needed. Drawing must be clear, neat and legible in order to serve its purpose. Hence it is extremely important for engineers to have good speed, accuracy, legibility and neatness in the drawing work.

2.2 Important Drawing Equipments

All drawings are made by means of various instruments. The quality of drawing depends to a large extent on the quality, adjustment and care of the instruments.

i. Drawing Paper

Drawing paper is the paper, on which drawing is to be made.

All engineering drawings are made on sheets of paper of strictly defined sizes, which are set forth in the U.S.S.R standards. The use of standard size saves paper and ensures convenient storage of drawings. *Now a day, A3 and A4 are the most commonly used paper sizes.* The U.S.S.R standard establishes five preferred sizes for drawings as tabulated bellow:

Table 2.1 Description of the size of drawing paper

Size designation	11	12	22	24	44
Sheet dimensions in mm	297x210	297x420	594x420	594x841	1,189x841
Corresponding designation of paper sheets according to the U.S.S.R Standard (for references)	A4	A3	A2	A1	A0

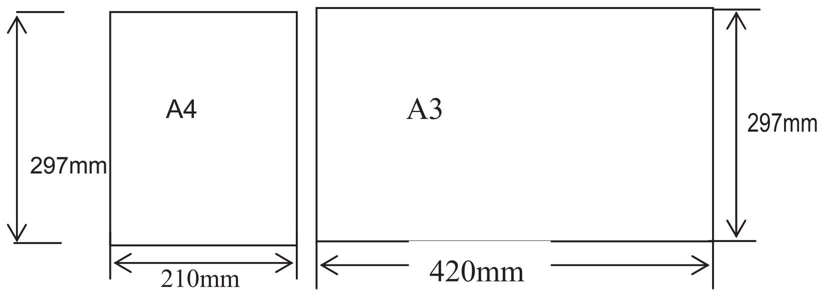
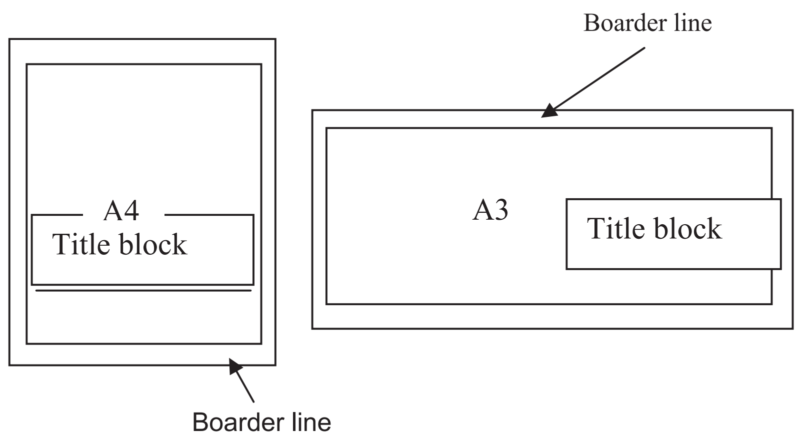


Figure 2.1 A4 and A3 standard papers

Title block is a rectangular frame that is located at the bottom of the sheet. It is recommended that space should be provided in all title blocks for such information as description of title of the drawing, dates, designer (drawer), and name of enterprise or educational institute, size (scale)



Sample for title block

TITLE	
DR.BY GUTEMA KETEMA	
CHECK.BY	
ASSIGN. NO.	
SCALE	INSTIT. AU
DATE 02/02/2003	

Figure 2.2 Sample Title block figure

ii. Triangles (setsquares)

They are used to construct the most common angles (i.e. 30^0, 45^0, 60^0) in technical drawings. The 45^0 x 45^0 and 30^0 x 60^0 triangles are the most commonly used for ordinary work. They are shown in the fig. 2.2 below.

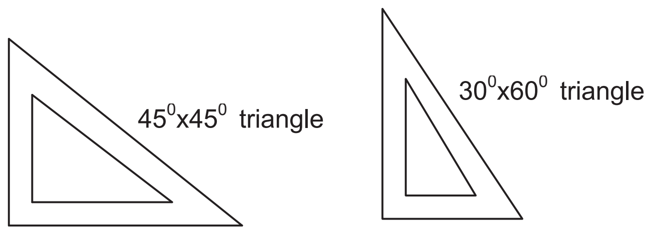


Figure 2.3 triangles or set squares

iii. T- square

It is used primarily to draw horizontal lines and for guiding the triangles when drawing vertical and inclined lines. It is manipulated by sliding the working edge (inner face) of the head along the left edge of the board until the blade is in the required position.

T-square

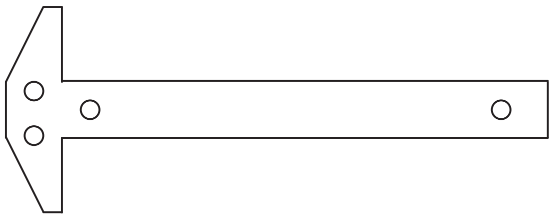
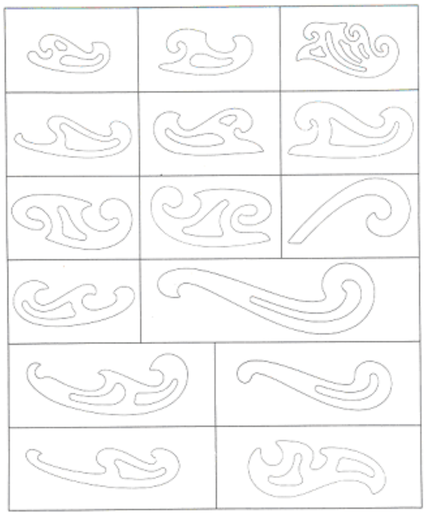
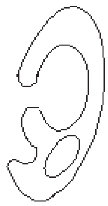


Figure 2.4 T-square

iv. French curve

It is used to draw irregular curves that are not circle arcs. The shape varies according to the shape of irregular curve.



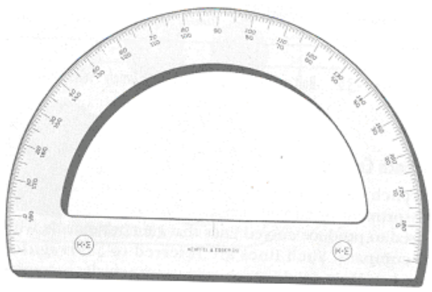


Assortment of French curves

Figure 2.5 French curves

v. Protractor

It is used for laying out and measuring angle.

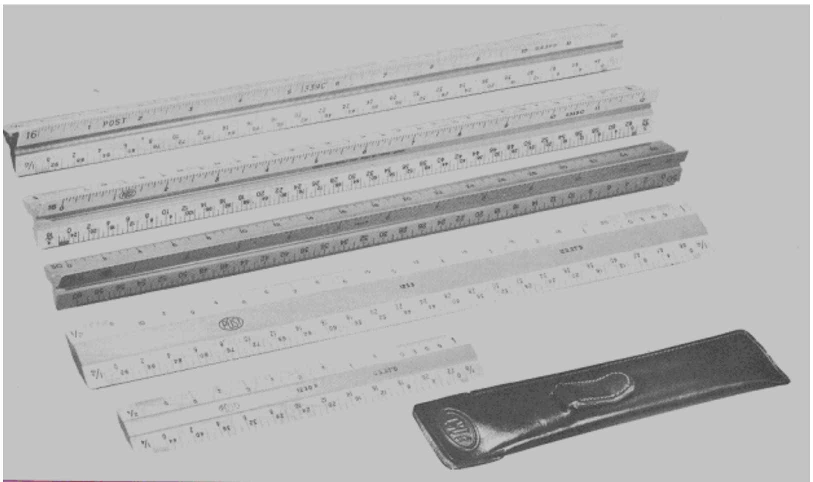


Protractor

Figure 2.6 Protractor

vi. Scale (ruler)

A number of kinds of scales are available for varied types of engineering design. **Figure** fig 2**.7** Scales with beveled edges graduated in mm are usually used.



