THE COPPERBELT UNIVERSITY

ED 111 / ED 211

ENGINEERING DRAWING MODULE

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OVERVIEW OF THE COURSE

This course is intended to equip students with the ability to design and communicate engineering concepts through drawings or graphic language. Therefore, students will be exposed to various types and methods of communicating graphically. This original concept or idea is usually placed on paper and communicated to others by way of graphic language. This graphic language may be drawings or sketches. The young engineer or designer must be able to create idea sketches, calculates stresses, analyze motions, size parts, specify materials and production methods, make design layouts and supervise the preparation of drawings and specifications that will control the numerous details of production, assembly, and maintenance of the product. In order to perform or supervise these many tasks, the engineer makes liberal use of freehand drawings. He or she must be able to record and communicate ideas quickly to associates and support personnel. The half course is very wide in term of coverage but the course module has endeavored to pick out the key topics and aspects of the course. The course is divided into two Units namely Plane and Solid Geometry. Engineering Drawing is a wide course but this module will endeavor to equip students with the necessary basic and important skills relating to Graphics design and communication. This module is presented in Chapter format but has 30 units which each illustrate and equip the student with the necessary skill to appreciate this course.

LEARNING OUTCOME

By the end of this course, students are able to:

1. Use drawing instruments and equipment

2. Visualize and Produce geometrical figures

3. Design and Produce Engineering drawings

4. Design Engineering systems from concepts and drawings

LIST OF ACRONYMS/ABBREVIATIONS

TD – Technical Drawing

ED – Engineering Drawing

3D – Three Dimensions

A/C- Across corners
A/F - Across flats
HEX HD - Hexagon head
ASSY - Assembly
CRS- Centers
CL -Center line
Ø -Diameter (preceding a dimension)
R -Radius (preceding a dimension, capital only)
RAD- Radius (in a note)
DRG- Drawing
FIG.- Figure
LH-Left hand
LG -Long
NO- Number
I/D -Inside diameter
O/D -Outside diameter
RH- Right hand
RD HD -Round head
SCR- Screwed
SPEC- Specification
SPHERE- Spherical
STD -Standard
mm -Millimeter
NTS -Not to scale
RPM -Revolutions per minute

CHAPTER ONE

INTRODUCTION TO GRAPHICS COMMUNICATIONS

CHAPTER OVERVIEW

Chapter 1 covers an introduction to graphical communications. The chapter has **2 units** and explains why today's Engineers must be able to communicate graphically and be able to create designs and build them into systems. The purpose of communication – irrespective of the form/means in which it is conveyed – is to pass a message from one entity (a person or group of people) to another entity (person or group) in the most convenient way and with minimum distortion or ambiguity [1]. Engineering drawing is key in understanding systems over a wide spectrum of industrial applications covering Electrical, Mechanical, Civil, Chemical, Mining Engineering etc. to name but a few. Engineering drawing is guided by principles, standards and conventions and hence this chapter will help the student understand them and eventually leading to **Chapter 2** where lettering and presentation are covered before the actual constructions are tackled in the following chapters.

OBJECTIVES

After completing this Chapter, you will be able to:

1. Describe why Technical drawings are an effective communications system for technical ideas about designs and products
2. Define important terms related to graphics communications for technology

Unit 1.1: Technical Drawing

Unit Overview

This unit introduces the course to the student. The student will get to be enlightened about the importance of the course and will appreciate why they need this course in their development into being Engineers.

Unit Objective

This unit will enable the student to appreciate the importance of the course and able to relate their field of study to the skills to be acquired in the course. The Lecturer will endeavor to explain in detail the aspects of this course applicable to their field of study and why they need the student needs engineering visualization and design skills.

1.1 Technical 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 further than verbal communication.

Unit 2: Engineering Drawing Tools

Unit Overview

This unit introduces the student to the tools to be used in the course. Like a famer training a farm worker how to use a hole, spade, axe, and other farming tools, so it is with engineering drawing. The student will be told which tools are required for the course. At the same time the student will get to be taught how to use the tools required in the course.

Unit Objective

This unit will train the student how to use instruments like a campus, drawing board, .T-square, set squares. This may seem an easy task but needs dedication and mastery.

1.2 Tools required

In order to produce drawings, an Engineer/Technologist requires Instruments. For this course, the following are the instruments required;

1. A3 drawing board inclusive of Tee square or 50 cm rule
2. Drawing pencils H to 6H
3. Drawing paper A3
4. Adhesive tape
5. Drawing instruments (Campus, divider, set squares, protractor ,eraser, small rule)

The A3 drawing board accommodates **A3** Drawing Paper. The campus is used for circular drawings, the divider for distance measurements, the protractor for angles, the Tee-square and set squares for horizontal, angular and vertical lines. In case of a mistake, an eraser may be used. Adhesive tape is used to stick the paper to the drawing Board. The instruments are physically shown in the figures below;

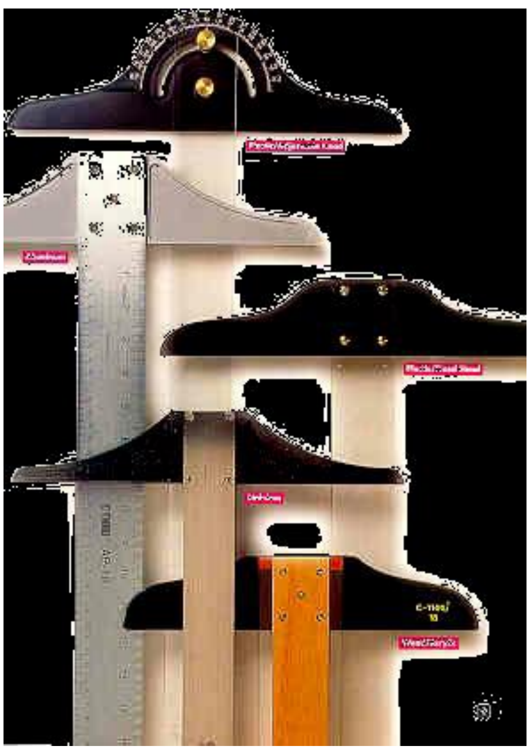


Figure 1.1: T- Squares

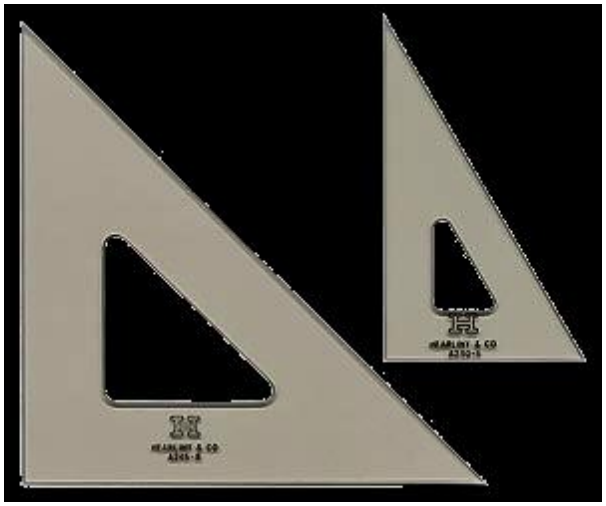


Figure 1.2: Set Squares ($45^0/90^0$ and $30^0/60^0$)

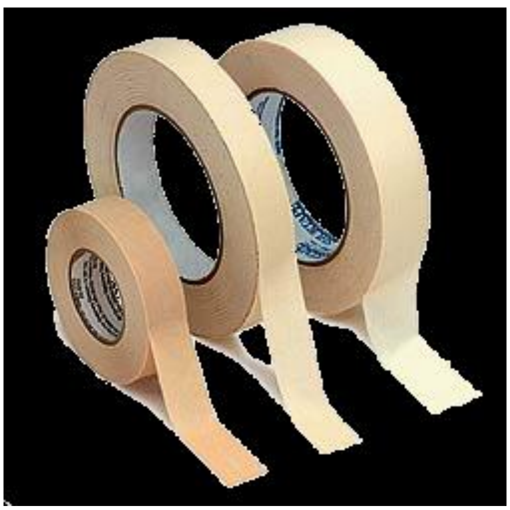


Figure 1.3: Adhesive Tape

Figure 1.4: Pencils

Figure 1.5: Drawing set with instruments

Figure 1.6: Drawing Instruments being used

Learning outcome

The student should be able appreciate the course in their career and know which tools and instruments are require in engineering drawing and how to use them.

CHAPTER TWO

LINES AND LETTERING

CHAPTER OVERVIEW

Chapter 2 has **4 units.** The Chapter explains and illustrates to the student how to letter and number in Engineering drawing. Like any other course, there are standards and conventions to be followed. Equally in ED, there is a **systematic way** of **lettering** and **numbering**. Man has developed graphic representation along two distinct lines. These are (i) Artistic and (ii) Technical. In our case, we will focus on **Technical drawings.**

OBJECTIVES

After completing this chapter, you will be able to:

1. Letter and number your drawings in line with standard format
2. Draw a Title block

Unit 2.1; Engineering drawing principles

Unit overview

In this unit, the student is guided on the important principles the must keep in mastering the course.

Unit Objective

To teach the student the principles of engineering drawing

Principles of Engineering drawing

The following are the important principles the student should strive to attain:

1. **Accuracy:** No drawing is of maximum usefulness if it is not accurate. The student must learn from the beginning that success in a College or University career or later in professional employment cannot be had if the habit of accuracy is not acquired.
2. **Speed:** 'Time is money' in industry, and there is no demand for the slow engineer. However, speed is not attained by hurrying; it is an unsought by-product of intelligent and continuous work. It comes with study and practice, and the fast worker is usually more mentally alert.

3. **Legibility:** The engineer should remember that the drawing is a means of communication to others, and that it must be clear and legible in order to serve its purpose well. Care should be given to details especially to lettering.
4. **Neatness:** If a drawing is to be accurate and legible, it must also be clean; therefore the student should constantly strive to acquire the habit of neatness. Untidy drawings are the result of sloppy and careless methods and will not be accepted by the instructor. This can be enhanced by ensuring that all your drawing equipment and instruments are lean and placed in an orderly manner. Your pencils should be sharpened and make sure that you get the correct choice of pencils. Your eraser should be clean too. The paper texture should be the correct one too. It should be noted that a drawing may be good but if it's not neat, you will definitely not make the correct impression to your instructor.

Unit 2.2; Types of lines

Unit overview

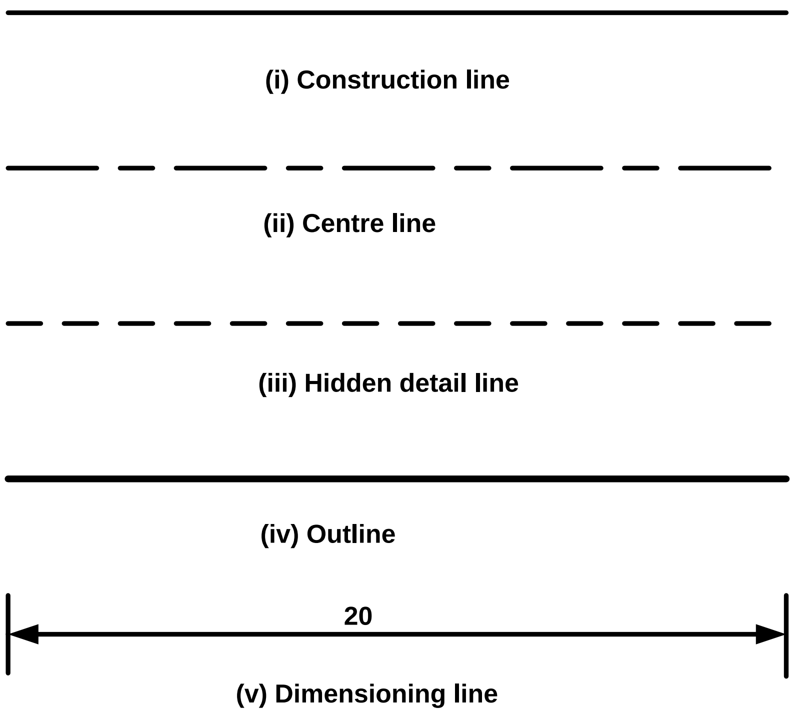
In this unit, the student learns about the type of lines used in engineering drawing. In ED, different types of lines are used to represent various visuals. It is thus outlined in this unit the types of lines used for representations.

Unit Objective

To enable the student use the correct types of lines when producing engineering drawing.

2.2 Types of lines

The following are the types of lines that will be used frequently in our drawings. Each line has a specific purpose as will be seen as we progress along the course.



Unit 2.3; Lettering and Numbering

Unit overview

In this unit, the student learns about how to write letters and do numbering in ED. In ED, there is a systematic way of lettering and numbering. This brings out the aspect of neatness and layout and makes drawings look neat. This is thus outlined in this unit the types of lines used for representations.

Unit Objective

To enable the student letter and number correctly as expected of the standards in ED.

2.3. Lettering and numbering

An engineer will always need to label their drawings and write some detail regarding the identity of the drawing and its features. Therefore, in order to promote uniformity, a lettering standard is followed by the engineer when they label their drawings. This is illustrated below.

A B C D E

F G H I J

K L M N O

P Q R S T

U V W X Y

Z

In any style of lettering, uniformity is essential. Uniformity in height, proportion, inclination, strength of lines, spacing of letters and spacing of words is essential. Good lettering is accomplished by conscious effort and practice. Always ensure that the guidelines are drawn before you do your lettering. Lettering without guidelines will result in poor lettering.

Numbering

Numbers should follow a specific order just like lettering.

1 2 3 4 5 6 7

8 9 0

Unit 2.4; Title block

Unit overview

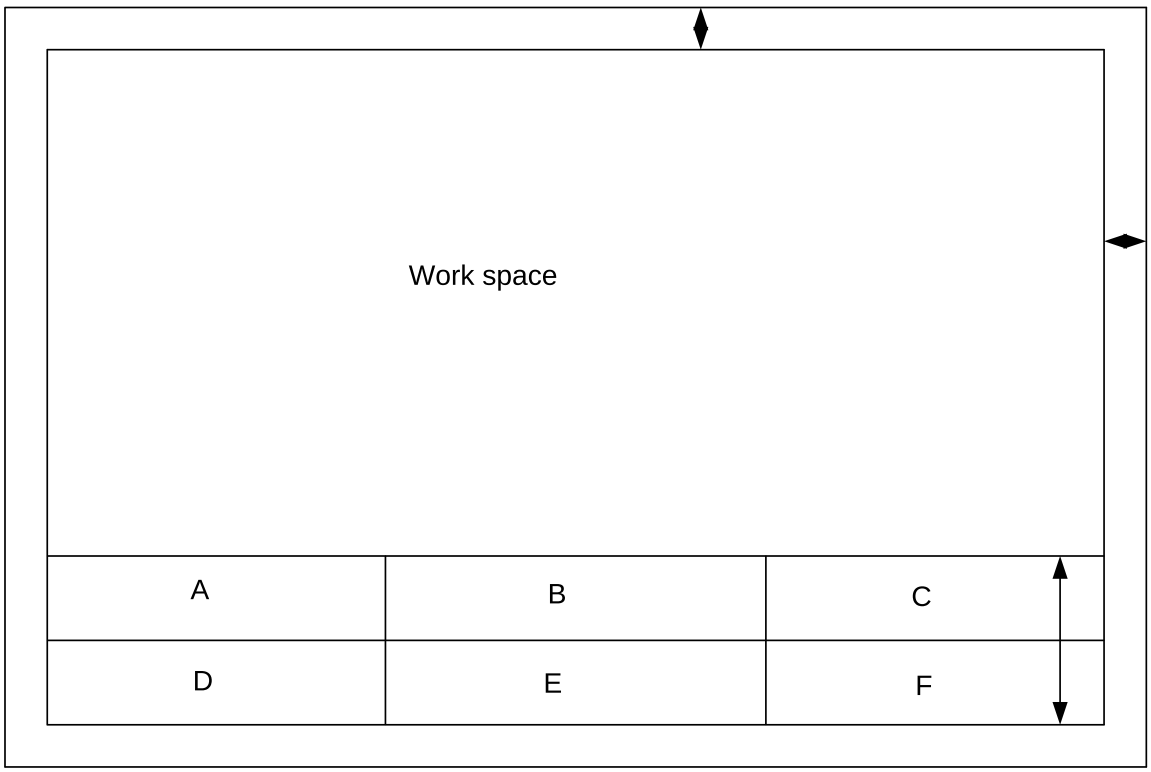
In this unit, the student learns about to present their work using a title blocks. Just like a house plan, there is certain detail that must accompany every drawing. This is what the title block presents and it is that paramount that the student learns how to draw their title block.

Unit Objective

To enable the student draw a title block

2.4 Title block

Engineering drawings need to be presented in a specific format. A complete drawing will always have certain details to accompany it that describe the actual contents of the drawing. In our course, we will need to present our work on A3 drawing paper and the drawing paper will have to be prepared according to the sample shown in the figure below. Part A is for the Name, Part B is for the Student Number, Part C is for the Programme, Part D is for the drawing Title/number, Part E is the date and Part F is for the School. Note that all dimensions used or given will be in mm. The spacing in between the border lines is 2mm.



A – Insert your Name in Full

B – Insert your Student ID number

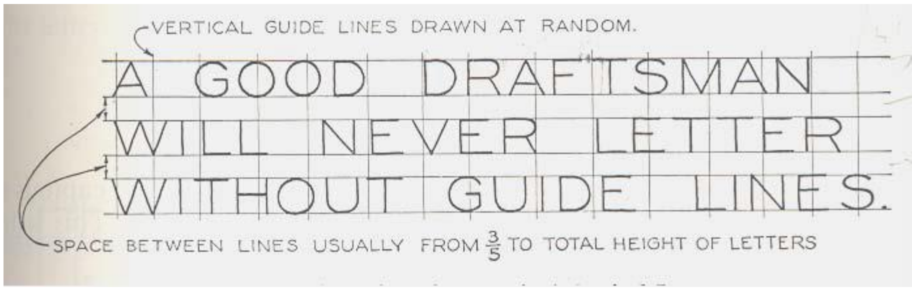
C – Insert your Programme (e.g. BEng CHEMICAL ENG or BSc WOOD SCE)

D – Insert the Drawing Number/Title

E – Insert the Date

F – The School (e.g. DDEOL, SMMS, SE, SB)

Guidelines are important when lettering. They guide the lettering and numbering process making the work look presentable and neat.



Exercise 1:

(i) Write the title block filling in your details as explained in Unit 2

(ii) Draw the 5 Different types of lines as illustrated in Unit 2

(iii) Draw a circle of radius 20mm. Note that the centre line must be shown and the circle must be in Bold.

NB: For further reading and activity, you can refer to pages 108-110 of reference text 3.