A variety of drafting scales

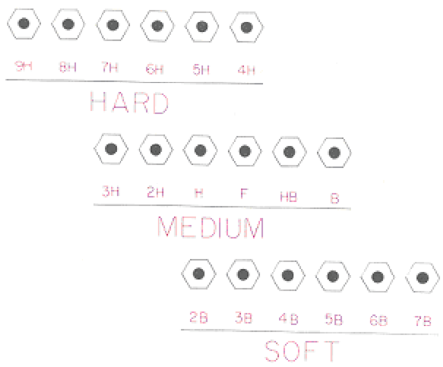
vii. Pencil

The student and professional man should be equipped with a selection of good, well-sharpened pencil with leads of various degrees of hardness such as: 9H, 8H, 7H, and 6H (hard); 5H& 4H (medium hard); 3H and 2H (medium); and H& F (medium soft). The grade of pencil to be used for various purposes depends on the type of line desired, the kind of paper employed, and the humidity, which affects the surface of the paper. Standards for line quality usually will govern the selection. For instance,

- **6H** is used for light construction line.
- **4H** is used for re-penciling light finished lines (dimension lines, center lines, and invisible object lines)
- **2H** is used for visible object lines
- **F** and **H** are used for all lettering and freehand work.

Table 2.2. Grade of pencil (lead) and their application

TASK	LEAD
CONSTRUCTION LINES	3H , 2H
GUIDE LINES	3H , 2H
LETTERING	H , F , HB
DIMENSION LINES	2H , H
LEADERLINES	2H , H
HIDDEN LINES	2H , H
CROSSHATCHING LINES	2H , H
CENTERLINES	2H , H
PHANTOM LINES	2H , H
STITCH LINES	2H , H
LONG BREAK LINES	2H , H
VISIBLE LINES	H , F , HB
CUTTING PLANE LINES	H , F , HB
EXTENSION LINES	2H , H
FREEHAND BREAK LINES	H , F , HB



Grades of lead (left) and lead-lines chart (right)

viii. Compass

It is used to draw circles and arcs both in pencil and ink. It consists of two legs pivoted at the top. One leg is equipped with a steel needle attached with a screw, and other shorter leg is, provided with a socket for detachable inserts.

viiii. Divider

Used chiefly for transferring distances and occasionally for dividing spaces into equal parts. i.e. for dividing curved and straight lines into any number of equal parts, and for transferring measurements.

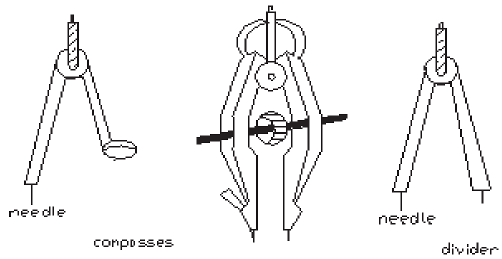


Figure 2.8 Compass and divider

X. Template

A template is a thin, flat piece of plastic containing various cutout shapes. It is designed to speed the work of the drafter and to make the finished drawing more accurate. Templates are available for drawing circles, ellipses, plumbing's, fixtures etc. Templates come in many sizes to fit the scale being used on the drawing. And it should be used wherever possible to increase accuracy and speed.

Drawing board is a board whose top surface is perfectly smooth and level on which the drawing paper is fastened.

Clinograph (Adjustable set square)-its two sides are fixed at 90^0 and the third side can be adjusted at any angle.

Rubber or eraser- extra lines or curves which are not required in the drawing are to be rubbed out or erased. Hence a rubber or eraser are required in the drawing work. Erasers are available in many degrees of hardness, size and shape.

Eraser shield –it is an important device to protect lines near those being erased. It is made up of thin metal plate in which gaps of different widths and lengths are cut.

Tracing paper – it is a thin transparent paper. Figures below it can be seen easily and traced out in pencil ink.

Drawing ink- it is used for making drawings in ink on tracing paper.

Review questions

1. Mention the main drawing equipments
2. Explain the use of different drawing equipments
3. Discuss the different type of pencils with their use

CHAPTER THREE

LETTERING AND LINES

Objectives:

At the end of this chapter students should be able to:

- Write letters according to the standard
- Explain the different line types
- Mention the application of each line type in technical drawings

3.1 Letter Styles

Letter styles are generally classified as *Gothic, Roman, Italic and Text.* They were all made with speedball pens, and are therefore largely single-stroke letters. If the letters are drawn in outline and filled in, they are referred to as "filled- in" letters. The plainest and most legible style is the *gothic* from which our single-stroke engineering letters are derived. The term *roman* refers to any letter having wide down ward strokes and thin connecting strokes. *Roman* letters include *old romans* and *modern roman*, and may be vertical or inclined. Inclined letters are also referred to as *italic*, regardless of the letter style; *text* letters are often referred to as *old English*.

Figure 3.1 Classification of letter styles

Depending up on the spacing between words and thickness of strokes, letters may be classified as follows.

- **Extended and Condensed Letters**

To meet design or space requirements, letters may be narrower and spaced closer together, in which case they are called "*Compresed" or "Condensed"letters.* If the letters are wider than normal, they are referred to as "*Extended"letters.*

- **Light Face and Bold Face Letters**

Letters also vary as to the thickness of the stems or strokes. Letters having very thin stems are called *Light Face Letters,* while those having heavy stems are called *Bold Face Letters.*

3.2 Technique of Lettering

"Any normal person can learn to letter if he is persistent and intelligent in his efforts." While it is true that" *Practice makes perfect,"* it must be understood that practice alone is not enough; it must be accompanied by continuous effort to improve.

There are three necessary steps in learning to letter:

1. Knowledge of the proportions and forms of the letters, and the order of the strokes.
2. Knowledge of composition- the spacing of the letters and words.
3. Persistent practice, with continuous effort to improve.

Guide Lines

Extremely light horizontal guidelines are necessary to regulate the height of letters. In addition, light vertical or inclined guidelines are needed to keep the letters uniformly vertical or inclined. Guidelines are absolutely essential for good lettering, and should be regarded as a welcome aid, not as an unnecessary requirement.

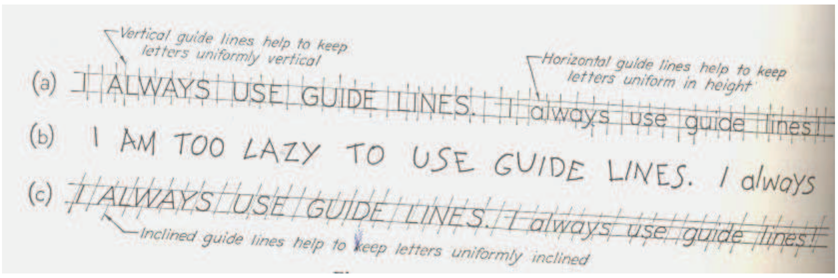


Figure 3.2 Guide lines

Make guidelines light, so that they can be erased after the lettering has been completed. Use a relatively hard pencil such as a 4H to 6H, with a long, sharp, conical point.

A. Guidelines for Capital Letters

On working drawings, capital letters are commonly made 3mm high, with the space between lines of lettering from ¾ th to the full height of the letters. The vertical guidelines are not used to space the letters (as this should always be done by eye while lettering), but only to keep the letters uniformly vertical, and they should accordingly be drawn at random.

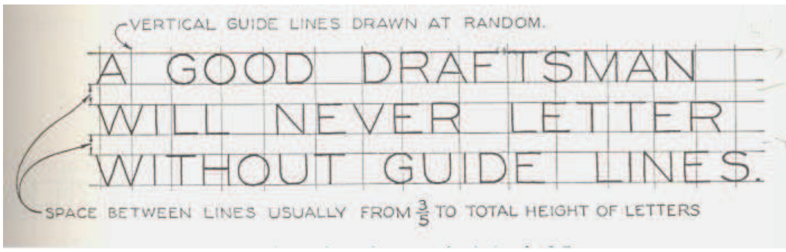


Figure 3.3 Guide lines for capital letters

A guideline for inclined capital letters is somewhat different. The spacing of horizontal guidelines is the same as for vertical capital lettering. The American Standard recommends slope of approximately 68.2^0 with the horizontal and may be established by drawing a "sloped triangle", and drawing the guidelines at random with T-square and triangles.