CHAPTER THREE

PLANE GEOMETRY

CHAPTER OVERVIEW

This Chapter has **13 units** and covers **Plane Geometry**. The chapter equips the students with knowledge on how to draw and construct several **geometrical shapes** using several methods.

OBJECTIVES

After completing this chapter, you will be able to:

1. Draw straight lines and circles
2. Construct Angles and Triangles
3. Construct quadrilaterals, polygons
4. Carry out area transformations
5. Produce surface developments
6. Construct geometrical shapes like the Ellipse, Parabola, Helix, Cycloid, Archimedean spiral,
7. Plot the loci of mechanisms

Unit 3.1: Lines

Unit Overview

Unit 3.1 covers various constructions involving lines. The unit covers, drawing lines, bisecting lines, dividing lines, construction of perpendiculars and bisection of an angle.

Unit Objective

- To enable the student draw lines
- To enable the student to bisect a line
- To enable the student to divide a line into a required number of parts
- To enable the student to construct a perpendicular
- To enable the student to bisect an angle

3.1 Lines

A straight line is generated by a point moving in a constant direction. In this section, we will carry out 3 operations.

3.1.1 Bisecting a Line

Steps;

- Draw the given line AB 60mm long
- Using a compass and reasonable radius, draw the given arcs to locate points C and D
- Having located the points, draw a line through C and D to give point 'o'.
- Measuring the distance AO and BO, it is seen that the line has been divided into half, hence 'Bisected'

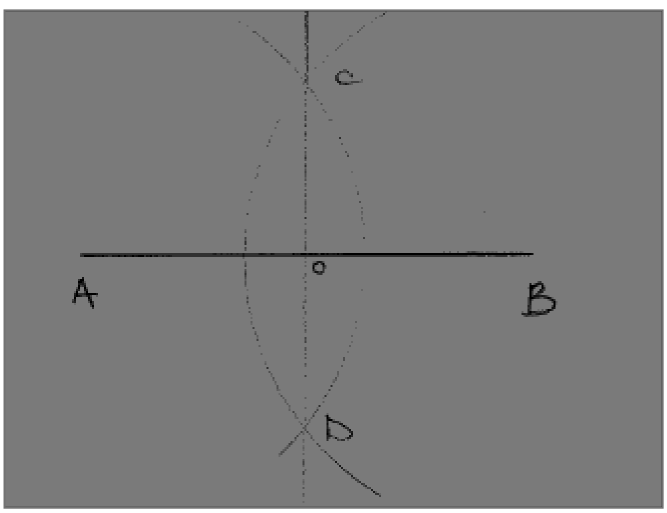


Figure 3.1. Bisecting a line

3.1.2 Dividing a line into a number of equal parts

Steps;

- Draw the given line AB 80 mm long
- Using a ruler and reasonable angle, draw line AC
- Using a divider, divide line AC into the required number of equal parts (5 in this case)

- Join the last division on line AC to point B
- Using set squares and a ruler, draw lines from the other points parallel to B5
- Measuring the resulting divisions on AB, it is seen that the line has been divided into 5 equal parts

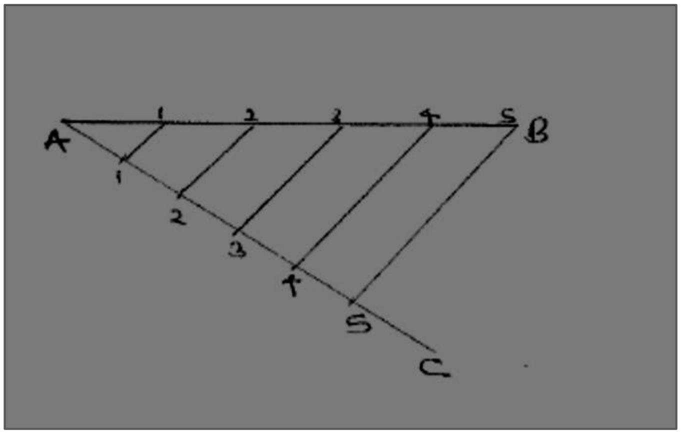


Figure 3.2. Dividing a line into a number of parts

3.1.3 Constructing a perpendicular

Steps;

- Draw the given line AB= 70mm
- Using a compass and reasonable radius, draw the given arcs o locate points 1 and 2
- Having located the points, draw a line through 1 and 2 to give point 'o'
- Measuring the distance Angle AO1 or BO1, the 90^{O} angle shows a 'perpendicular' has been constructed

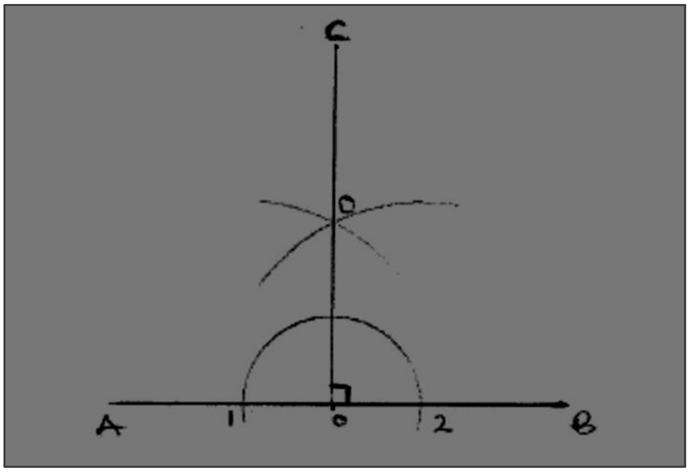


Figure 3.3. Constructing a perpendicular

3.1.4 Bisecting an Angle

Steps;

- To bisect an angle means to divide it in half or to cut it in to two equal angles.
- ***Given:*** Angle BAC 72^0 using a protractor
- The compass at any convenient radius and swing an arc from point A
- 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.
- : Where these arcs intersect, locate point D
- Draw a straight line from A to D
- This line will bisect angle B<u>A</u>C and establish two equal angles: C<u>A</u>D and B<u>A</u>D.

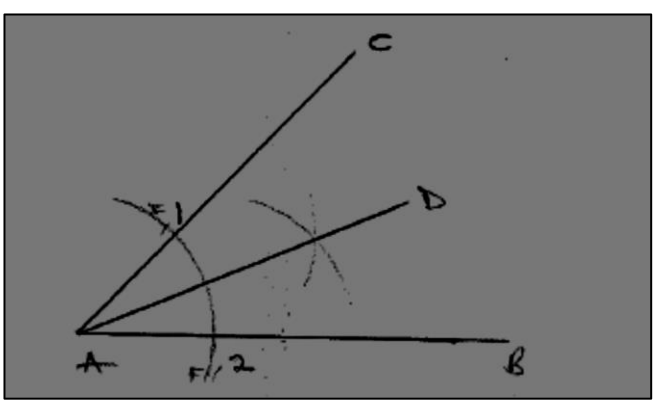


Figure 3.4. Bisecting an Angle

Unit 3.2: Angles

Unit Overview

Unit 3.2 covers the construction of angles. The unit covers construction of selected angles and how their derivatives can be constructed. For example, a 60^0 angle is constructed and this leads to a 30^0 angle once bisected. It is thus shown that several other angles can indeed be constructed.

Unit Objective

This unit will enable the student to;

Construct a 30^o, 60^0, 90^0 and 45^0 and other derivative angles.

3.2 Angles

An angle is formed by the intersection of two lines. There are three major kinds of angles: right angels, acute angles and obtuse angles.

3.2.1 Constructing a 30^O angle

Steps;

- Draw a line AB in outline
- Using A as the centre, open your compass to a reasonable radius and draw an arc as shown in the figure below to locate point 1
- Using the radius and point 1 as the centre, draw an arc to locate point 2
- This leads to a 60^o angle
- Bisecting the angle above gives 30^O

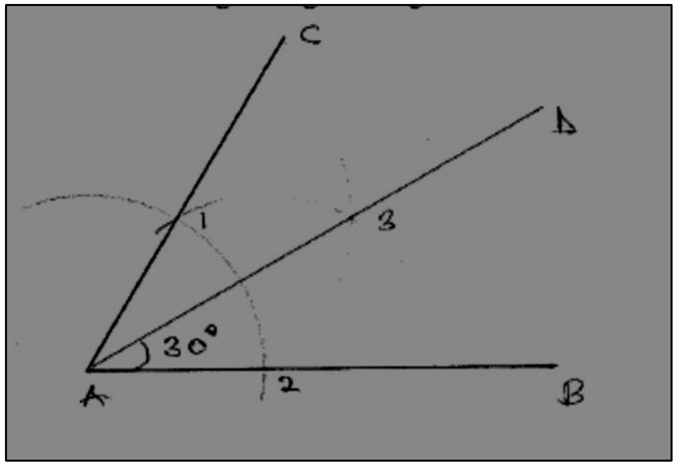


Figure 3.5. Constructing a 30^{O} angle

3.2.2 Constructing a 60^{O} angle

Steps;

- Draw a line AB in outline
- Using A as the centre, open your compass to a reasonable radius and draw an arc as shown in the figure below to locate point 1
- Using the radius and point 1 as the centre, draw an arc to locate point 2
- This leads to a 60^{o} angle

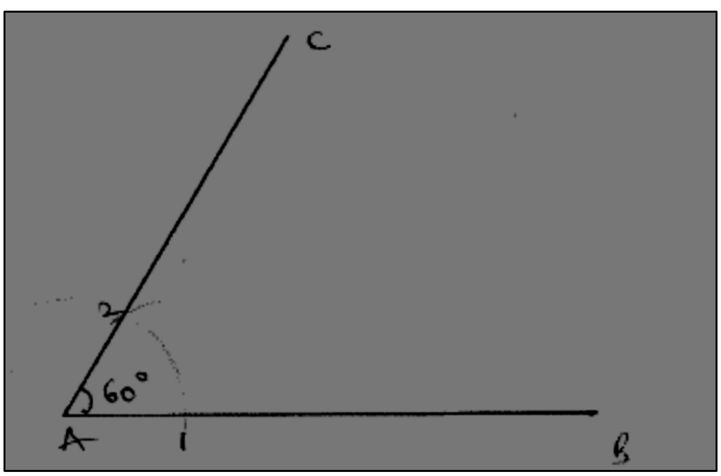


Figure 3.6. Constructing a 60^{O} angle

3.2.3 Constructing a 90^O angle

Steps;

- Draw a line AB in outline
- Using A as the centre, open your compass to a reasonable radius and draw an arc as shown in the figure below to locate points 1 and 2
- Using a compass and at points 1 and 2, draw 2 arcs which will intersect at point 3.
- From point A, draw a line to pass through point 3
- This leads to a 90^O angle

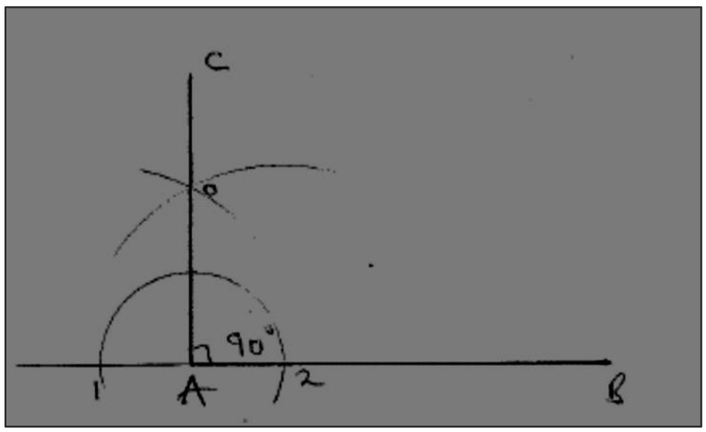


Figure 3.7. Constructing a 90^O angle

3.2.4 Constructing a 45^O angle

Steps;

- Draw a line AB in outline
- Using A as the centre, open your compass to a reasonable radius and draw an arc as shown in the figure below to locate points 1 and 2
- Using a compass and at points 1 and 2, draw 2 arcs which will intersect at point 3.
- From point A, draw a line to pass through point 3
- This leads to a 90^O angle
- Bisecting the angle above gives 45^O

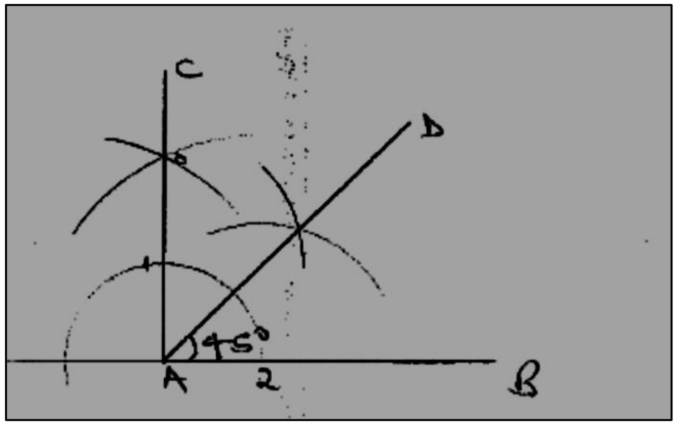


Figure 3.8. Constructing a 45^{O} angle

3.2.5 Other Angles (22.5^{O})

Steps;

- Draw a line AB in outline
- Using A as the centre, open your compass to a reasonable radius and draw an arc as shown in the figure below to locate points 1 and 2
- Using a compass and at points 1 and 2, draw 2 arcs which will intersect at point 3.
- From point A, draw a line to pass through point 3
- This leads to a 90^{O} angle
- Bisecting the angle above gives 45^{O}
- Bisect the 45^{O} angle to give a $22,5^{O}$ angle

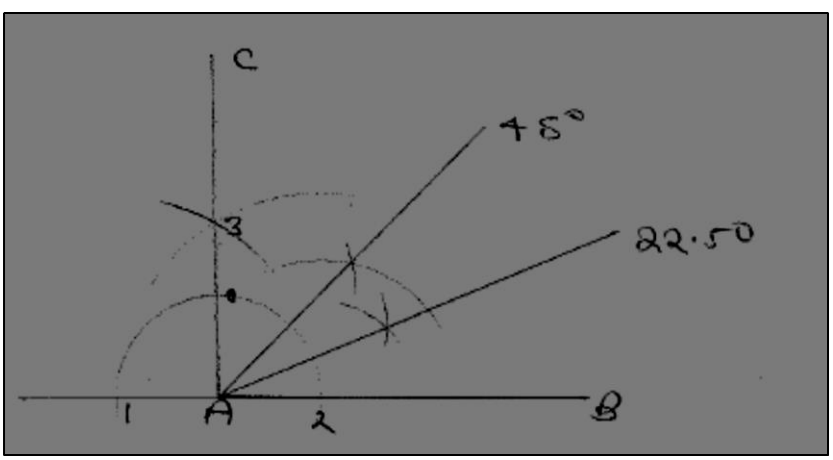


Figure 3.9. Constructing a 22.5^{O} angle

3.2.6 Other Angles (15^{O})

Steps;

- Draw a line AB in outline
- Using A as the centre, open your compass to a reasonable radius and draw an arc as shown in the figure below to locate point 1
- Using the radius and point 1 as the centre, draw an arc to locate point 2
- This leads to a 60^{o} angle
- Bisecting the angle above gives 30^{O}
- Bisecting 30^{O} gives 15^{O}

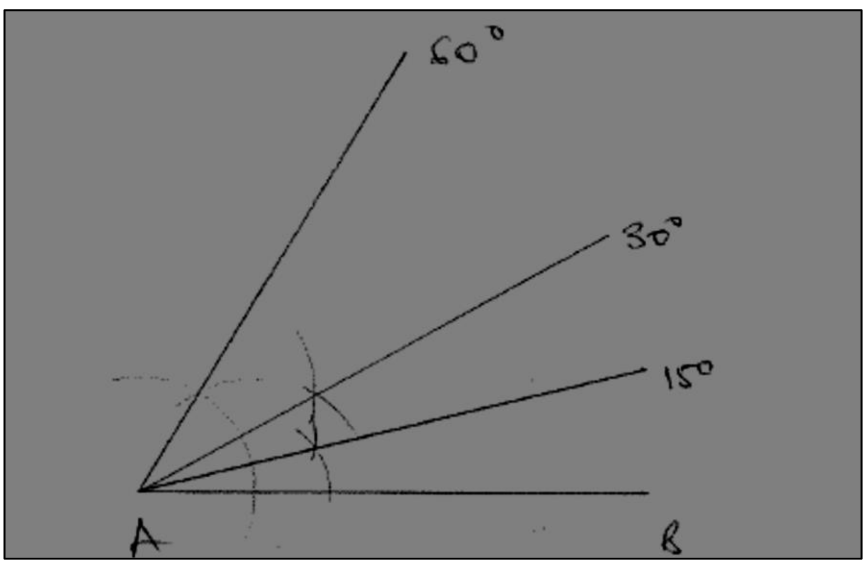


Figure 3.10. Constructing a 15^{O} angle

Exercise 2:

(i) Construct a $\mathbf{120^{O}}$ angle using constructional methods

(ii) Construct a $\mathbf{72.5^{O}}$ angle using constructional methods

(iii) Construct a $\mathbf{135^{O}}$ angle using constructional methods

(iv) Construct a $\mathbf{270^{O}}$ angle using constructional methods

(v) Construct a perpendicular on a line AB=80mm

(vi) Divide a line 120mm into 8 equal parts using constructional methods

NB: For further reading and activity, you can refer to pages 111-115 of reference text 3.

Unit 3.3 : Triangles

Unit Overview

Unit 3.3 covers construction of Triangles using various methods. A triangle is a closed plane figure with three straight sides and their interior angles sum up exactly $\mathbf{180^{O}}$. The various kinds of triangles: a right triangle, an equilateral triangle, an isosceles triangle, and an obtuse angled triangle. In this section, we will construct Triangles given 4 different conditions.

Unit Objective

This unit will enable the student to;

- Construct a triangle given 3 sides
- Construct a triangle given 2 sides and an angle
- Construct a triangle given 1 side and an angle
- Construct a triangle given 3 sides

3.3 TRIANGLES

3.3.1. Constructing a triangle given 3 sides

Steps;

- Draw the given line **AB** = 80mm
- Using a *compas*s and radius equal to side **AC =** 78mm, and using point **A**, draw an arc
- Using a *compass* and radius equal to side **BC=**81mm, and using point B, draw an arc that intersect the earlier arc at *point 1*
- *Point 1* now labeled as point C is the final point to be joined in outline to points A and B to complete the required triangle **ABC**. The figure below illustrates this;

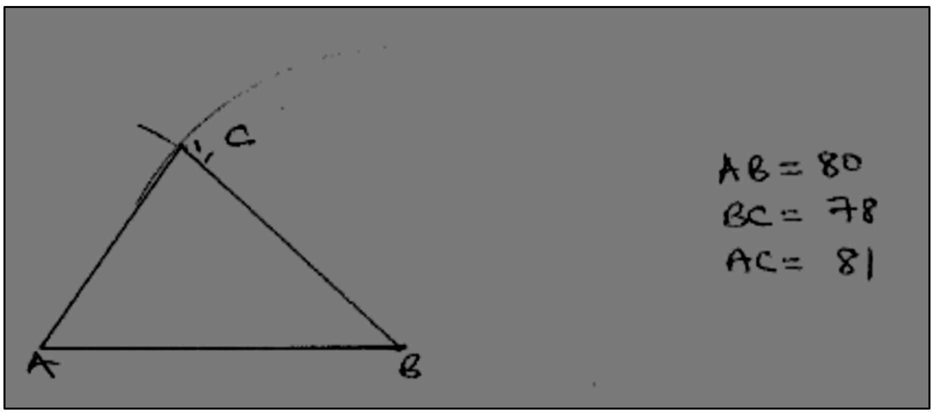


Figure 3.11. Constructing a triangle given 3 sides

3.3.2. Constructing a triangle given 2 sides and an angle

Steps;

- Draw the given line **AB**=91mm
- Using a compass and radius equal to side **AC=**80mm, and using *point **A**,* draw an arc
- Using a *compass* or *protractor* depending on the given angle (60^0), using *point **B***, construct or measure the given angle
- Draw a line through the constructed or given angle and that line will intersect the earlier arc '**AC**' at a *point* '**C**'
- Using Outline, join point **C–A** and **C-B** to give the required triangle **ABC**
- *Point 1* now labeled as point C is the final point to be joined in outline to points A and B to complete the required triangle **ABC**

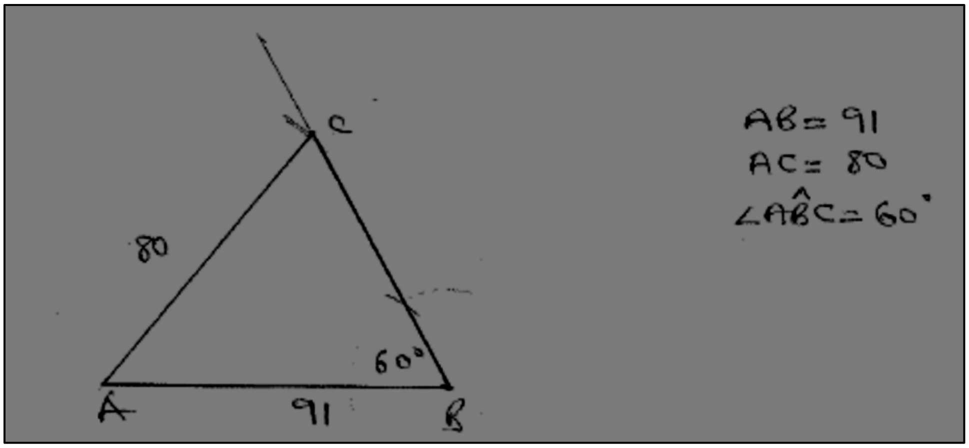


Figure 3.12. Constructing a triangle given 2 sides and an angle

3.3.3. Constructing a triangle given 1 side and 2 angles

Steps;

- Draw the given line **AB=**101mm
- Using a *compass* and/or *protractor*, construct/draw the required angles using *points A* (49^0)and *B* (72^0)
- Having located the point 'C', join using outline, point C-A and C-B to give the required triangle ABC

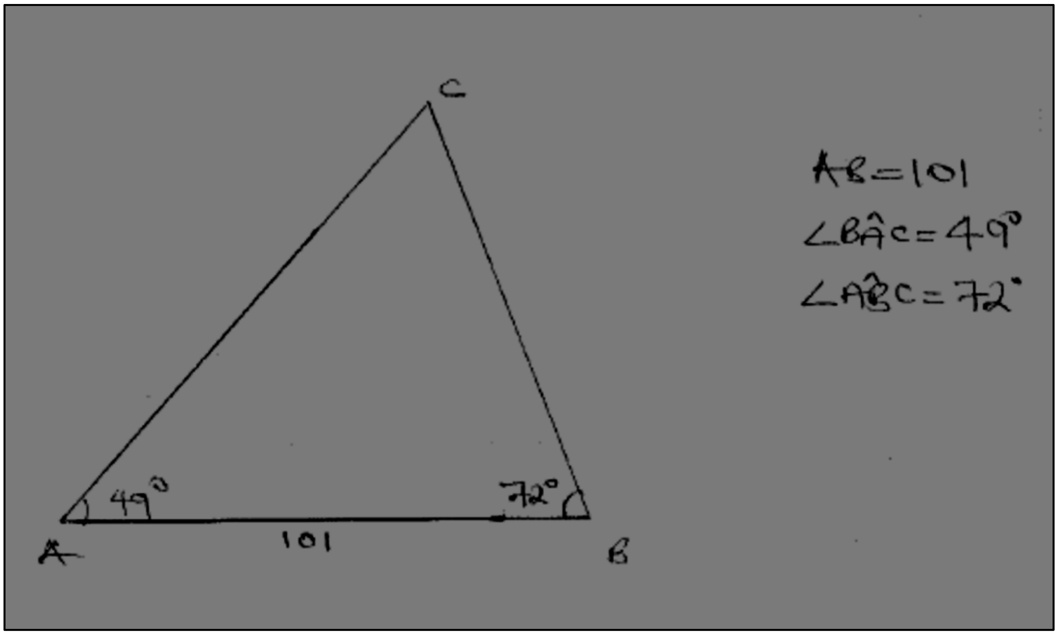


Figure 3.13. Constructing a triangle given 1 side and 2 angles

3.3.4. Constructing a triangle given the height, 1 side and 1 angle

Steps;

- Draw the given line AB =85mm
- Using a *compass* radius for the given height= 60mm, strike arcs to enable the drawing of line '1-2'
- Depending on the location of the required angle (60^0), using either points 'A' or 'B'
- Construct or draw the required angle and this should lead to the location of point 'C'
- Using outline, join points 'C-A' and 'C-B to give the required triangle 'ABC'

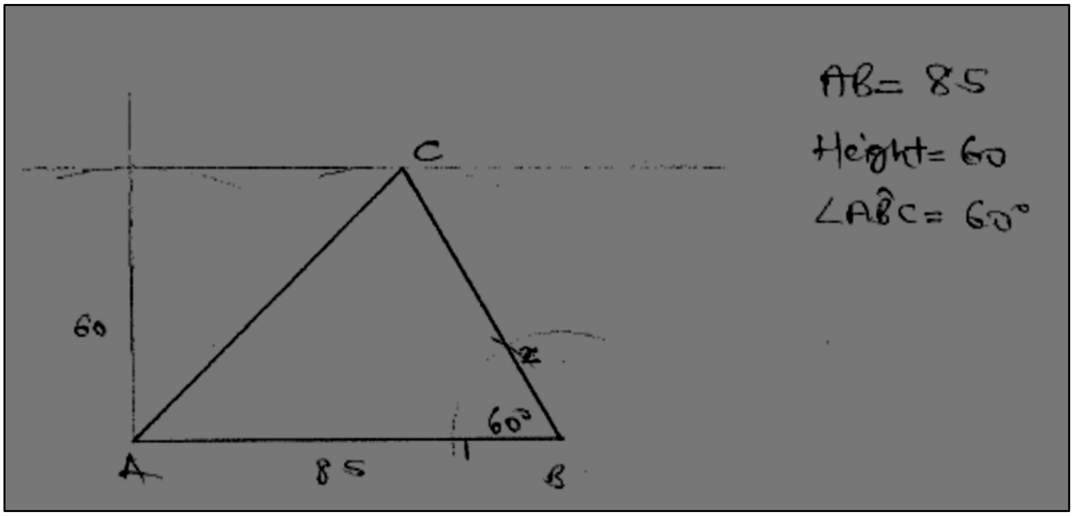


Figure 3.15. Constructing a triangle given the height, 1 side and 1 angle

3.3.5 Inscribing a Circle in a given Triangle

It is required that a circle be drawn inside a given triangle to touch all 3 sides

Steps;

- Draw the given triangle ABC
- Bisect any two angles
- The Bisectors meet at point 'o'
- Drop a vertical line rom point 'o' to touch AB at point 4

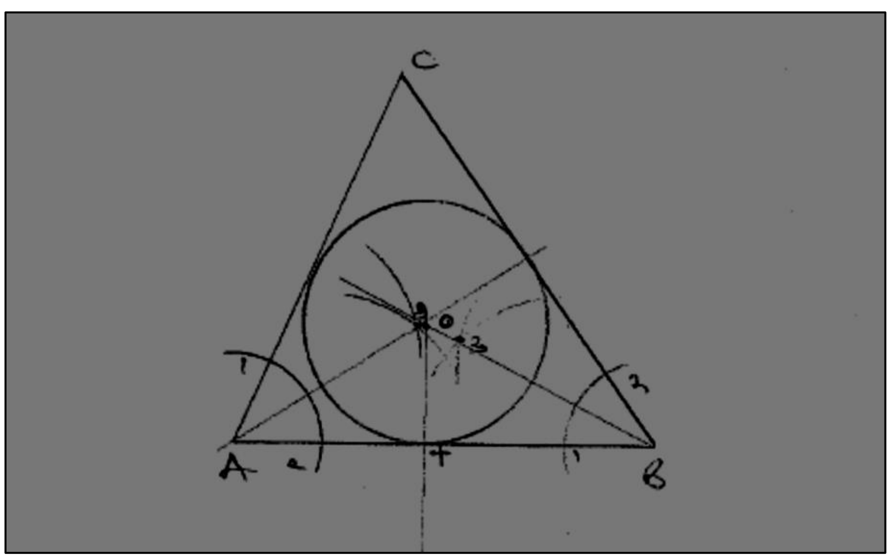


Figure 3.16. Inscribing a circle in a Triangle

3.3.6 Escribing a circle on a given Triangle

Steps;

- Draw the given triangle ABC (AB=91mm,BC=83mm, AC=81mm)
- Bisect any two sides
- The Bisectors meet at point 'o'
- Using a compass and 'oA' as radius, draw a circle to touch corners A, B and C

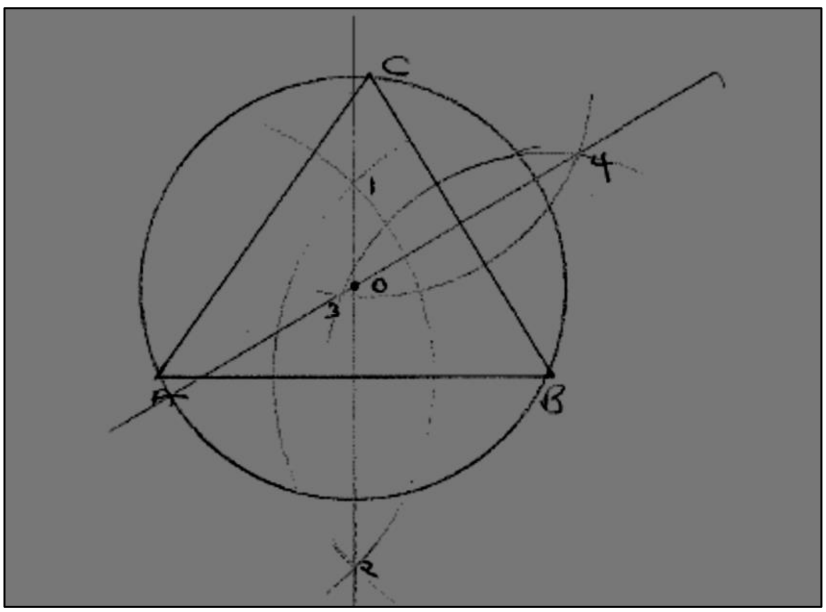


Figure 3.17. Escribing a circle on a given Triangle

Exercise 3:

(i) Construct a Triangle ABC given that AB=90mm, BC= 78mm, AC= 81mm
(ii) Construct a Triangle ABC given that AB=92mm, B<u>A</u>C= 60^{O}, AC=79mm
(iii) Construct a Triangle ABC given that AB=87mm, B<u>A</u>C= 72^{O}, Height = 83mm
(iv) Inscribe a circle in the 3 Triangles constructed above

NB: For further reading and activity, you can refer to pages 112-118 of reference text 3.

Unit 3.4: Quadrilaterals

Unit Overview

This unit covers the construction of **Quadrilaterals**. A Quadrilateral is a plane figure bounded by four straight sides. When opposite sides are parallel, the quadrilateral is also considered to be a parallelogram. We will construct a square and rectangle in our case;

Unit Objective

At the end of this unit the student will be able to construct;

- A Square
- A Rectangle

3.4 QUADRILATERALS

3.4.1. Constructing a Square

Steps;

- Draw the given line AB equal to the length of each side of the square
- At points A and B construct perpendiculars
- Using a compass, at points A and B draw arcs above the given points equal to the length of the square sides
- The arcs will strike the perpendiculars at points C and D
- Join Points A,B,C and D in outline to give the required square

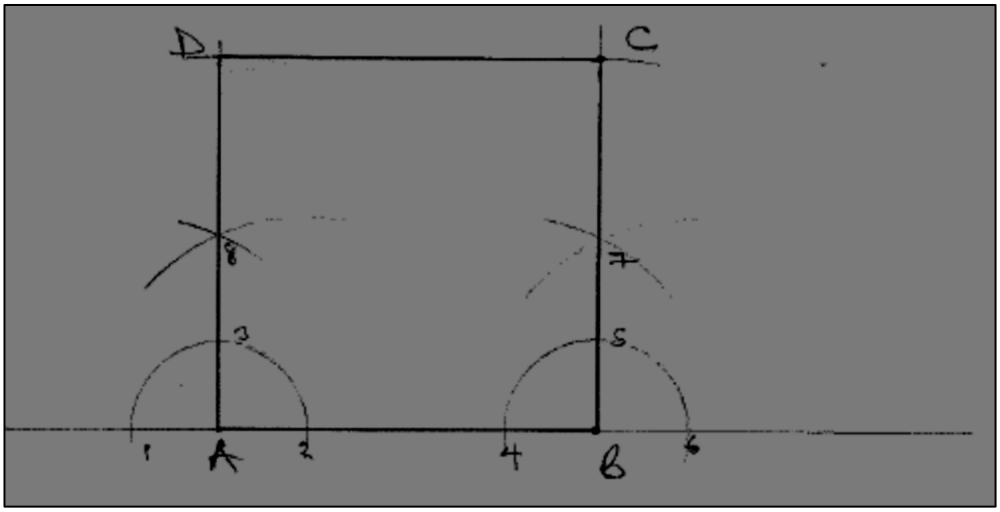


Figure 3.18. Constructing a Square

3.4.2. Constructing a Rectangle

Steps;

- Draw the given line AB equal to the length of the longest side of the required rectangle
- At points A and B construct perpendiculars
- Using a compass, at points A and B draw arcs above the given points equal to the height of the rectangle
- The arcs will strike the perpendiculars at points C and D
- Join Points A,B,C and D in outline to give the required Rectangle

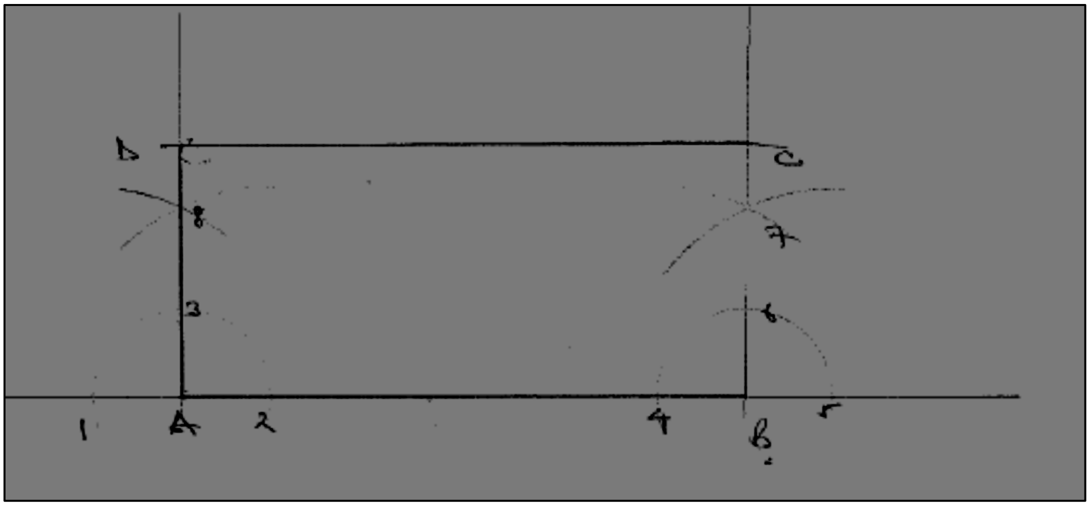


Figure 3.19. Constructing a Rectangle

Unit 3.5: Polygons

Unit Overview

This Unit covers the construction of **Polygons**. A polygon is a closed plane figure with 5 or more straight sides. The most important of these polygons is the pentagon. Once the pentagon is constructed, it is easier to derive other polygons with more sides. However there are other methods for constructing other polygons like the 6 sided (Hexagon), 8-sided (Octagon) amongst other polygons.