Figure 3.4 Guide lines for inclined capital letters

B. Guidelines for Lower-Case Letters

Lower-case letters have four horizontal guidelines, called the *cap line, waistline, and base line* and *drop line.* Strokes of letters that extend up to the cap line are called *ascenders,* and those that extend down to the drop line, *descenders. Since* there are only five letters ***(p, q.g, j, y)*** that have descenders, the drop lines are little needed and are usually omitted. In spacing guidelines, space "a" may very from 3/5to 2/3 of space "b".

The term single stoke or one stoke does not mean that the entire letter is made without lifting the pencil. But the width of the stroke is the width of the stem of the letter.

Single stoke lettering

The salient features of this type of lettering are:

- Greatest amount of lettering on drawings is done in a rapid single stroke letter i.e. either vertical, or inclined.
- The ability to letter and perfectly can be acquired only by continued and careful practice
- it is not a matter of artistic talent or event of dexterity in hand writing

Order of strokes

They are necessary to have legible and accurate letter styles. In the following description an alphabet of slightly extended vertical capitals has-been arranged in-group. Study the slope of each letter with the order and direction of the storks forming it. The proportion of height and width of various letters must be known carefully to letter them perfectly.

The I-H-T Group

- The letter I is *The Foundation Stroke*.
- The top of T is drawn first to the full width of the square and the stem is started accurately at its mid point.

The L-E-F Group

- The L is made in two strokes.
- The first two strokes of the E are the same for the L, the third or the upper stoke is lightly shorter than the lower and the last stroke is the third as long as the lower
- F has the same proportion as E

The V-A-K Group

- V is the same width as A, the A bridge is one third up from the bottom.
- The second stroke of K strikes stem one third up from the bottom and the third stroke branches from it.

The M-W Group

- are the widest letters
- M may be made in consecutive strokes of the two verticals as of N
- W is made with two V's

The O-Q-C-G Group

- The O families are made as full circles and made in two strokes with the left side a longer arc than the right.
- A large size C and G can be made more accurately with an extra stroke at the top.

The D- U-J Group

- The top and bottom stokes of D must be horizontal, fail line to observe this is a common fault with beginners
- U is formed by two parallel strokes to which the bottom stroke be added.
- J has the same construction as U, with the first stroke omitted.

The P-R-B Group

- The number of stokes depends up on the size of the letter.
- The middle line of P and R are on centerline of the vertical line.

Figure 3.5 Order of strokes for capital letters

Figure 3.6 Order of strokes for inclined capital letters

3.3 Spacing of Letters

Uniformity in spacing of letters is a matter of equalizing spaces by eye. *The background area between letters, not the distance between them, should be approximately equal.* Some combinations, such as LT and VA, may even have to be slightly overlapped to secure good spacing. In some cases the width of a letter may be decreased. For example, the lower stroke of the L may be shortened when followed by A.

Words are spaced well apart, but letters with in words should be spaced closely. Make each word a compact unit well separated from the adjacent words. For either upper case or lower-case lettering, make the spaces between words approximately equal to a capital O. Avoid spacing letters too far apart and words too close together.

3.4 Lettering in Maps

Letters are generally used on maps as follows:

- Vertical capital: name of states, countries, towns, capitals, titles of the map etc
- Vertical lower case: name of small towns, villages, post offices etc.
- Inclined capital: name of oceans, bays, gulfs, large lakes, rivers etc.
- Inclined lower case: name of rivers, creeks, small lakes, ponds, marshes and springs

3.5 Conventional Lines

Each line on a technical drawing has a definite meaning and is drawn in certain ways. There are certain conventional lines recommended by American Standard Association. According to the standard," *three widths of line;, thick, medium, and thin are recommended… exact thickness may vary according to the size and type of drawing…"*

There should also be a distinct contrast in the thickness of different kinds of lines, particularly between the thick lines and thin lines.

In technical drawings, make construction lines so light that they can barely be seen, with a hard sharp pencil such as 4H to 6H. For visible lines, hidden lines, and other “thick” lines use relatively soft pencils, such as F or H. All thin lines except construction line must be thin, but dark. They should be made with a sharp medium grad pencil, such as H or 2H.

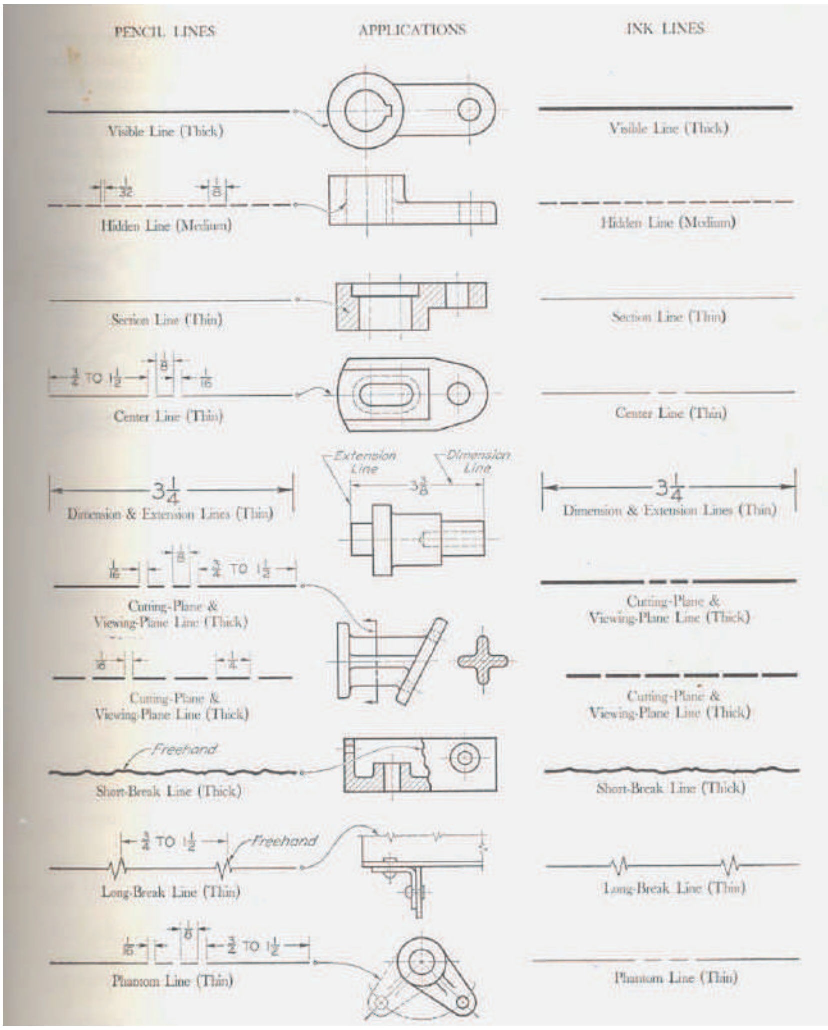


Figure 3.7 Conventional lines

Review Questions

1. Discuss the different types of lines
2. Explain the application of each line types in technical drawings

CHAPTER FOUR
GEOMETRIC CONSTRUCTION

Objectives:

At the end of this chapter students should be able to:

- Define geometric nomenclatures like angles, lines etc
- Discuss the steps to construct different geometric figures like lines, arcs, polygon, ellipse etc

4.1 Introduction

Strict interpretation of geometric construction allows use of only the compass and an instrument for drawing straight lines, and with these, the geometer, following mathematical theory, accomplishes his solutions. In technical drawing, the principles of geometry are employed constantly, but instruments are not limited to the basic two as T-squares, triangles, scales, curves etc. are used to make constructions with speed and accuracy. Since there is continual application of geometric principles, the methods given in this chapter should be mastered thoroughly. It is assumed that students using this book understand the elements of plane geometry and will be able to apply their knowledge.

The constructions given here afford excellent practice in the use of instruments. Remember that the results you obtain will be only as accurate as your skill makes them. Take care in measuring and drawing so that your drawings will be accurate and professional in appearance.

4.2 GEOMETRIC NOMENICLATURE

A. POINTS IN SPACE

A point is an exact location in space or on a drawing surface. A point is actually represented on the drawing by a crisscross at its exact location. The exact point in space is where the two lines of the crisscross intersect. When a point is located on an existing line, a light, short dashed line or cross bar is placed on the line at the location of the exact point. Never represent a point on a drawing by a dot; except for sketching locations.