Unit Objective

At the end of this unit the student will be able to construct;

- A regular pentagon
- A regular hexagon
- A regular hexagon across corners
- A regular hexagon across flats
- A regular Octagon across corners
- A regular Octagon across flats

3.5 POLYGONS

3.5.1. Constructing a Regular Pentagon

Steps;

- Draw the given line AB = 50mm equal to the length of the side of the required regular pentagon
- Bisect the line AB to locate point 'o'
- Using centre 'o' and radius Ao, draw an arc to locate point 4 on the bisector
- Using either point A o B, open your compass to AB and draw an arc to locate point 6
- Bisect the distance 4-6 to get point
- Using point 5 as the centre, and your compass opened to '5A or 5B and point 5 as the centre, draw a complete circle
- Using a compass with a radii equal to AB and starting at point A, draw an arc to touch the earlier circle at points E, D and C
- Having located points C, D and E, join them in outline to give the required Pentagon

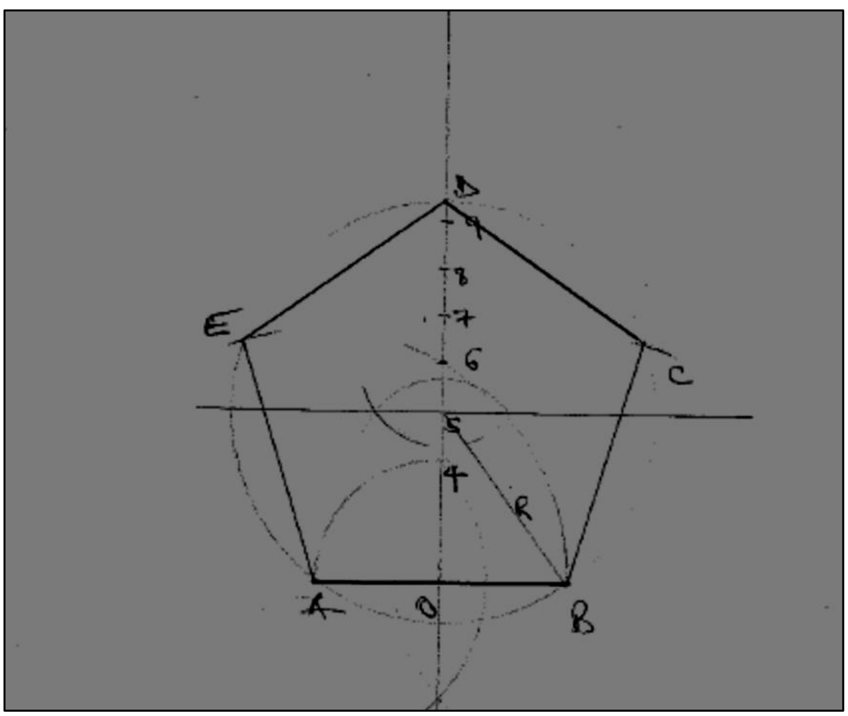


Figure 3.20. Constructing a regular Pentagon

3.5.2. Constructing a regular Hexagon

A hexagon is a six sided polygon. It can be constructed using several methods. This module will consider 2 other methods

3.5.2.1 Hexagon given distance across corners

Steps:

- Using a compass and radius equal to half the distance across corners given (90mm), draw a circle in construction
- Using a ruler and pair of set squares, divide the circle into 4 quadrants as shown in the figure below
- This gives points 1,2,3 and 4
- Using the radius of the circle, and the compass placed at points, 1, 2, 3 and 4 strike on the circle to give points A,B,C,D,E and F
- Joining these points gives the required Hexagon

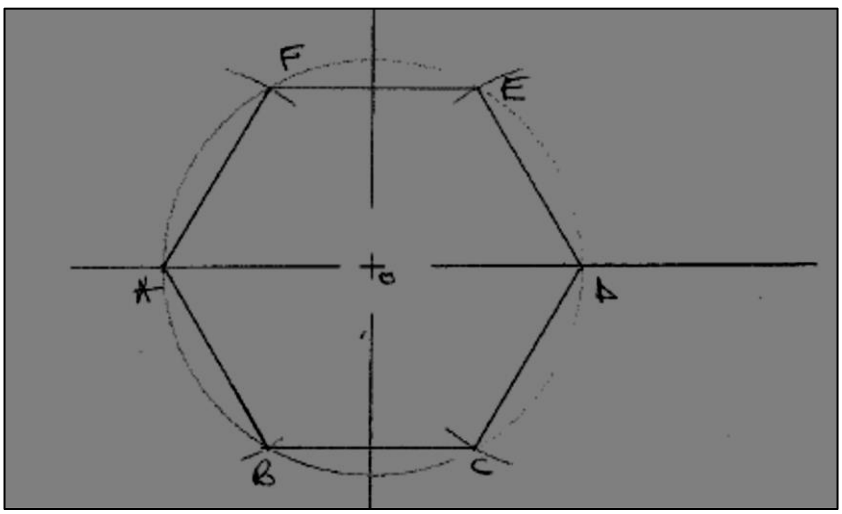


Figure 3.21. Constructing a regular Hexagon

3.5.2.2 Hexagon given distance across flats

Steps:

- Using a compass and radius equal to half the distance across corners given, draw a circle in construction
- Using a 30^{O}/ 60^{O}set square draw diagonals as shown in the figure below
- This gives points 1,2,3 and 4
- Complete the Hexagon by drawing tangents to the centre lines and diagonals as shown in the figure below

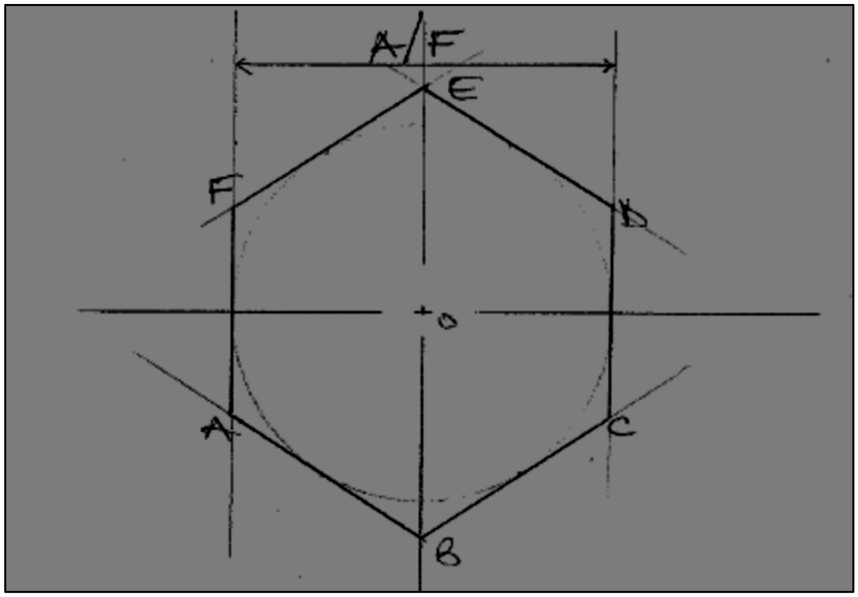


Figure 3.22. Constructing a regular Hexagon

3.5.3. Constructing a regular Octagon

- An Octagon is an eight sided polygon. It can be constructed using several methods. This unit will consider 2 other methods;

3.5.3.1 Octagon given distance across corners

Steps:

- Using a compass and radius equal to half the distance across corners (88mm) given, draw a circle in construction
- Using a ruler and 45^{O}set square, divide the circle into 8 parts by drawing diagonals as shown in the figure below
- This gives points A,B,C,D,E,F,G and H
- Join the points to give the required regular Octagon

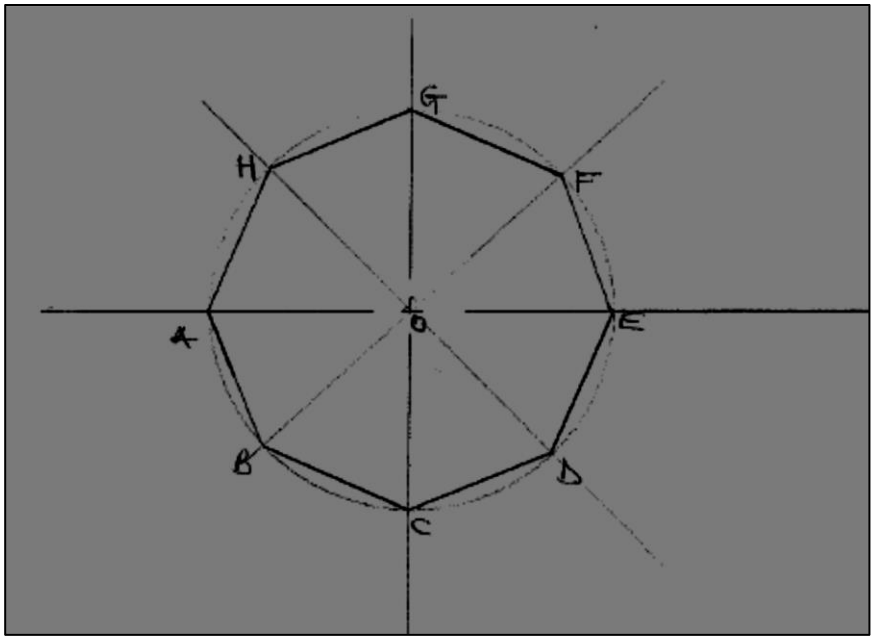


Figure 3.23. Constructing a regular Octagon

3.5.3.2 Octagon given distance across flats

Steps:

- Using a compass and radius equal to half the distance across flats (80mm) given, draw a circle in construction
- Using a 45^{O}set square draw centre lines and diagonals as shown in the figure below
- This gives points 1,2,3,4,5,6,7 and 8
- Complete the Octagon by drawing tangents to the centre lines diagonals as shown in the figure below

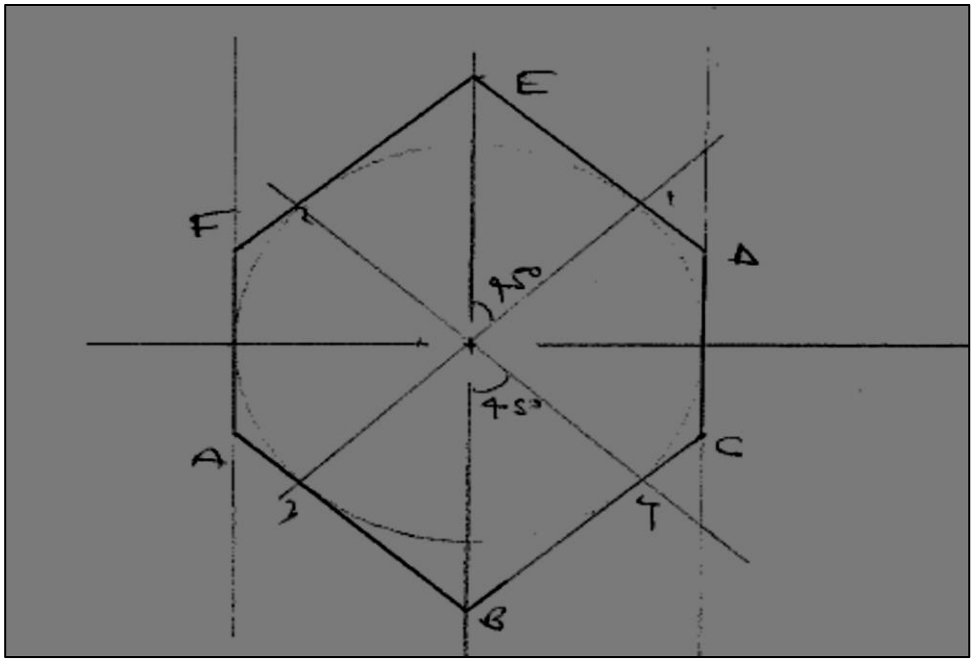


Figure 3.24. Constructing a regular Octagon

3.5.4. Constructing other Polygons

Steps;

- Draw the given line AB equal to the length of the side of the required regular polygon
- Bisect the line AB to locate point 'o'
- Using centre 'o' and radius Ao, draw an arc to locate point 4 on the bisector
- Using either point A o B, open your compass to AB and draw an arc to locate point 6
- Bisect the distance 4-6 to get points , 7,8…..(depending on the required number of sides)
- Using point 6,7,8….. as the centre, and your compass opened to 6,7,8…A or 6,7,8…B and point 6,7,8… as the centre, draw a complete circle
- Using a compass with a radii equal to AB and starting at point A, draw an arc to touch the earlier circle at points C,D,E,F….
- Having located points C, D, E, F…, join them in outline to give the required Polygon

Exercise 4

(i) Construct a Square with each side 67mm
(ii) Construct a Rectangle given that AB=92mm, BC= 60mm
(iii) Construct a 7 sided polygon given each side = 60mm
(iv) Construct a 11 sided polygon sided given each side = 50mm

NB: For further reading and activity, you can refer to pages 121-125 of reference text 3.

Unit 3.6: Area Transformations

Unit Overview

This unit covers **Area Transformations.** We will construct various geometrical shapes and transform them into shapes that are different but having the same area. This equips the student with design and modification skills but with the ability to maintain certain key properties.

Unit Objective

At the end of this unit, the student will be able to;

- Transform a Rectangle into a Square of equal area
- Transform a Square into a Rectangle of equal area
- Transform a Triangle into a Rectangle of equal area
- Transform a Pentagon into a triangle of equal area
- Transform a Hexagon into a triangle of equal area

3.6 AREA TRANSFORMATIONS

3.6.1 Transforming a Rectangle into a Square of equal area

Steps;

- Construct the given Rectangle ABCD (AB=80, BC=40,CD=80, AC=40)
- Extend line BC vertically
- Using a campus and BC as radius, using B as centre draw an arc to locate point 1

- Bisect the distance A-1 to locate point 2
- Using the distance B-2 and 2 as centre with your compass opened to 2-1, strike the vertical extension of BC to locate point 4. The same radius can be used to locate the last point by striking horizontally rom point 4 and points 1. The meeting of the 2 arcs gives point 5.
- Join the 4 points B, 4, 1 and 5 to give the expected Rectangle

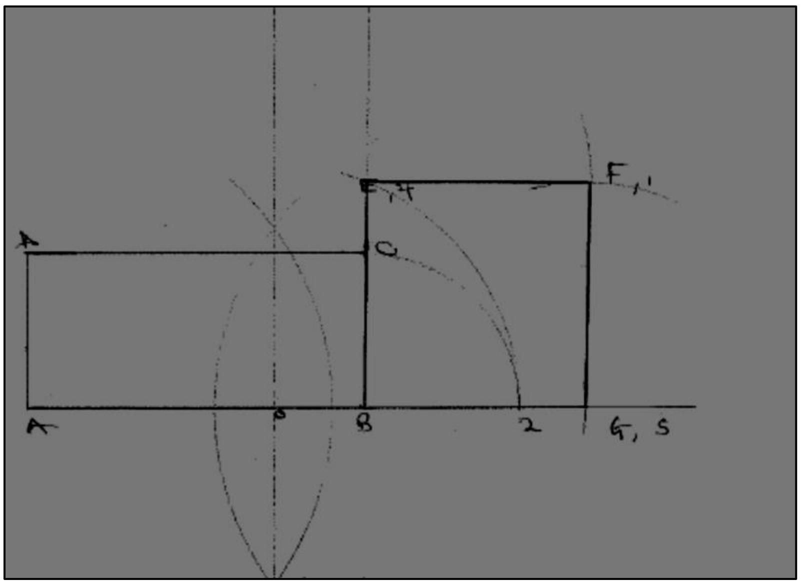


Figure 3.25. Area Transformations

3.6.2 Transforming a Square into a Rectangle of equal area

The reverse process of the earlier process facilitates or the transformation of a square into a rectangle of equal area.

Steps;

- Construct the given Square ABCD
- Extend line BD
- Bisect the distance BD
- Using the distance AB, strike along an extension of AB to give point 1
- From point 1 extend a vertical to give point 2
- Join points A, 1, C and 2 to give the required rectangle

- This is shown is shown in the figure below

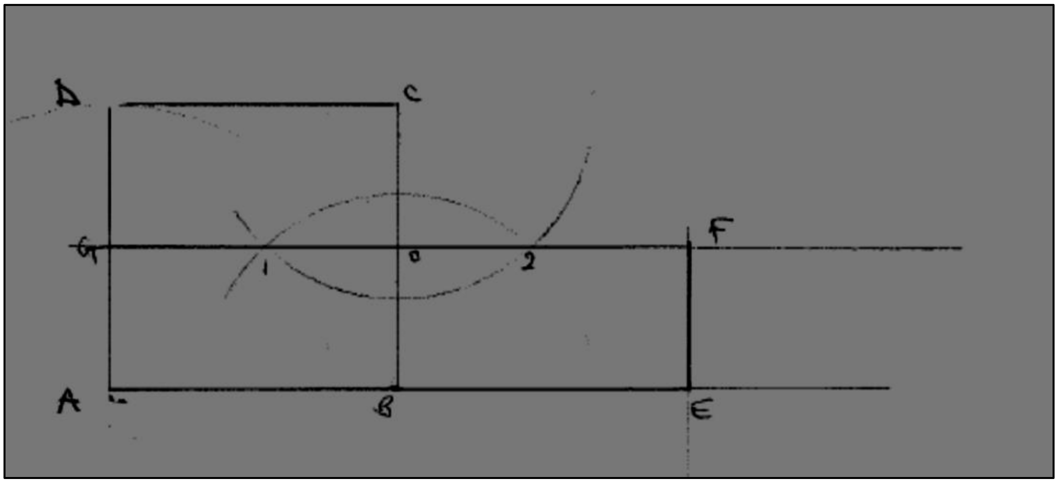


Figure 3.26. Area Transformations

3.6.3 Transforming a Triangle into a Rectangle of equal area

Steps;

- Construct the given Triangle ABC (AB=85mm, AC=83mm, BC=79mm)
- From point C, drop a vertical to line AB to give point 1
- Bisect the distance C-1 to give point 2
- Draw a horizontal from point 2.
- From points A and B, draw verticals to give points 3 and 4
- Join points A,,B, 3 and 4 to give the required Rectangle
- This is shown is shown in the figure below

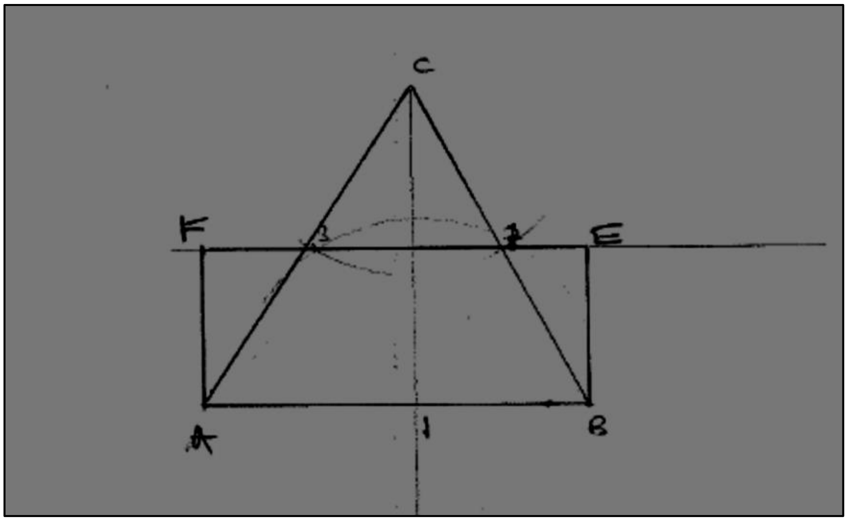


Figure 3.27. Area Transformations

3.6.4 Transforming a Pentagon into a triangle of equal area

Steps;

- Construct the given pentagon ABCDE (All sides = 50mm)
- Join point D to point A and B
- From points C and E, draw lines parallel to lines D-A and D-B to touch an extension of line AB in either direction to give points 1 and 2
- From point D, join D to 1 and D to 3 to give the required triangle D12

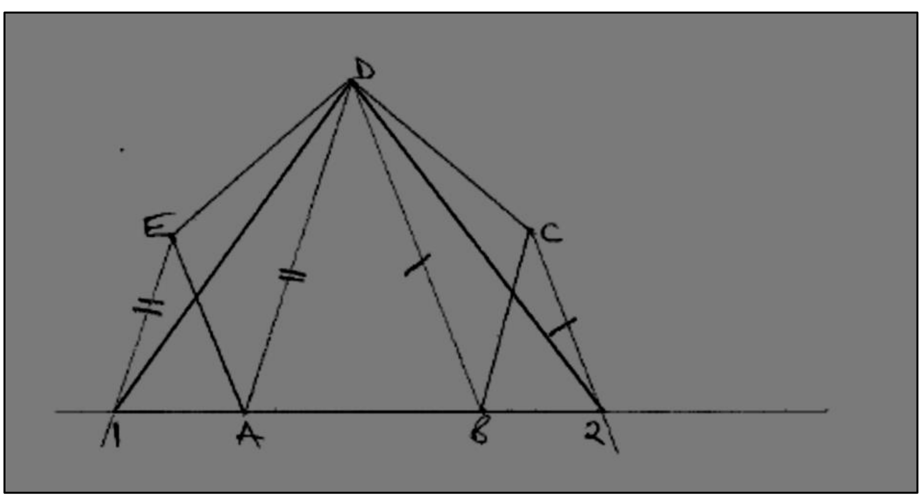


Figure 3.28. Area Transformations

3.6.5 Transforming a Hexagon into a triangle of equal area

Steps;

- Construct the given Hexagon ABCDEF (All sides =50mm)
- Join point D to point A and B
- From points C and E, draw lines parallel to lines D-A and D-B to touch an extension of line AB in either direction to give points 1 and 2
- From point D, join D to 1 and D to 3 to give the required triangle D12

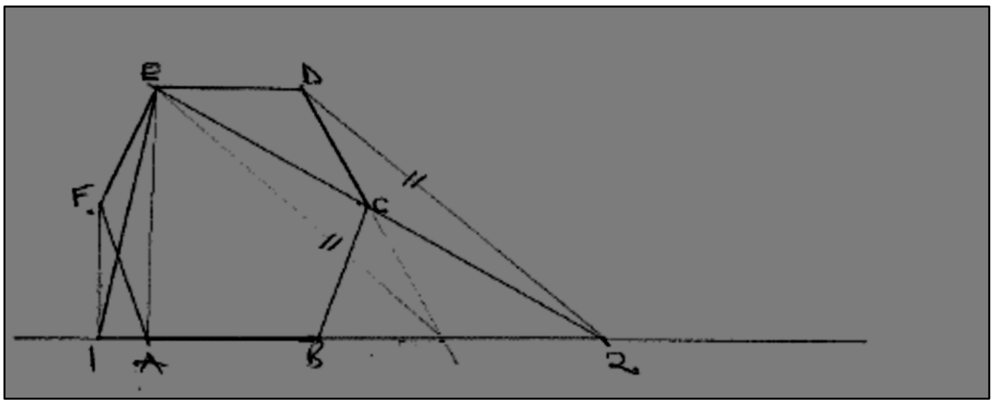


Figure 3.29. Area Transformations

Exercise 5:

(i) Construct a Triangle ABC given that AB=79mm, BC= 73mm, AC= 81mm. Transform the constructed triangle into a rectangle of equal area

(ii) Construct a regular pentagon ABCDE given that AB=52mm, Transform the constructed triangle into a rectangle of equal area

(iii) Construct a Hexagon ABCDE given that AB=47mm, Transform the constructed Hexagon into a triangle of equal area

NB: For further reading and activity, you can refer to pages 134-135 of reference text 3.

Unit 3.7: Surface Developments

Unit Overview

This **unit** covers **Surface developments**. This is a very important part o plane geometry as it creates visual skills in the student on how to view an object in 3 dimensions and being able to show all the surfaces of the object on one plane. A surface development shows the surfaces of a figure on a plane surface. This unit will illustrate the drawing of the surface developments or a Cube, Pyramid and cone.

Unit Objective

At the end of the unit, the student would have learnt the following;

- Draw the surface development of a Cube
- Draw the surface development of a Cone
- Draw the surface development of a Pyramid

3.7 SURFACE DEVELOPMENTS

3.7.1 Surface development of a Cube

Steps;

- Using given dimensions (All sides= 40mm) , draw the front view of the given cube
- Draw the plan of the given cube
- From the front view, extend the lines AB and CD as shown
- Using the dimensions AB, from point '0' strike 4 times to give point 4 points and draw verticals as shown in the diagram. The results in the outer surface of the cube being represented
- Draw two squares, as shown to represent the base and top of the cube

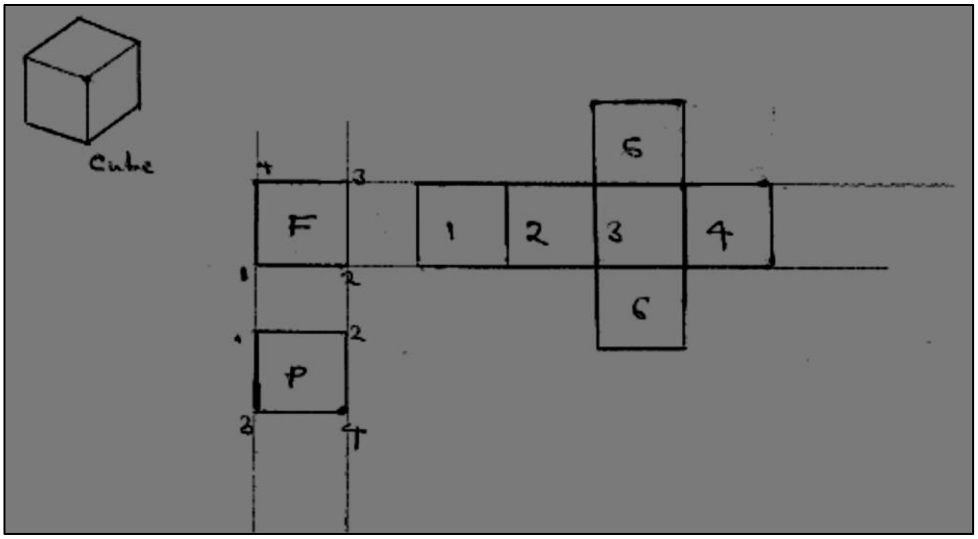


Figure 3.30. Surface development of a cube

3.7.2 Surface development of a Cone

Steps;

- Using given dimensions (Height = 70mm, base radius = 20mm), draw the front view of the given cone
- Draw the plan of the given cone
- From the front view
- Divide the plan into 12 equal parts
- Using point 'O' strike 12 times
- Join points 3 to 1 and 2
- Draw the Circle as shown to represent the base of the cone

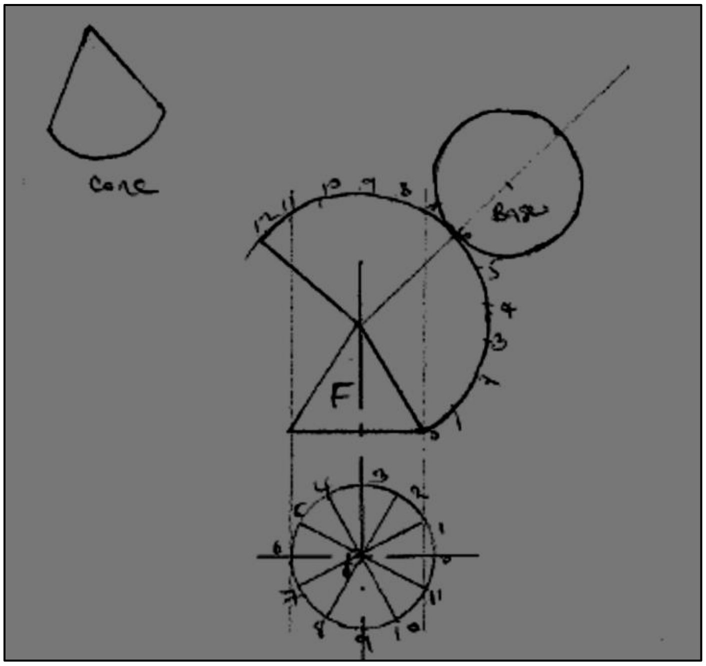


Figure 3.31. Surface development of a cone

3.7.3 Surface development of a Pyramid

Steps;

- Using given dimensions (Height = 72mm, Square base= 30mm per side), draw the front view of the given pyramid
- Draw the plan of the given pyramid
- From the front view, extend the lines AB and CD as shown
- Using the dimensions AB, from point '0' strike 4 times to give point 4 points and draw verticals as shown in the diagram. The results in the outer surface of the cube being represented
- Draw a squares, as shown to represent the base of the pyramid

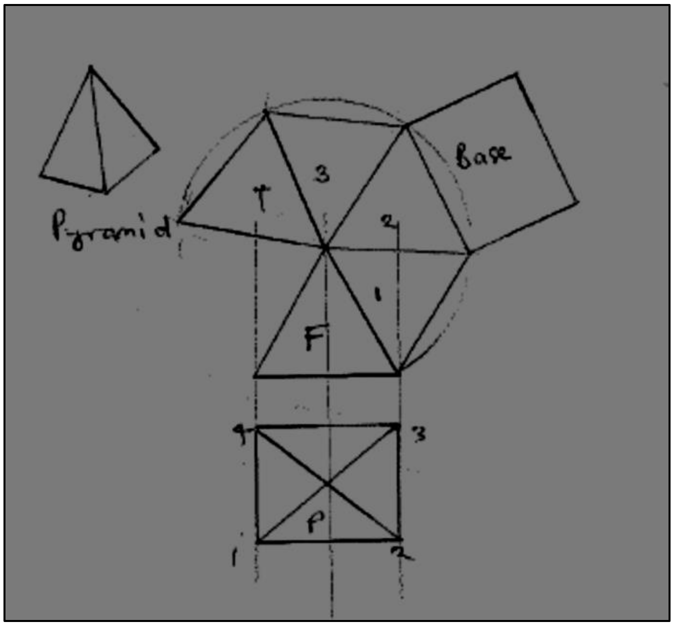


Figure 3.32. Surface development of a pyramid

Exercise 6:

(i) Draw the surface development of a **Cube** with the following dimensions. Each side = 40mm. Draw the Front view, End View and Plan for the said Cube.

(ii) Draw the surface development of a **Cone** with the following dimensions. Height= 70mm, Base radius =20mm Draw the Front view, End View and Plan for the said Cone.

(iii) Draw the surface development of a **Pyramid** with the following dimensions. Height = 90mm. Base = 40 by 40 mm .Draw the Front view, End View and Plan for the said Pyramid.

NB: For further reading and activity, refer to pages 155-159 of reference text 3.

Unit 3.8: Tangents and Circles in contact

Unit Overview

This section covers **Tangents and circles in contact.** This is a very import component of plane geometry in that most of the mechanical designs we see in most machines and Equipments do go through a design process involving this important constructions.

Unit Objective

This unit will enable the student to do the following;

- Draw a Circle Tangent to a Line at a Given Point

- Draw a Tangent from a point 'P' outside the circle
- Draw an Exterior Tangent to two circles of different diameters
- Draw an Interior Tangent to two circles of different diameters
- Draw an Exterior Circular Tangent to two circles of different diameters
- Draw an Exterior Circular Tangent to two circles of different diameters

3.8 TANGENTS AND CIRCLES IN CONTACT

3.8.1. Draw A Circle Tangent to a Line at a Given Point

Steps;

- Draw the given circle or radius 25mm
- Locate point **P** at any convenient point.
- Draw a line from the centre of the circle through point **P**
- Construct a perpendicular at point **P**
- The perpendicular is tangential to the circle at point **P**

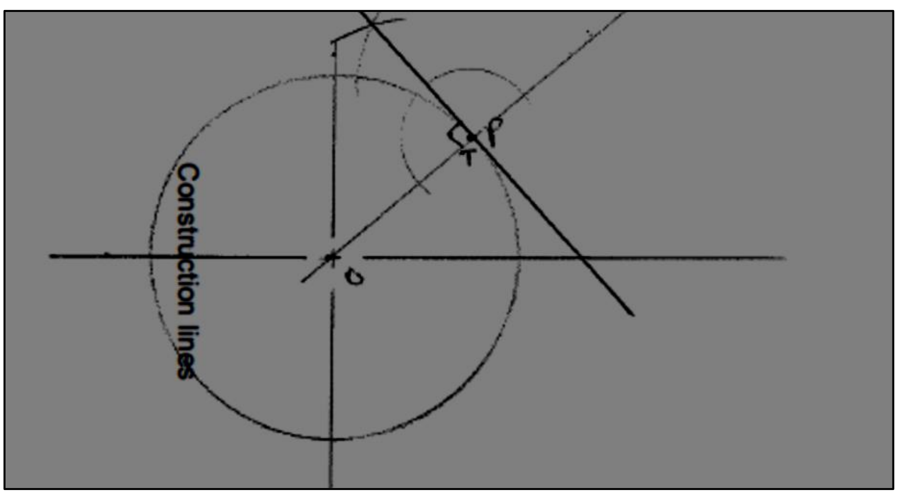


Figure 3.34: Tangents

3.8.2 Tangent from a point 'P' outside the circle

Steps:

- Draw the given circle (R= 30mm) and locate point ;P; (100mm from the circle centre and 20mm below the circle centre)
- Join point 'P' to the centre o the circle

- Bisect the distance O-P
- The bisector touches the circle at point ‘T’
- Draw a line through point ‘T’
- Draw a line from point ‘P’ through point ‘T’
- The two lines drawn form a 90^{O} angle or perpendicular at point ‘T’

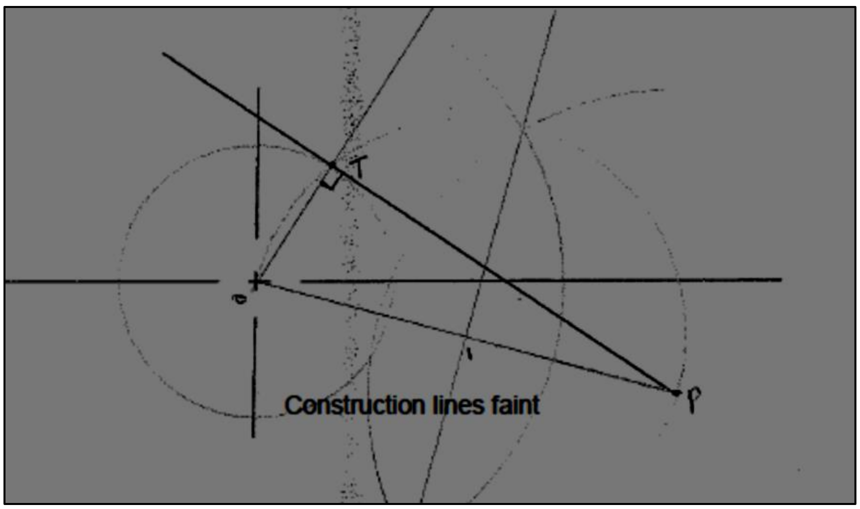


Figure 3.35. Tangent from point ‘p’

3.8.3 Exterior Tangent to two circles of different diameters

Steps:

- Draw the given circles (R1=30mm, R2=20mm)
- Bisect the distance (120mm) between the circles
- Subtract the two radii and draw an arc to touch the semi-circle at point 1 and 2
- Draw lines from centres O1 and O2 to points 1 and 2
- This gives the Tangential points T_1 and T_2

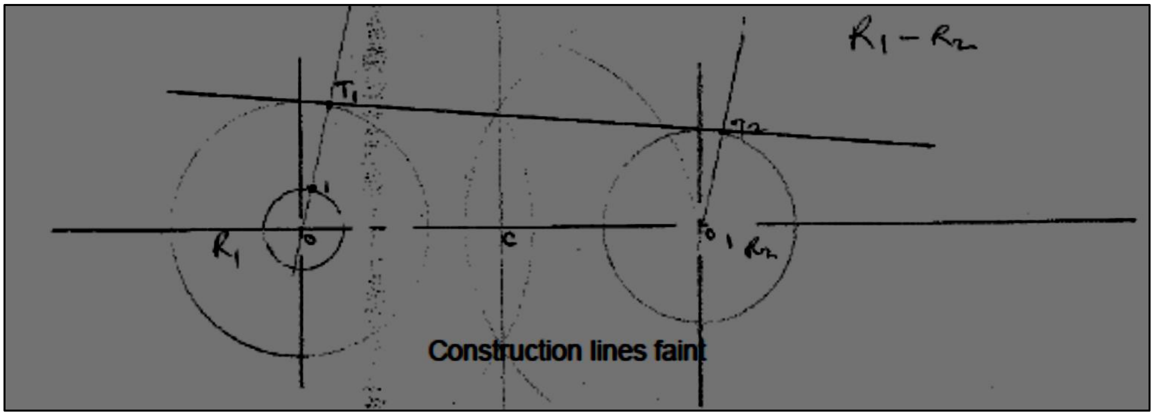


Figure 3.36. Linear Tangents

3.8.4 Interior Tangent to two circles of different diameters

Steps:

- Draw the given circles
- Bisect the distance between the circles
- Add the two radii and draw an arc to touch the semi-circle at point 1 and 2
- Draw lines from centres O1 and O2 to points 1 and 2
- This gives the Tangential points $\mathbf{T_1}$ and $\mathbf{T_2}$

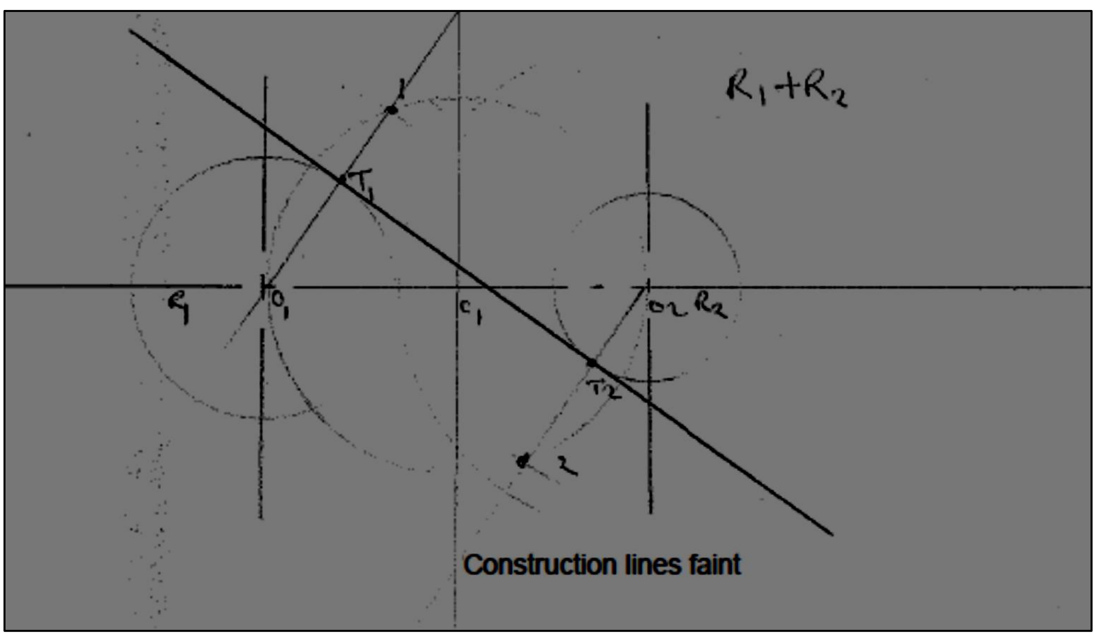


Figure 3.37. Linear Tangents

3.8.5 Exterior Circular Tangent to two circles of different diameters-Scenario 1

Steps:

- Draw the given circles (R1=22mm, R2=18mm)
- Bisect the distance (120mm) between the circles
- The connecting arc radius is 80mm
- Subtract R1 from the arc radius (80mm) and draw an arc as shown below
- Subtract R2 from the arc radius (80mm) and draw an arc as shown below
- The two arcs meet at point 2
- Draw two lines from point 2 through the centres of the 2 circles to give points T1 and T2
- Using the arc radius (100mm) and with your campus set at point 2 (the joint point of the 2 earlier arcs) join point T1 and T2 using a bold arc

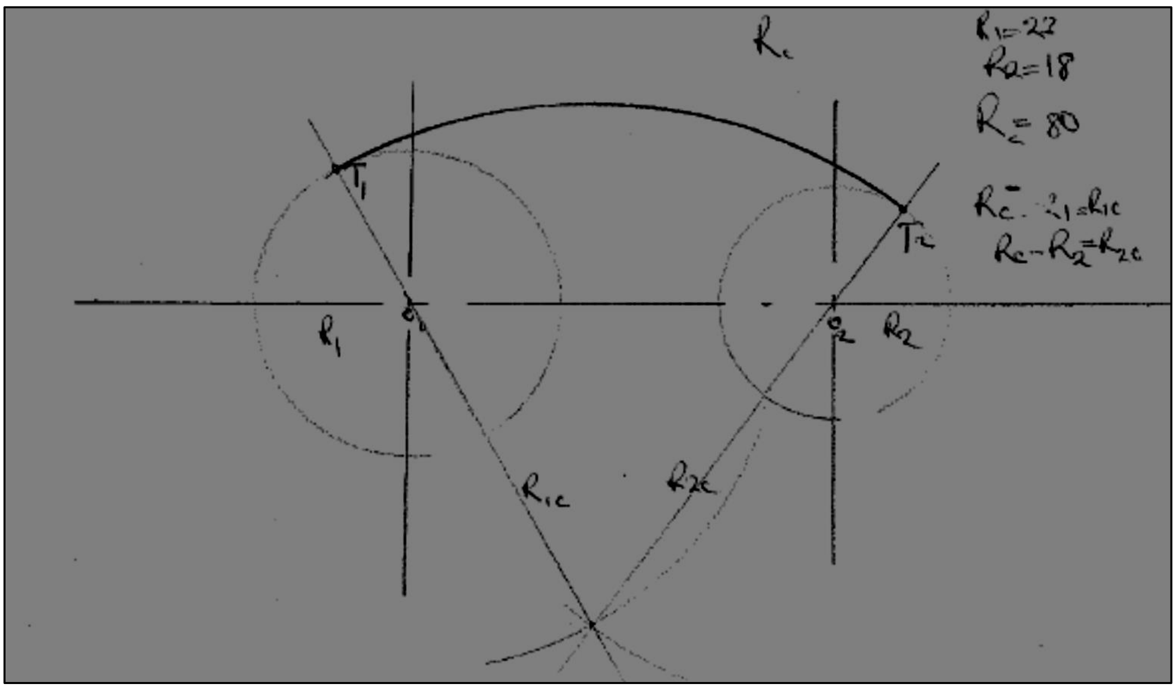


Figure 3.38. Circular Tangents

3.8.6 Exterior Circular tangent to two circles of different diameters-Scenario 2

Steps:

- Draw the given circles (R1=15mm, R2=10mm)
- Bisect the distance (120mm) between the circles
- The connecting arc radius is 60mm
- Subtract R1 from the arc radius (60mm) and draw an arc as shown below
- Subtract R2 from the arc radius (60mm) and draw an arc as shown below
- The two arcs meet at point 2

- Draw two lines from point 2 through the centres of the 2 circles to give points T1 and T2
- Using the arc radius (60mm) and with your campus set at point 2 (the joint point of the 2 earlier arcs) join point T1 and T2 using a bold arc

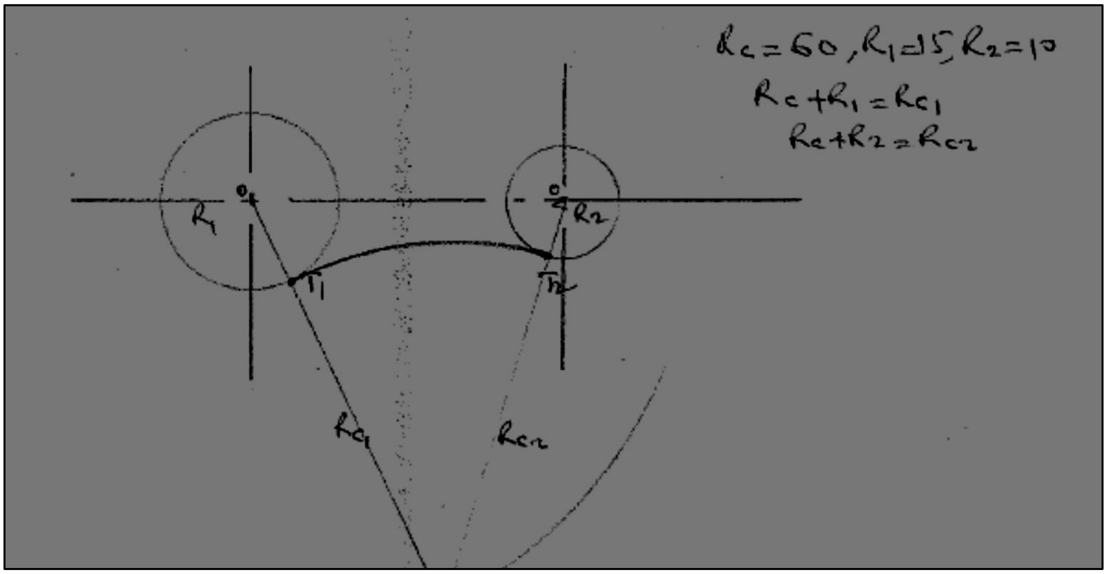


Figure 3.39. Circular Tangents

NB; For further activity and reading, refer to pages 131-133 of reference text 3.

Unit 3.9: Parabola

Unit Overview

In this unit, we cover construction of a parabola. This is a very import component of plane geometry in that most of the mechanical designs we see in most machines and Equipments do go through a design process involving this important constructions.

Unit Objective

This unit will enable the student to construct a **Parabola.**

3.9 PARABOLA

A parabola has two key dimensions, the height and the span. The height is always longer than the span. Below is illustrated the steps in constructing a parabola.

Steps:

- Construct a rectangle, height (120mm) as given and the span (80mmm) of the required parabola
- Divide the span into 8 equal parts
- Divide the height into 4 equal parts
- Join the middle top division to the side divisions
- Draw vertical line from the 8th division
- The vertical lines and diagonal lines met at respective points (i.e: diagonal 1 meets vertical 1, diagonal 2 meets diagonal 2 and so on ..)
- Dot these points and using your free hand , join the points in bold
- This gives the required parabola

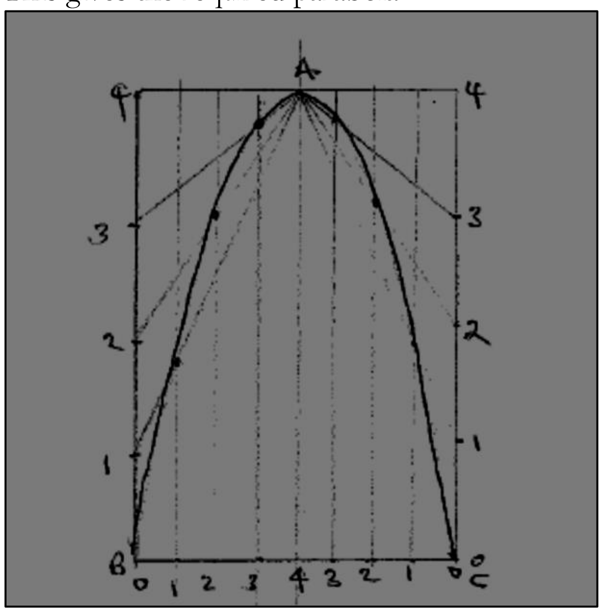
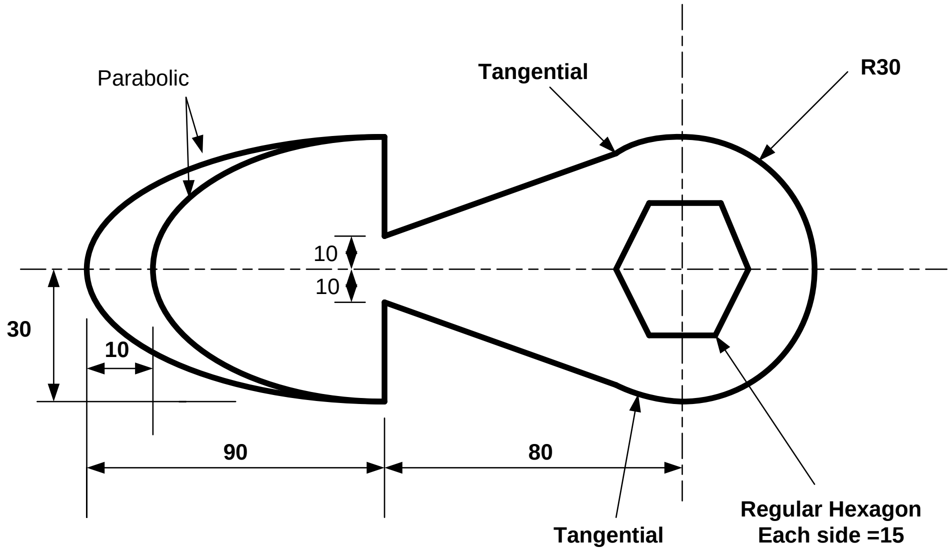


Figure 3.40. Parabola

Exercise 7

(i) Using constructional methods, construct a Parabola whose height is 160mm and span of 100 mm

(ii) Construct the geometrical shape shown in the figure below



NB: For further reading and activity, refer to pages 144-145 of reference text 3

Unit 3.10: Ellipse

Unit Overview

In this **unit,** we will construct an **Ellipse** using 2 main methods namely; the rectangular method and concentric circle method. An Ellipse is said to be oval Shaped, It has a major and Minor axis as key dimensions. The steps below illustrate the construction of an Ellipse. Using the rectangular and concentric circle methods.

Unit Objective

At the end of the unit, the student will be able to construct an ellipse using 2 methods namely

- Rectangular method
- Concentric circle method

3.10 ELLIPSE

3.10.1 Rectangular Method

Steps:

- Using the dimensions given for the minor and major axis, draw a rectangle as shown in the figure below
- Divide the major axis into 8 equal parts and number accordingly
- Divide the sides AD and BC into 12 equal parts and number accordingly
- Using points AB1 and CD1 draw diagonal lines from these points through the centre divisions to meet the earlier diagonals at their respective corresponding points.
- This locates the points that will be joined
- Using freehand, join the points in outline to give the required Ellipse

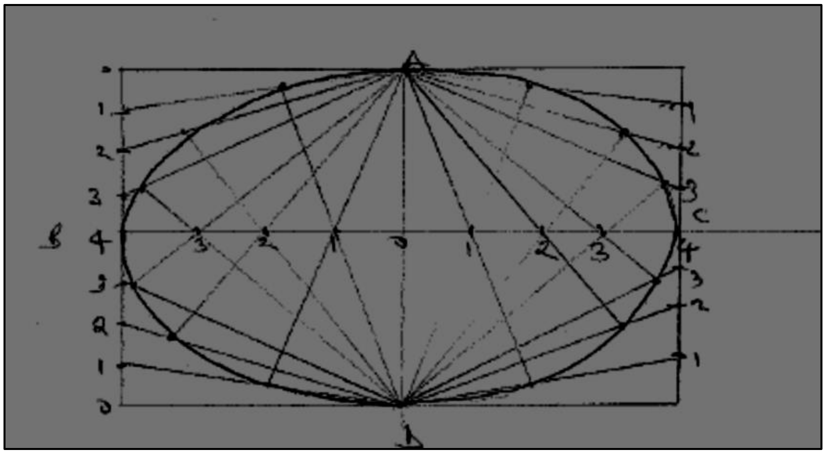


Figure 3.41: Ellipse construction using the rectangular method

3.10.2 Concentric Circle Method

Steps:

- Using the dimensions given for the minor and major axis, draw the two circles shown in the figure below
- Divide the circles into 12 equal parts and number accordingly
- From the Outer circle, drop verticals
- From the inner circle, draw horizontals
- The verticals and horizontals meet as shown in the figure below
- This locates the points that will be joined to get the required ellipse
- Using freehand, join the points in outline to give the required Ellipse

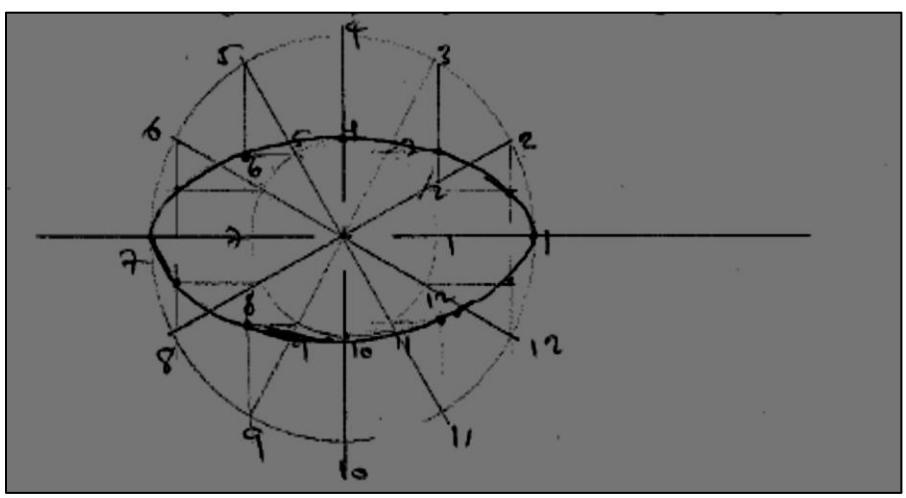
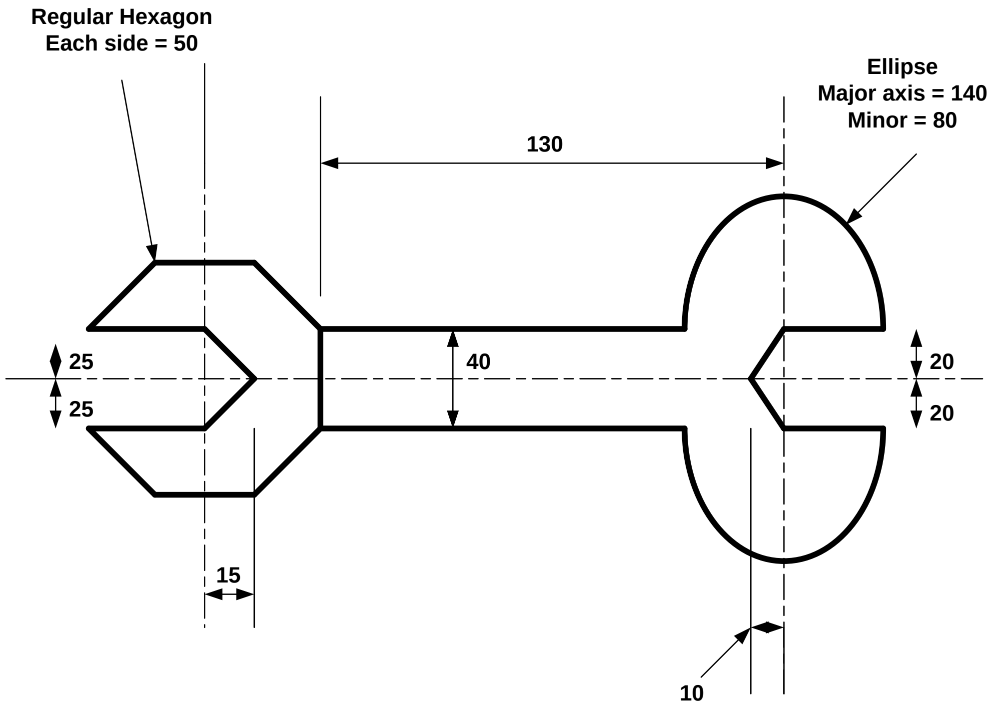


Figure 3.42 . Ellipse construction using the Concentric circle method

Exercise 8.

Using construction methods, draw the figure given below;



NB: For further reading and activity, refer to pages 142-143 of reference text 3

Unit 3.11: Helix

Unit Overview

This **unit** covers the construction of the **helix**. These geometrical shapes are usually used in the design of mechanical parts for a number of industrial Equipments. The step by step process of constructing these shapes is illustrated below.