B. LINE

Lines are straight elements that have no width, but are infinite in length (magnitude), and they can be located by two points which are not on the same spot but fall along the line. Lines may be straight lines or curved lines.A straight line is the shortest distance between two points. It can be drawn in any direction. If a line is indefinite, and the ends are not fixed in length, the actual length is a matter of convenience. If the end points of a line are important, they must be marked by means of small, mechanically drawn crossbars, as described by a pint in space.

Straight lines and curved lines are considered parallel if the shortest distance between them remains constant. The symbol used for parallel line is //. Lines, which are tangent and at 90^0 are considered perpendicular. The symbol for perpendicular line is ⊥.

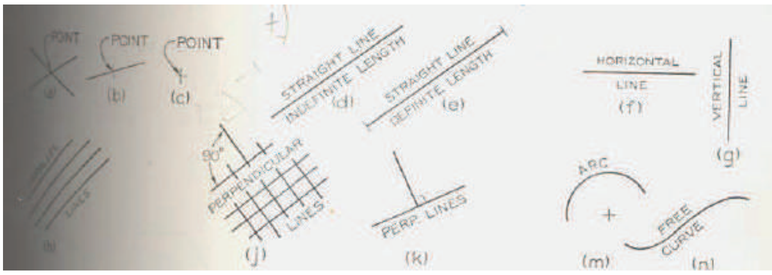


Figure 4.1 Points and lines

C. ANGLE

An angle is formed by the intersection of two lines. There are three major kinds of angles: right angels, acute angles and obtuse angles. The right angle is an angle of 90^0, an acute angle is an angle less than 90^0, and an obtuse angle is an angle more than 90^0. A straight line is 180^0. The symbol for an angle is < (singular) and <'s (Plural). To draw an angle, use the drafting machine, a triangle, or a protractor.

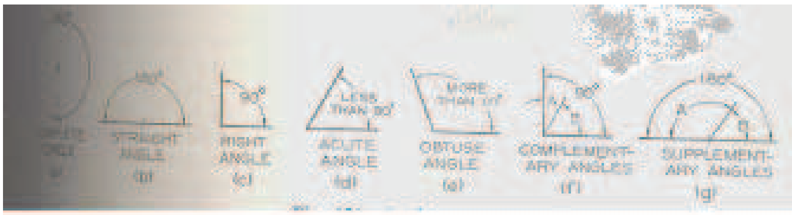


Figure 4.2 Angles

D. TRIANGLES

A triangle is a closed plane figure with three straight sides and their interior angles sum up exactly 180^0. The various kinds of triangles: a right triangle, an equilateral triangle, an isosceles triangle, and an obtuse angled triangle.

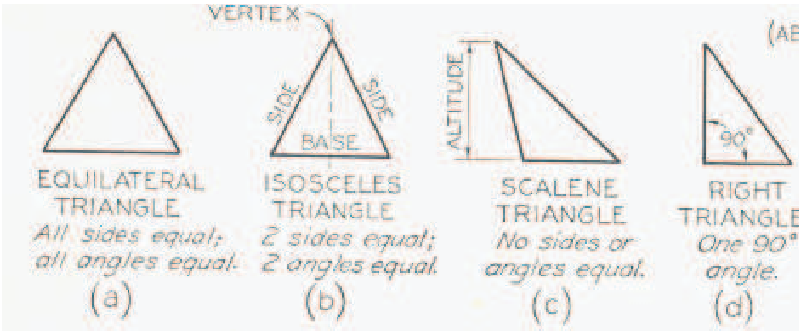


Figure 4.3 Triangles

E. QUADRIALTERAL

It is a plane figure bounded by four straight sides. When opposite sides are parallel, the quadrilateral is also considered to be a parallelogram.

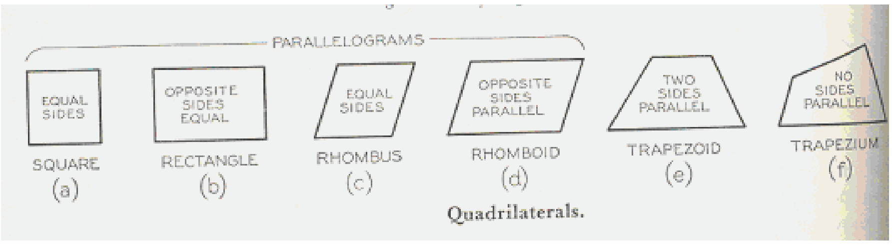


Figure 4.4 Quadrilaterals

F. POLYGON

A polygon is a closed plane figure with three or more straight sides. The most important of these polygons as they relate to drafting are probably the triangle with three sides, square with four sides, the hexagon with six sides, and the octagon with eight sides.

Figure 4.5 Polygons

G. CIRCLE

A circle is a closed curve with all points on the circle at the same distance from the center point. The major components of a circle are the diameter, the radius and circumference.

- *The diameter of the circle* is the straight distance from one outside curved surface through the center point to the opposite outside curved surface.
- *The radius of a circle* is the distance from the center point to the outside curved surface. The radius is half the diameter, and is used to set the compass when drawing a diameter.
- *A central angle*: is an angle formed by two radial lines from the center of the circle.
- *A sector*: is the area of a circle lying between two radial lines and the circumference.
- *A quadrant*: is a sector with a central angle of 90^0 and usually with one of the radial lines oriented horizontally.
- *A chord*: is any straight line whose opposite ends terminate on the circumference of the circle.
- *A segment*: is the smaller portion of a circle separated by a chord.
- *Concentric circles* are two or more circles with a common center point.
- *Eccentric circles* are two or more circles with out a common center point.

♦ *A semi circle* is half of the circle.

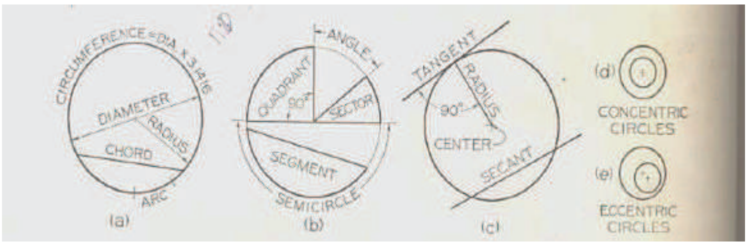


Figure 4.6 Circle

H. SOLIDS

They are geometric figures bounded by plane surfaces. The surfaces are called *faces*, and if these are equal regular polygons, the solids are *regular polyhedra*

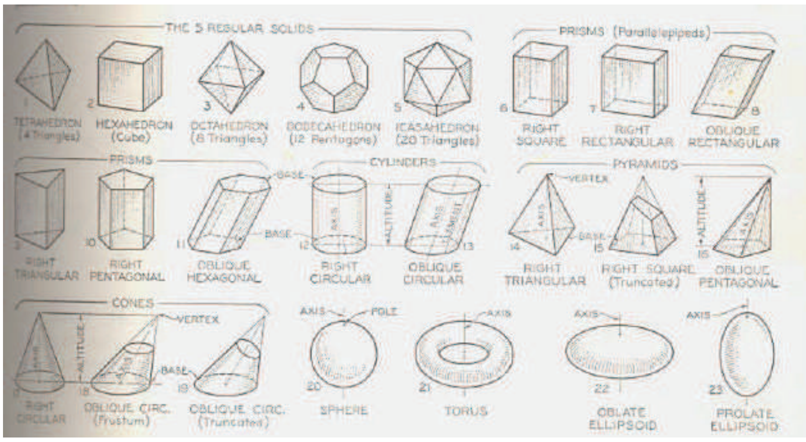


Figure 4.7 Solids

4.3 Techniques of Geometric constructions

To construct the above mentioned geometric figures, we have to know some principles and procedures of geometric construction. Thus, the remaining of this chapter is devoted to illustrate step-by-step geometric construction procedures used by drafters and technicians to develop various geometric forms.

A. How to Bisect a Line or an Arc

To bisect a line means to divide it in half or to find its center point. In the given process, a line will also be constructed at the exact center point at exactly 90^0.

Given: Line A-B

Step 1: Set the compass approximately two-thirds of the length of line A-B and swing an arc from point A.

Step 2: Using the exact same compass setting, swing an arc from point B.

Step 3: At the two intersections of these arcs, locate points D and E

Step 4: Draw a straight-line connecting point D with point E. Where this line intersects line A-B, it bisects line A-B. Line D-E is also perpendicular to line A-B at the exact center point.