Unit Objective

This unit will enable the student to construct a **helical spring.**

3.11 HELIX

A Helix is constructed using 2 main dimensions namely the **outside diameter** and the **pitch**. . The helix can be right hand or left hand depending on the starting point. In this example below, we will construct a right hand helix. To construct a helix, proceed as follows;

Steps:

- Draw a circle with radius equal to half the outside diameter of 60mm
- Divide the circle into 12 equal parts

- Divide the pitch (30mm) into 12 equal parts
- Draw horizontal lines from the divided circle
- Based on the number of pitch divisions, mark the given points accordingly and locate the required points which will eventually be joined using your free hand

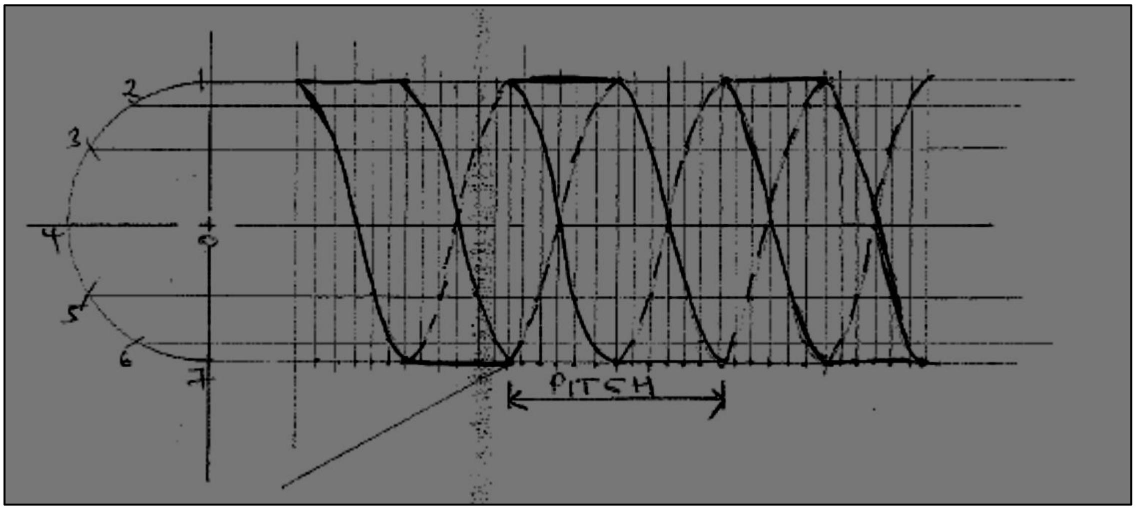


Figure 3.43. Helix construction

Exercise 9

Using geometrical methods, construct the following

(i) A right hand helical square spring (Diameter=80mm, pitch = 30mm)
(ii) A left hand helical square spring (Diameter=80mm, pitch = 30mm)
(iii) Comment of the difference between the two constructions given above

NB: For further reading and activity, refer to pages 148-149 of reference text 3

Unit 3.12: Archimedean Spiral

Unit Overview

This **unit** covers the construction of the **Archmedian spiral**. These geometrical shapes are usually used in the design of mechanical parts for a number of industrial Equipments. The step by step process of constructing these shapes is illustrated below.

Unit Objective

In this unit the student will learn how to construct an Archimedean spiral

3.12 ARCHEMEDIAN SPIRAL

Steps:

- Draw a circle with radius equal to half the outside diameter (70mm)
- Divide the circle into 12 equal parts
- Divide half of the horizontal centre line into 12 equal parts
- Draw circles in construction and number accordingly.
- Match each line with its corresponding circular position and mark the points
- The points are then joined using your freehand to come up with the required archmedian spiral

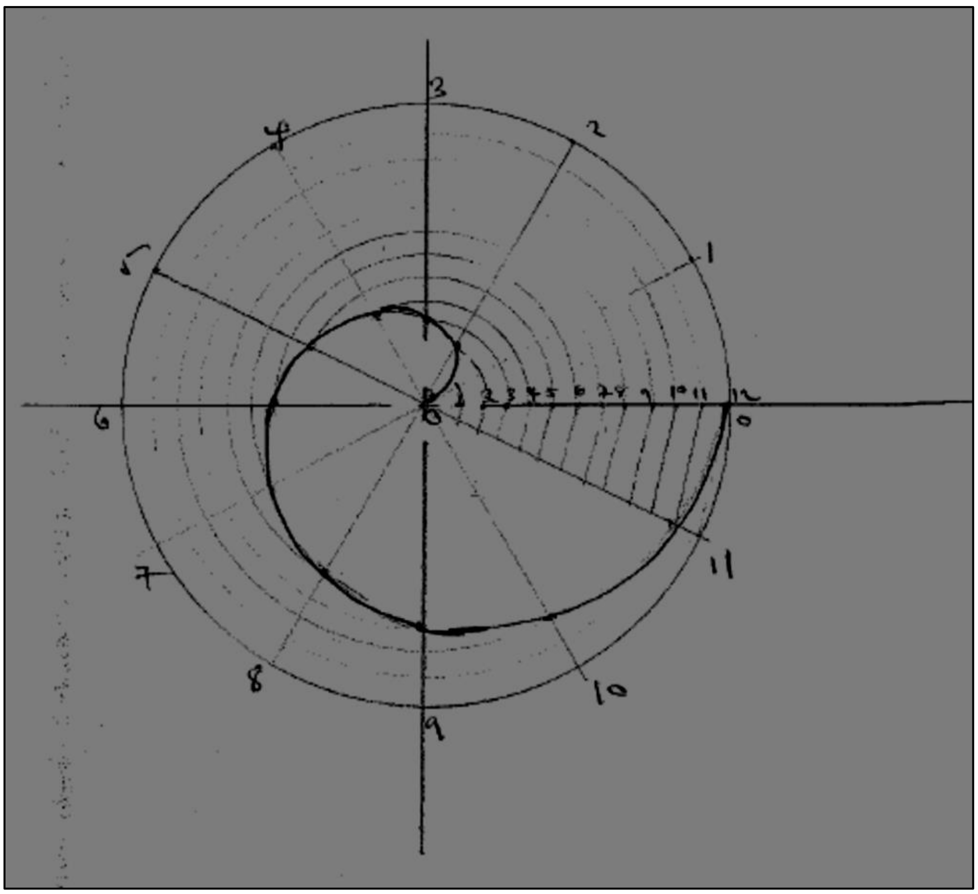


Figure 3.44. Archimedean Spiral

Exercise 10

Using geometrical methods, construct the following

(i) An Archimedean spiral in a circle of radius 40 mm and using 8 divisions
(ii) An Archimedean spiral in a circle of radius 60 mm and using 4 divisions
(iii) Comment of the difference between the two constructions given above

(iv) Which is the most preferable amongst the above in coming up with the best curve?

NB: For further reading and activity, refer to pages 148-149 of reference text 3

Unit 3.13: Loci Mechanisms

Unit Overview

This **unit** covers the construction of the **loci mechanisms**. These geometrical constructions are usually used in the design of mechanical parts for a number of moving industrial Equipments. A **loci** is a **path** followed by a point or points of a given moving mechanism.. The step by step process of constructing these shapes is illustrated below.

Unit Objective
This unit will enable the student to construct the Loci of given mechanisms.

3.13 LOCI MECHANISMS

Steps:

- Draw the given Mechanism (dimensions are given in the diagram below)
- Divide the circle into 12 equal parts
- For each division, reproduce the initial mechanism set up and do that or 12 point round the circle. This will enable you to the necessary points for 'p' which will then be joined to give the path followed by point 'P' for one revolution.

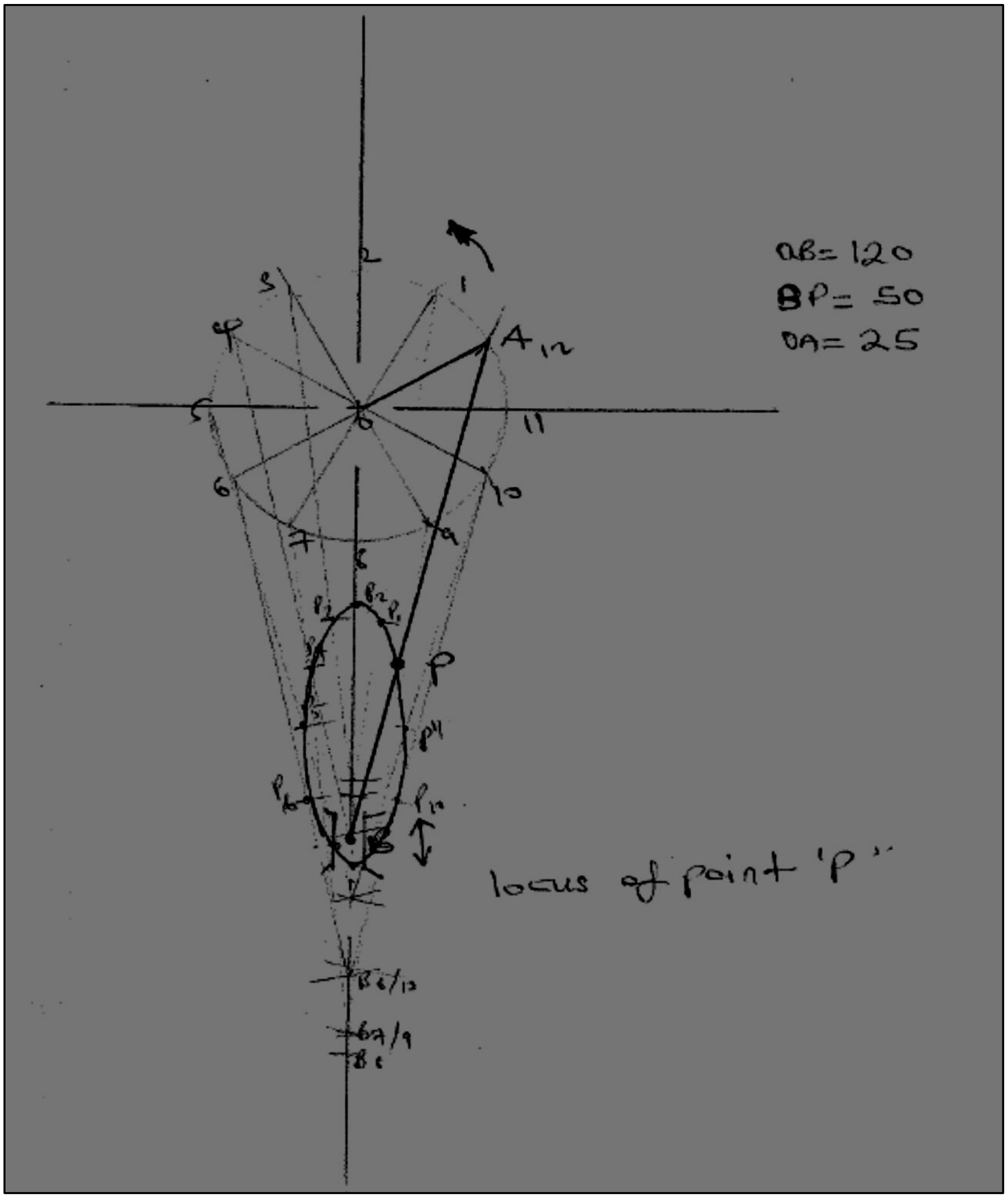
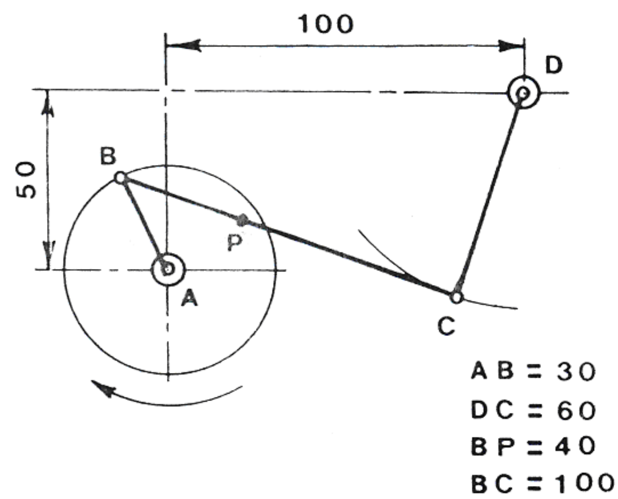


Figure 3.46 . Loci Mechanisms

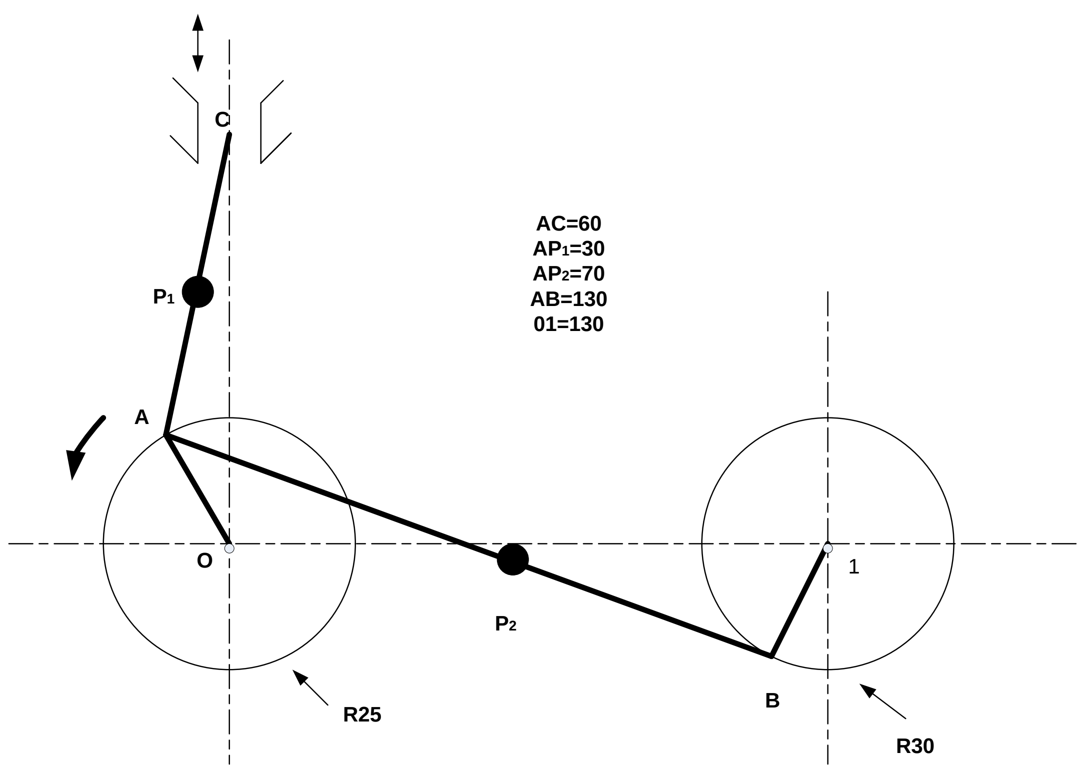
Exercise 11

Using geometrical methods, plot the loci for the following mechanisms

(i) Draw the locus of point P for the mechanism shown in, for one revolution of the crank AB.



(ii) Plot the loci of points P_1 and P_2 in the mechanism shown in the figure below;



NB: For further reading and activity, refer to pages 152-153 of reference text 3

CHAPTER FOUR

SOLID GEOMETRY

OVERVIEW

This **Chapter** has **6 units** and covers **Solid Geometry**. The chapter equips the students with knowledge on how to sketch, draw 3D objects in isometric, sketch and draw orthographic views of objects and draw sectional views..

OBJECTIVES

After completing this chapter, you will be able to:

1. Draw FreeHand Sketches
2. Draw Isometric drawings
3. Draw Freehand orthographic drawings
4. Draw Orthographic drawings using instruments
5. Draw sectional views of orthographic drawings using instruments
6. Dimension the drawn views and objects

Unit 4.1: Freehand Sketching

Unit Overview

This unit covers free hand sketching. Freehand sketching is important to an Engineer. Before an actual design is done, one must be able to produce a freehand sketch and get to have a view of the object before the actual drawing is done using instruments.

Unit Objective

This unit will enable the student produce Freehand sketches

4.1 FREE HAND SKETCHING

The ability to make free hand sketches is a valuable asset acquired by practice. Any sketch should satisfy the following requirements'

(a) *It should describe the shape of the object completely showing the relative parts in fair proportion but not to any particular scale.*

(b) *It should carry all essential dimensions.*

The following examples will illustrate how to come up with a free hand sketch of an object.

Example 1: Sketch the object shown below:

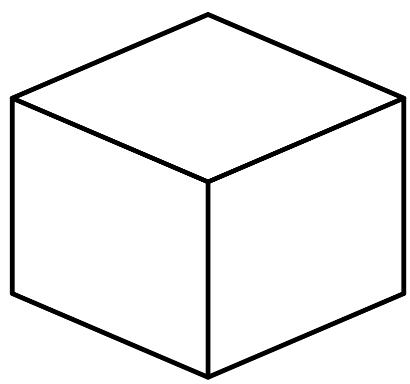


Figure 4.1 . Freehand Sketching

Step 1:

Sketch the lines shown below in construction;

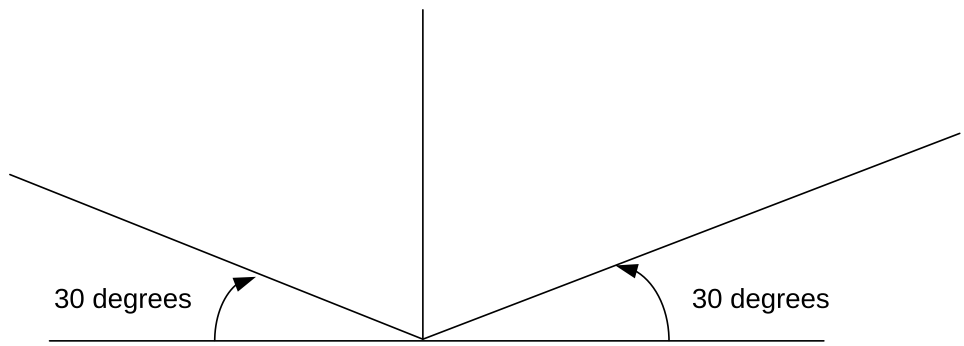


Figure 4.2 . Freehand Sketching

Step 2:

Approximate the given dimensions of the given object on to your sketch and proceed to complete the construction lines of the entire sketch as shown in the figure below.