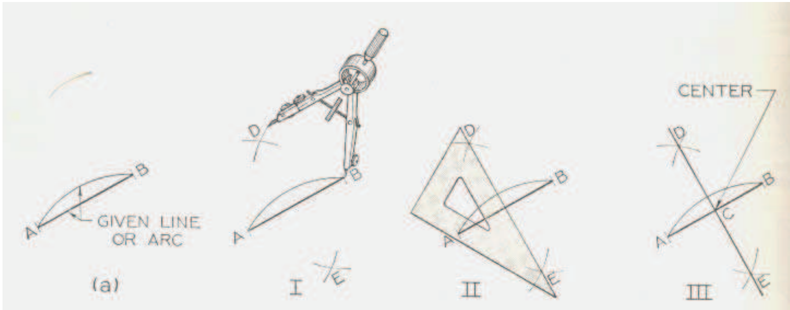


Figure 4.8 Example on how to bisect a line or arc

B. HOW TO DIVIDE A LINE IN TO Number of EQUAL PARTS

Given: Line A-B

Step 1: Draw a construction line AC that starts at end A of given line AB. This new line is longer than the given line and makes an angle of not more than 30^0 with it.

Step 2: Find a scale that will approximately divide the line AB in to the number of parts needed (11 in the example below), and mark these divisions on the line AC. There are now ‘n’ equal divisions from A to D that lie on the line AC (11 in this example).

Step 3: Set the adjustable triangle to draw a construction line from point D to point B. Then draw construction lines through each of the remaining ‘n-1’ divisions parallel to the first line BD by sliding the triangle along the straight edge. The original line AB will now be accurately divided.

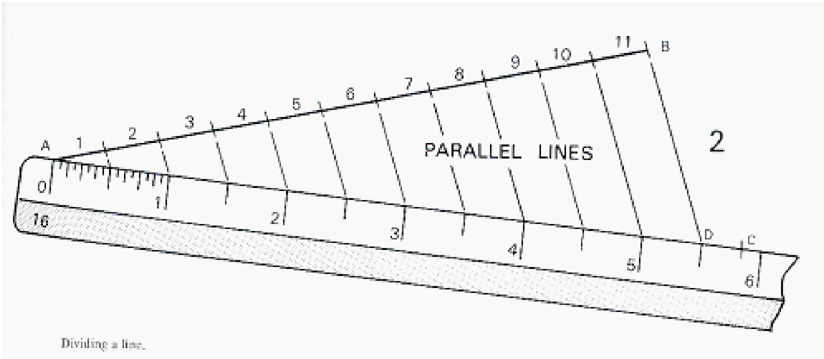


Figure 4.9 Example on how to divide a line in to a number of equal parts

C. How to Bisect an Angle

To bisect an angle means to divide it in half or to cut it in to two equal angles.

Given: Angle BAC

Step 1: Set the compass at any convenient radius and swing an arc from point A

Step 2: Locate points E and F on the legs of the angle, and swing two arcs of the same identical length from points E and F, respectively.

Step 3: Where these arcs intersect, locate point D. Draw a straight line from A to D. This line will bisect angle BAC and establish two equal angles: CAD and BAD.

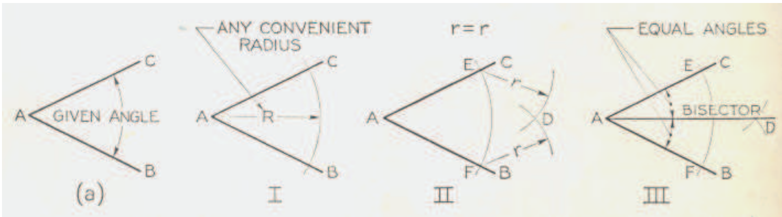


Figure 4.10 Example on how to bisect an angle

D. How to Draw an Arc or Circle (Radius) Through Three Given Points

Given: Three points in space at random: A, Band C.

Step 1: With straight line, lightly connect points A to B, and B to C,

Step 2: Using the method outlined for bisecting a line, bisect lines A-B and B-C

Step 3: Locate point X where the two extended bisectors meet. Point X is the exact center of the arc or circle.

Step 4: Place the point of the compass on point X and adjust the lead to any of the points A, B, or C (they are the same distance), and swing the circle. If all work is done correctly, the arc or circle should pass through each point.

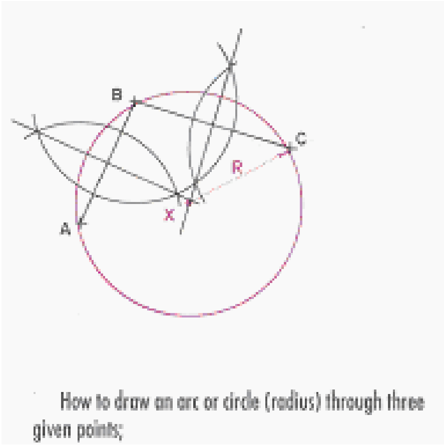


Figure 4.11 Example on how to draw an arc or circle

E. How to Draw a Line Parallel to a Straight Line at a Given Distance

Given: Line A-B, and a required distance to the parallel line.

Step 1: Set the compass at the required distance to the parallel line. Place the point of the compass at any location on the given line, and swing a light arc whose radius is the required distance.

Step 2: Adjust the straight edge of either a drafting machine or an adjusted triangle so that it line sup with line A-B, slide the straight edge up or down to the extreme high point, which is the tangent point, of the arc, then draw the parallel line.

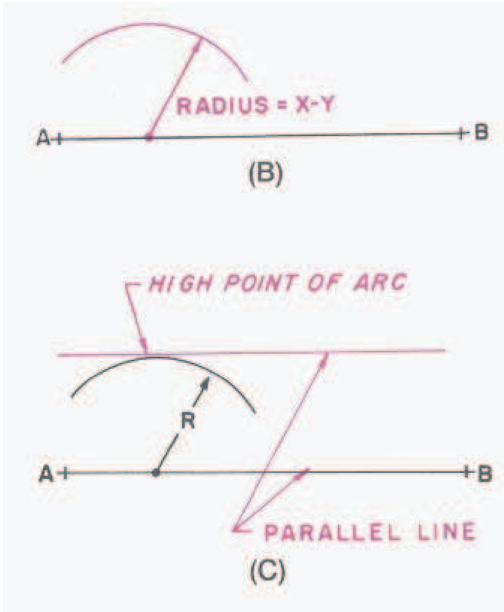


Figure 4.12 Example on how to draw parallel line

F. How to Draw a Line Parallel to a Line Curved Line at a Given Distance

Given: Curved line A-B, and a required distance to the parallel line,

Step 1: Set the compass at the required distance to the parallel line. Starting from either end of the curved line, place the point of the compass on the given line, and swing a series of light arcs along the given line.

Step 2: using an irregular curve, draw a line along the extreme high points of the arcs.

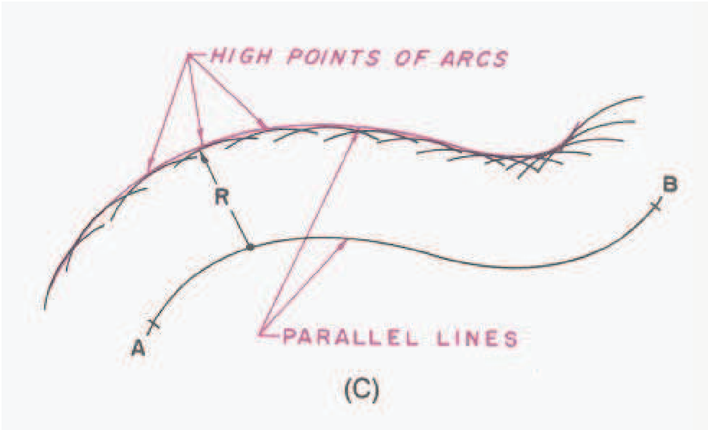


Figure 4.13 Example on how to draw parallel curved line

G. How to Draw a Perpendicular Lines to a Line at a Point

Method 1

Given: Line A-B with point P on the same line.

Step 1: Using P as a center, make two arcs of equal radius or more continuous arc (R1) to intercept line A-B on either side of point P, at points S and T.

Step 2: Swing larger but equal arcs (R2) from each of points S and T to cross each other at point U.

Step 3: A line from P to U is perpendicular to line A-B at point P

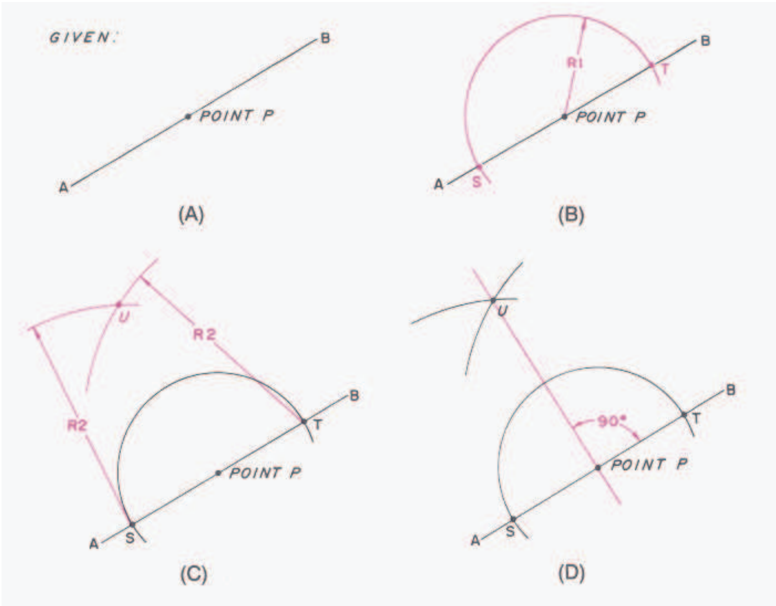


Figure 4.14 Example on how to draw a perpendicular line, to a point outside the line

H. How to Draw a Perpendicular to a Line at a Point

Method 2

Given: Line A-B with point P on the line.

Step 1: Swing an arc of any convenient radius whose center O is at any convenient location NOT on line A-B, but positioned to make the arc cross line A-B at points P and Q

Step 2: A line from point Q through center O intercepts the opposite side of the arc at point R

Step 3: Line R-P is perpendicular to line A-B (A right angle has been inscribed in asemi circle)

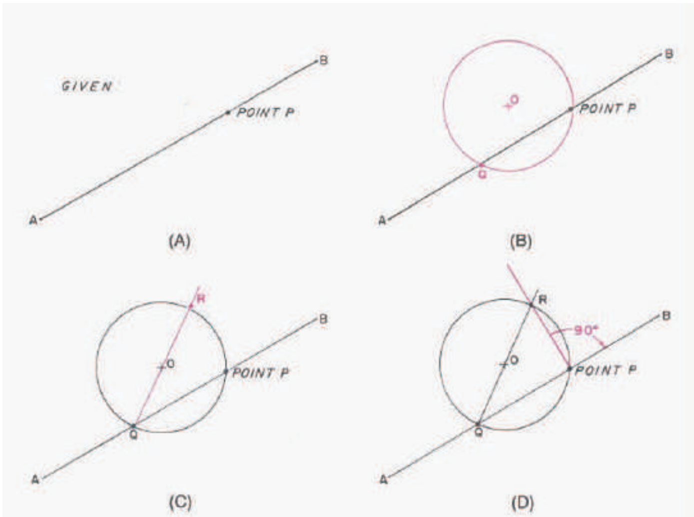


Figure 4.15 Example on how to draw a perpendicular line, to a point on the line

I. How to Draw a Perpendicular to a line from a Point Not on the Line

Given: Line A-B and point P

Step 1: Using P as a center, swing an arc (R1) to intercept line A-B at points G and H.

Step 2: Swing larger, but equal length arcs (R2) from each of the points G and H to intercept each other at point J.

Step 3: Line P-J is perpendicular to line A-B

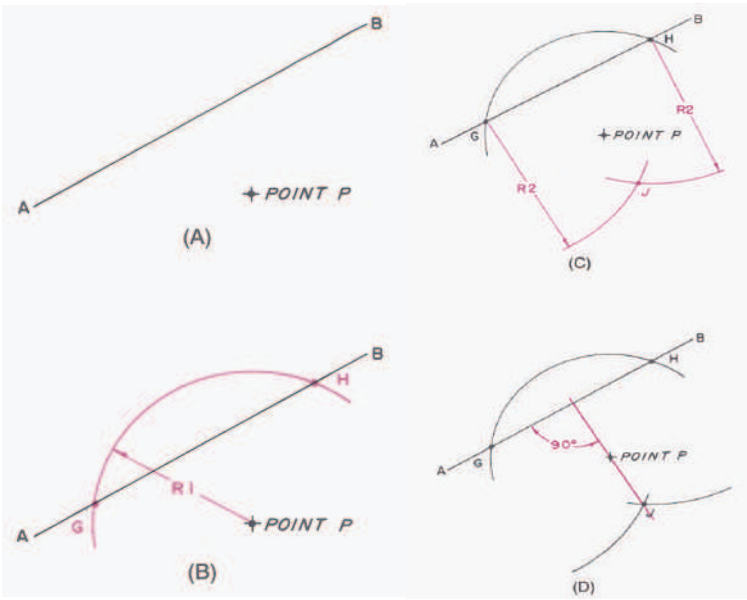


Figure 4.16 Example on how to draw a perpendicular line, to a point outside the line

J. How to Draw a Triangle with Known Lengths of Sides

Given: lengths 1, 2, and 3.

Step 1: Draw the longest length line, in this example length 3, with ends A and B. Swing an arc (R1) from point A whose radius is either length 1 or length 2; in this example length 1.

Step 2; using the radius length not used in step 1, swing an arc (R2) from point B to intercept the arc swung from point A at point

Step 3: Connect A to C and B to C to complete the triangle

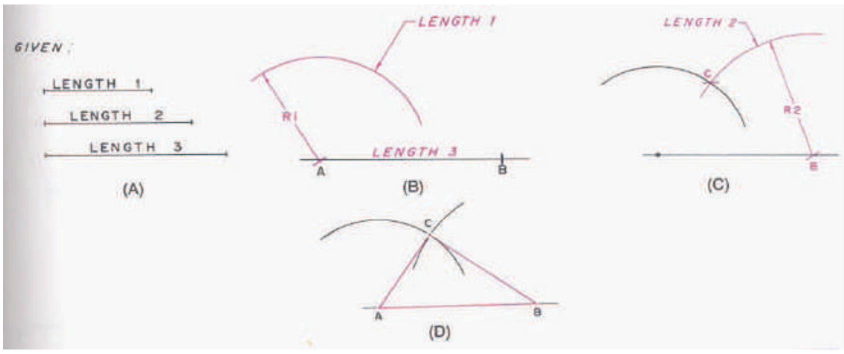


Figure 4.17 Example on how to draw triangles with given sides

K. How to Draw a Square

Method-1

Given: The locations of the center and the required distance across the sides of a square.

Step 1: Lightly draw a circle with a diameter equal to the distance around the sides of the square. Set the compass at half the required diameter.

Step 2: Using triangles, lightly complete the square by constructing tangent lines to the circle. Allow the light construction lines to project from the square, with out erasing them.

Step 3: Check to see that there are four equal sides and, if so, darken in the actual square using the correct line thickness.

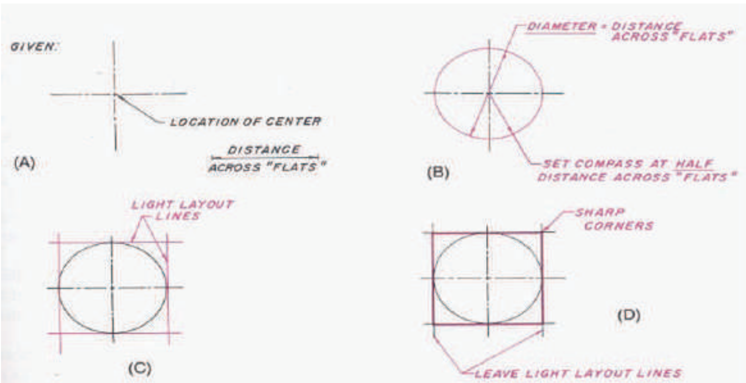


Figure 4.18 Example on how to draw square with given side

Method-2

Given one side AB. Through point A, draw a perpendicular. With A as a center, and AB as radius; draw the arc to intersect the perpendicular at C. With B and C as centers, and AB as radius, strike arcs to intersect at D. Draw line CD and BD.

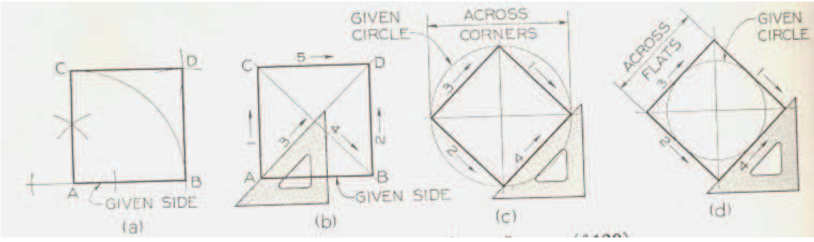


Figure 4.19 Example on how to draw square with given side

L. How to Draw A Pentagon (5 Sides)

Given: The locations of the pentagon center and the diameter that will circumscribe the pentagon.

Step 1: Bisect radius OD at C.

Step 2: With C as center, and CA as radius, strike arc AE. With A as center, and AE as radius, strike arc EB.

Step 3: Draw line AB, then set off distances AB around the circumference of the circle, and draw the sides through these points.

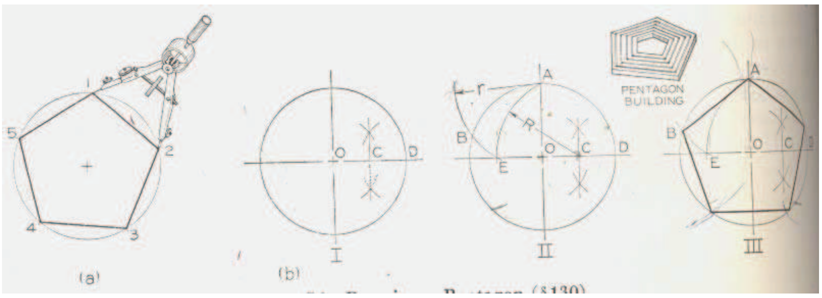


Figure 4.20 Example on how to draw pentagon with a given side

M. How to Draw A Hexagon (6 Sides)

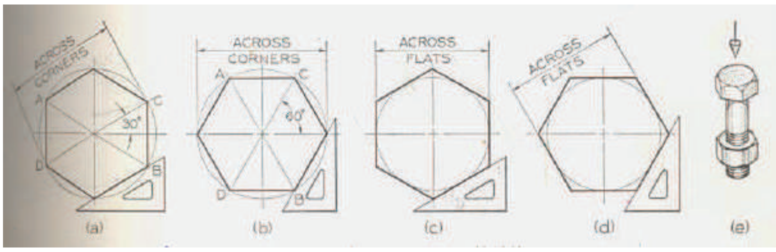


Figure 4.21 Example on how to draw hexagon with a given side

N. To Draw Any Sided Regular Polygon

To construct a regular polygon with a specific number of sides, divide the given diameter using the parallel line method as shown in fig below. In this example, let us assume seven-sided regular polygon. Construct an equilateral triangle (0-7-8) with the diameter (0-7) as one of its sides. Draw a line from the apex (point 8) through the second point on the line (point 2). Extend line 8-2 until it intersects the circle at point 9. Radius 0-9 will be the size of each side of the figure. Using radius 0-9 step off the corners of the seven sides polygon and connect the points.

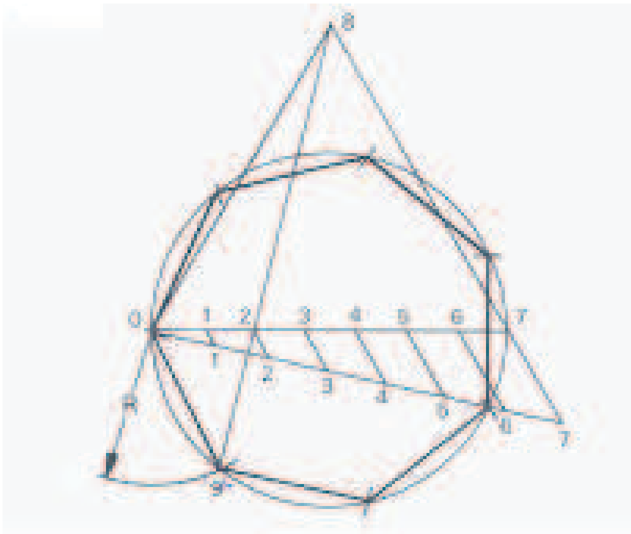


Figure 4.22 Example on how to draw any sided regular polygon

O. To Draw A Circle Tangent to a Line at a Given Point

Given: Given line AB and a point on the line.

Step 1: At P erect a perpendicular to the line.

Step 2: Set off the radius of the required circle on the perpendicular.

Step 3: Draw circle with radius CP.

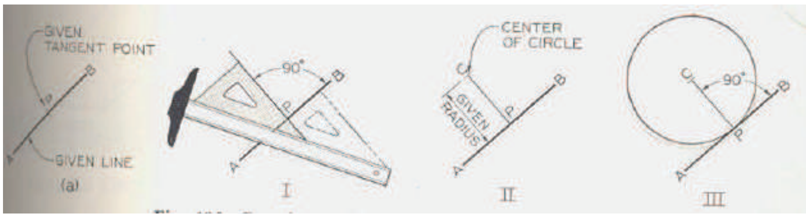


Figure 4.23 Example on how to draw a tangent to a line

P. To Draw a Tangent to A Circle through a Point

Method-1

Given*: Point P on the circle.*

Move the T-square and triangle as a unit until one side of the triangle passes through the point P and the center of the circle; then slide the triangle until the other side passes through point P, and draw the required tangent.

Method-2

Given: Point P outside the circle

Move the T-square and triangles as a unit until one side of the triangle passes through point P and, by inspection, is the tangent to the circle; and then slide the triangle until the other side passes through the center of the circle, and lightly mark the point of tangency T. finally move the triangle back to its starting position and draw the required tangent.

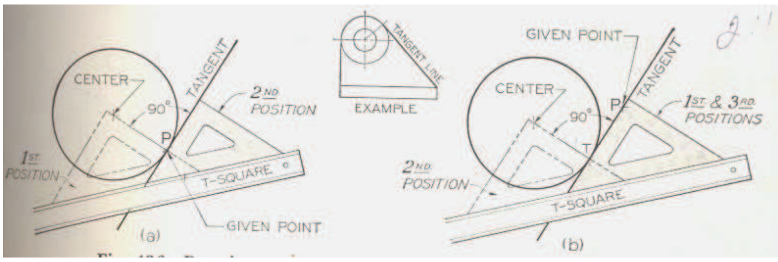


Figure 4.24 Example on how to draw a tangent to a circle

Q. To Draw Tangents to Two Circles

Move the T-square and triangles as a unit until one side of the triangle is tangent, by inspection, to the two circles; then slide the triangle until the other side passes through the center of one circle, and lightly mark the point of tangency. Then slide the triangle until the side passes through the center of the other circle, and mark the point of tangency. Finally slide the triangle back to the tangent position, and draw the tangent lines between the two points of tangency. Draw the second tangent line in similar manner.

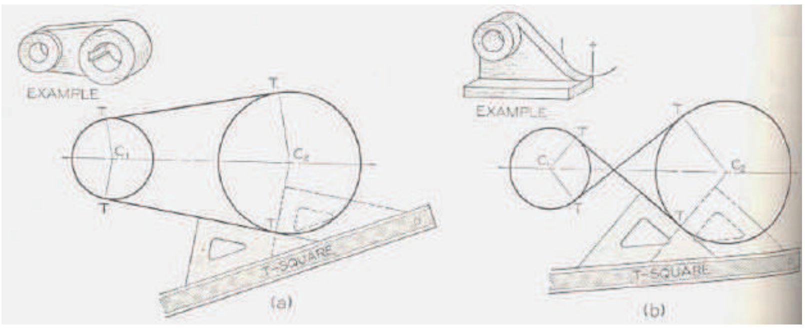


Figure 4.25 Example on how to draw a tangent to two circles

R. HOW TO CONSTRUCT AN ARC TANGENT TO an Angle

Given: A right angle, lines A and B and a required radius.

Step 1: Set the compass at the required radius and, out of the way, swing a radius from line A and one from line B.

Step 2: From the extreme high points of each radius, construct a light line parallel to line A and another line parallel to line B.

Step 3: Where these lines intersect is the exact location of the required swing point. Set the compass point on the swing point and lightly construct the required radius. Allow the radius swing to extend past the required area. It is important to locate all tangent points (T.P) before darkening in.

Step 4: Check all work and darken in the radius using the correct line thickness. Darken in connecting straight lines as required. Always construct compass work first, followed by straight lines. Leave all light construction lines.

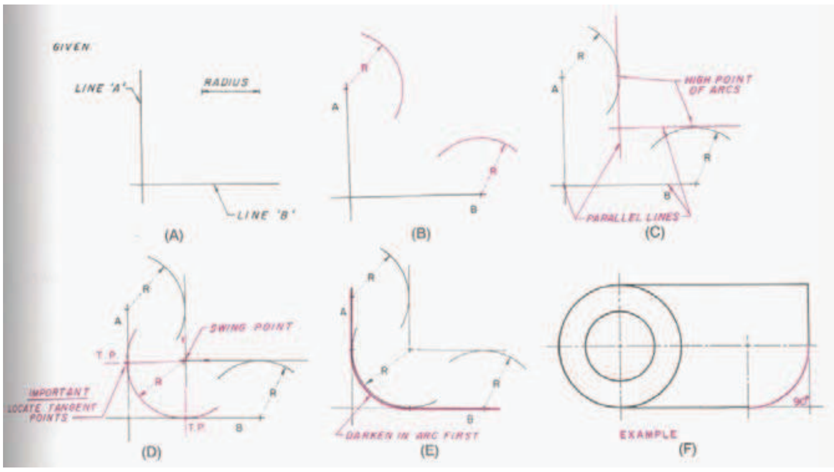


Figure 4.26 Example on how to draw an arc tangent to an angle

S. How to Construct an Arc Tangent to Two Radii or Diameters

Given: Diameter A and arc B with center points located, and the required radius.

Step 1: Set the compass at the required radius and, out of the way, swing a radius of the required length from a point on the circumference of given diameter A. Out of the way, swing a required radius from a point on the circumference of a given arc B.

Step 2: From the extreme high points of each radius, construct a light radius out side of the given radii A and B.

Step 3: Where these arcs intersect is the exact location of the required swing point. Set the compass point on the swing point and lightly construct the required radius. Allow the radius swing to extend past the required area.

Step 4: Check all work; darken in the radii using the correct line thickness. Darken in the arcs or radii in consecutive order from left to right or from right to left, thus constructing a smooth connecting line having no apparent change in direction.

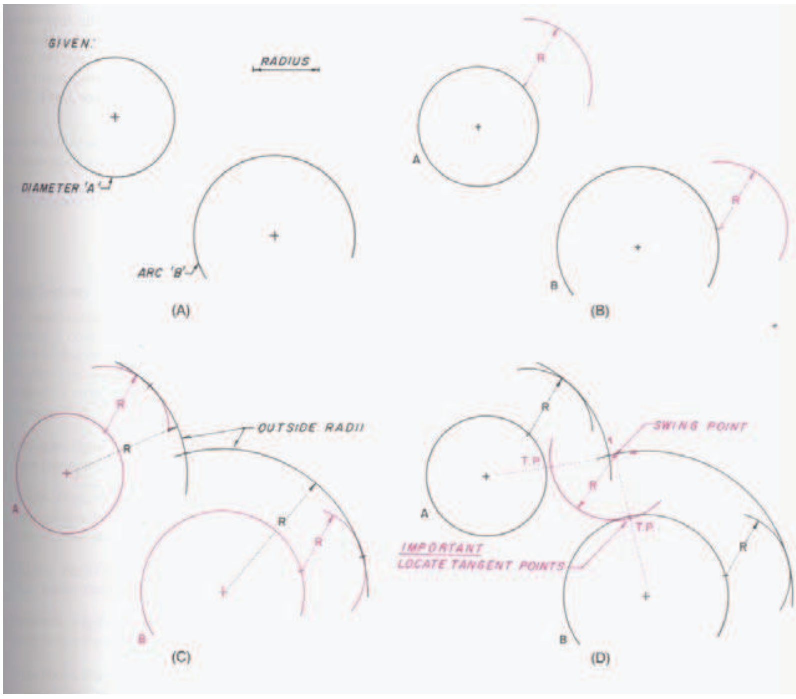


Figure 4.27 Example on how to draw an arc tangent to two radii or diameter

T. To Draw an Ellipse (By Four-Centered Method)

Join 1 and 3, layoff 3-5 equal to 01-03. This is done graphically as indicated in the fig. Below by swinging 1 around to 5 with O as center where now 03 from 05 is 3-5; the required distance. With 3 as center, an arc from 5 to the diagonal 1-3 locates 6. Bisect 1-6 by a perpendicular crossing 0-1 at 9 and intersecting 0-4 produced (if necessary) at 10.

Make 0-9’ equal to 0-9, and 0-10’ equal to 0-10. Then 9, 9’, 10, and 10’ will be centers for four tangent circle arcs forming a curve approximating the shape of an ellipse.

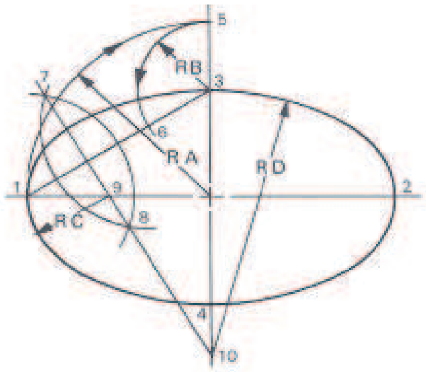


Figure 4.28 Example on ellipse construction using four centered method

U. How to Draw an Ogee Curve

An ogee curve is used to join two parallel lines. It forms a gentle curve that reverses itself in a neat symmetrical geometric form.

Given: Parallel lines A-B and C-D

Step 1: Draw a straight line connecting the space between the parallel lines. In this example, from point B to point C.

Step 2: Make a perpendicular bisector to line B-C to establish point X.

Step 3: Draw a perpendicular from line A-B at point B to intersect the perpendicular bisector of B-X, which locates the first required swing center. Draw a perpendicular from line C-D at point C to intersect the perpendicular bisector of CX, which locates the second required swing center.

Step 4: Place the compass point and adjust the compass lead to point B, and swing an arc from B to X. Place the compass point on the second swing point and swing an arc from X to C. This completes the ogee curve.

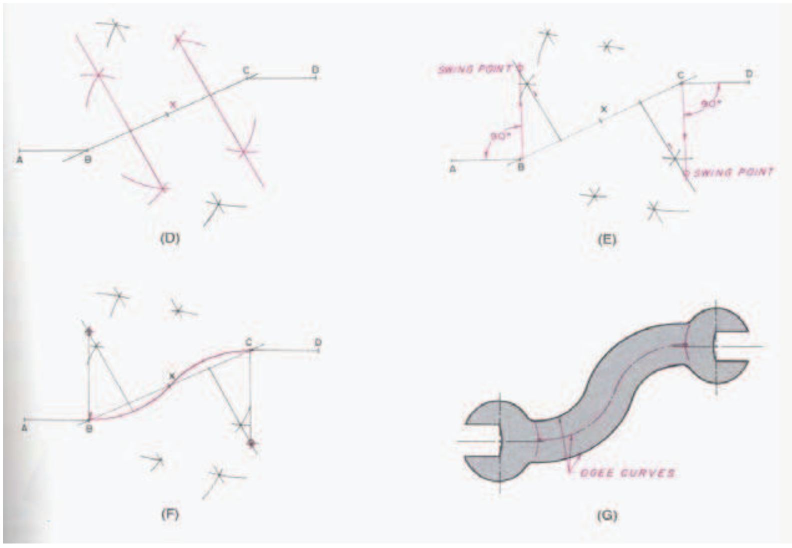


Figure 4.29 Example on ogee curve construction

Review questions

1. The side of a certain triangle is 2 cm. Construct an equilateral triangle based on the given side by using compass and ruler.
2. Show the procedure how to divide a line in to number of equal parts
3. Draw a line parallel to straight line AB at 2cm distance.