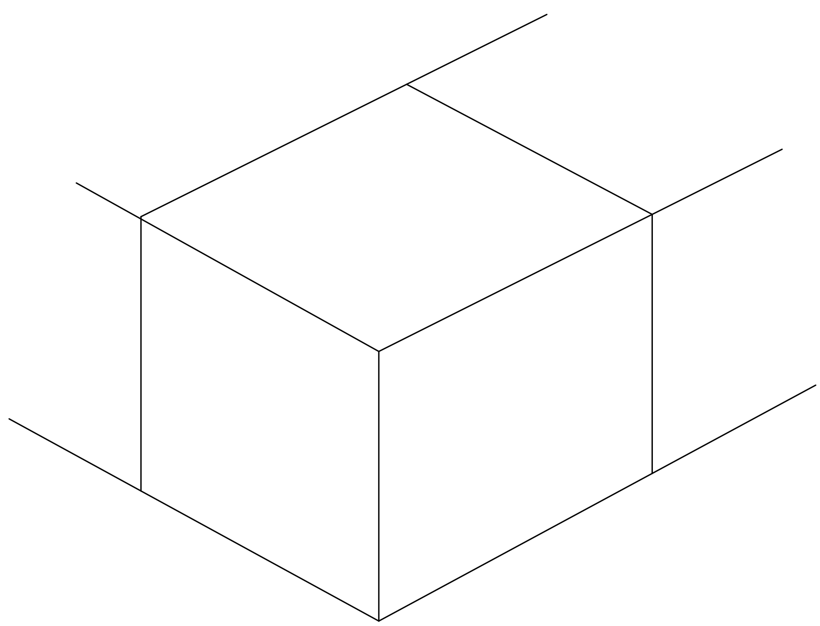


Figure 4.3 . Freehand Sketching

Step 3:

Complete the object by outlining the construction lines as shown in the figure below;

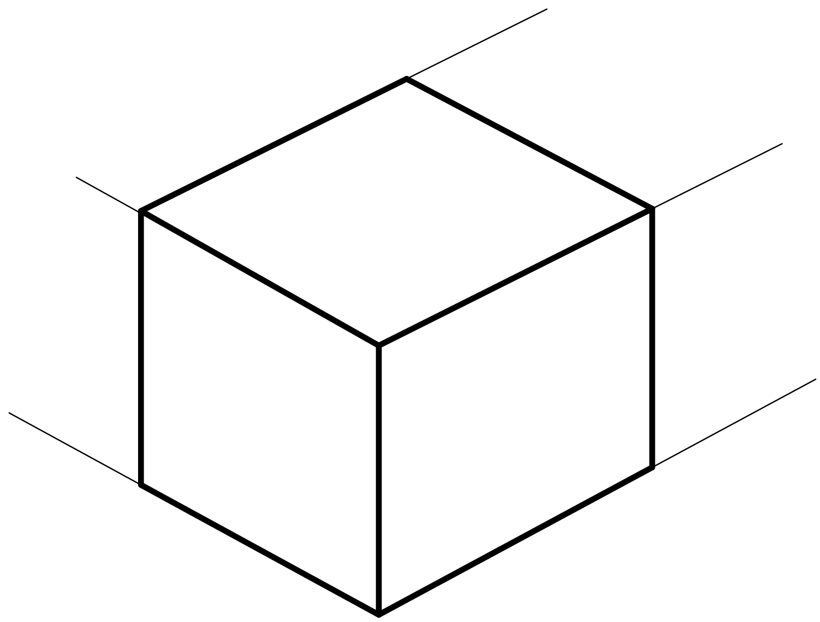


Figure 4.4 . Freehand Sketching

<u>Example 2:</u> Sketch the object shown below;

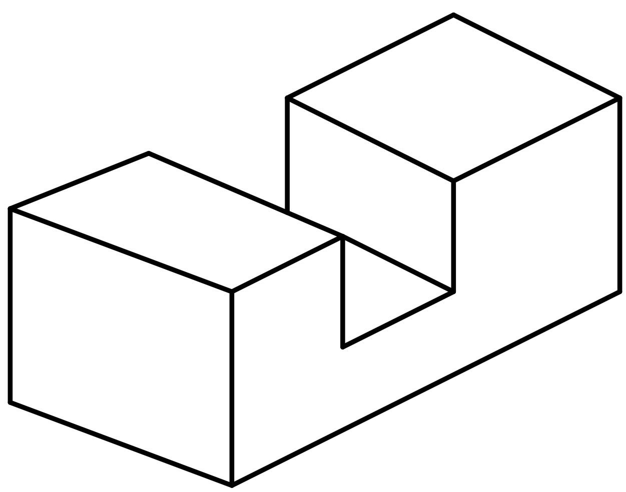


Figure 4.5 . Freehand Sketching

Step 1:

Sketch the construction lines as was done for the previous example;

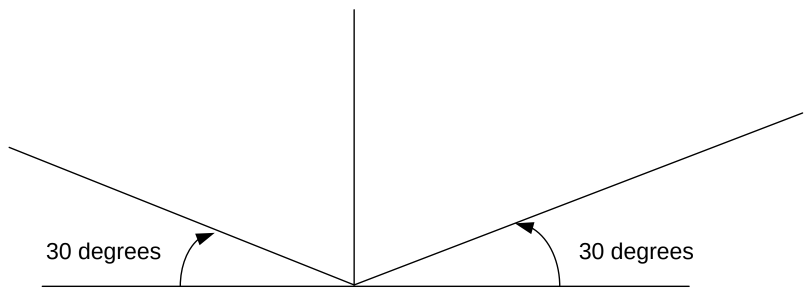


Figure 4.6 . Freehand Sketching

Step 2:

Begin to add the dimensions to your sketch by beginning with the outer dimensions as shown below;

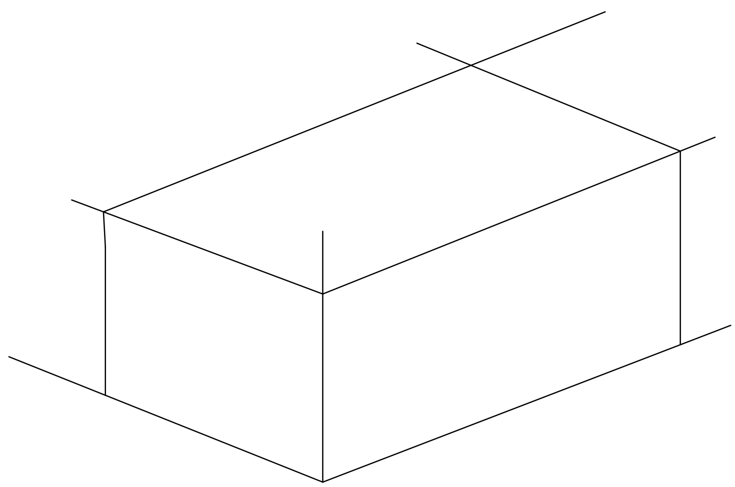


Figure 4.7 . Freehand Sketching

Step 3:

Complete the dimensioning and details of the sketch before proceeding to outline the object.

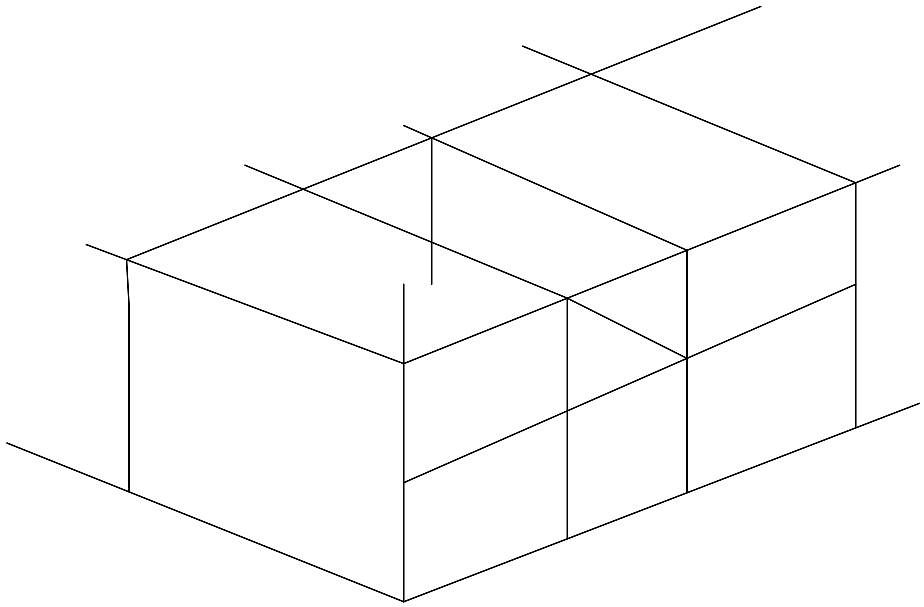


Figure 4.8.a . Freehand Sketching

Step 4:

Outline the object as shown below;

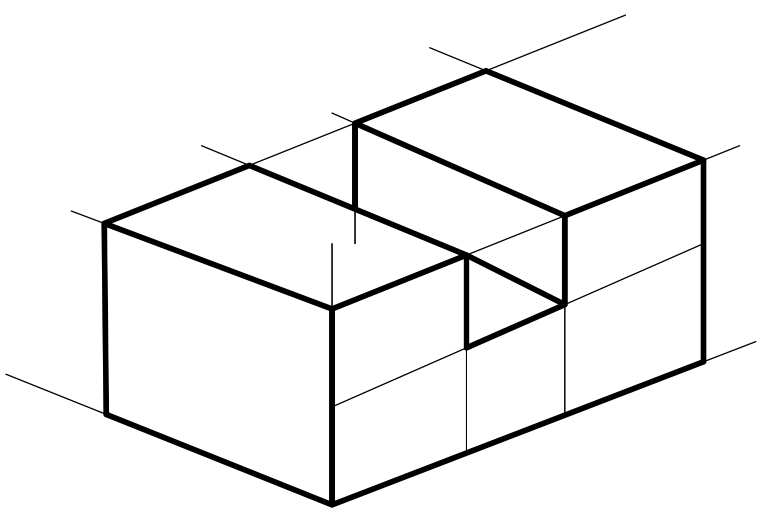


Figure 4.8.b. Freehand Sketching

Example 3:

Sketch the object shown below;

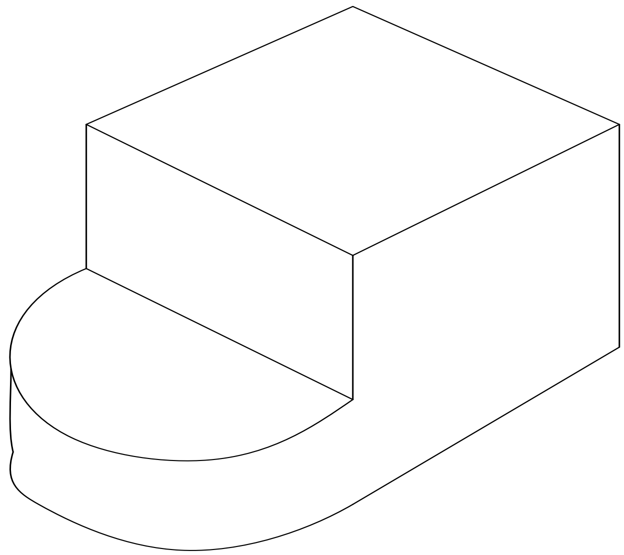


Figure 4.9 . Freehand Sketching

Step 1;

Sketch the outer dimensions of the object as shown below;

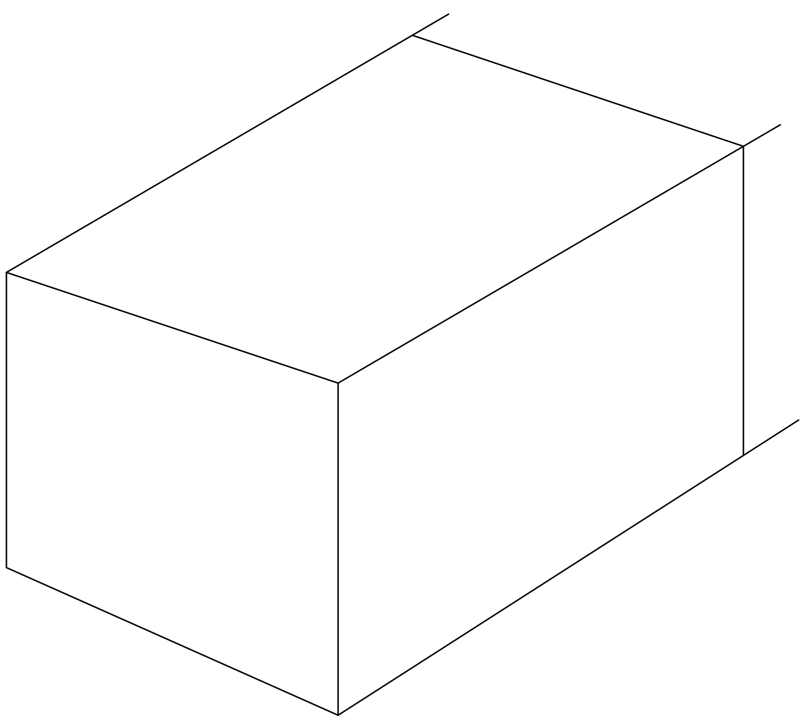


Figure 4.10 . Freehand Sketching

Step 2;

Proceed to sketch the circular part by making use of the isometric circles principal.

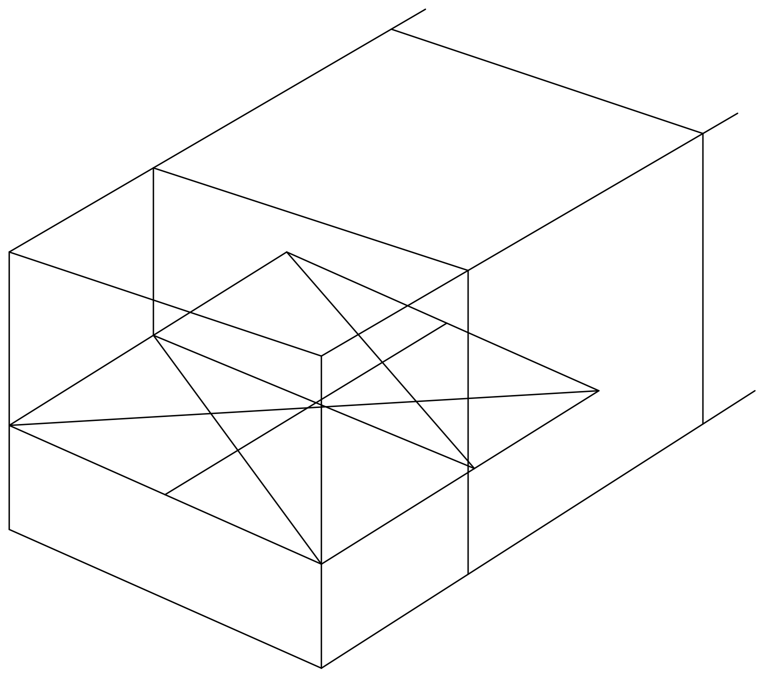


Figure 4.11 . Freehand Sketching

Step 3;

Proceed to complete the circular curves and make sure you do not get mixed up due to the several lines on the circular part.

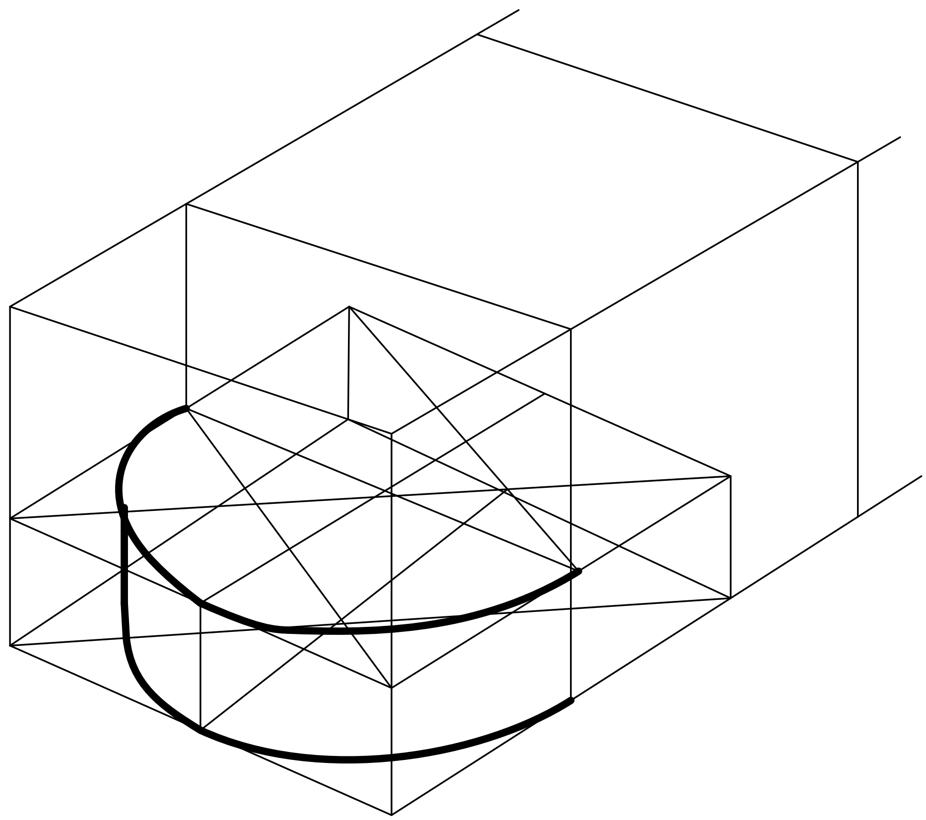


Figure 4.12 . Freehand Sketching

Step 4;

Proceed to complete the remaining part of the drawing.

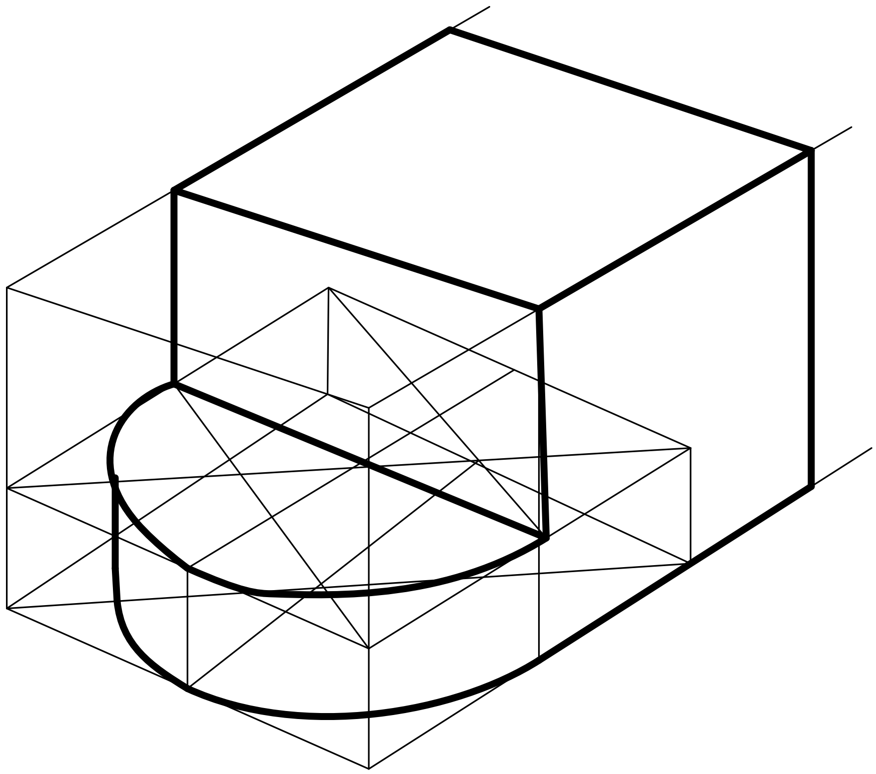


Figure 4.13 . Freehand Sketching

Unit 4.2; Isometric drawing

Unit Overview

This **unit** covers free **isometric drawing.** Just like Freehand sketching is important to an Engineer; isometric drawing is the actualization of the freehand sketches using instruments. Isometric circles are constructed using isometric circles and the other parts of the drawings also done using instruments.

Unit Objective

This unit will enable the student to produce isometric drawings

4.2 . ISOMETRIC DRAWING

For Isometric drawing, the procedures that were followed for free hand sketching can suffice in helping one to understand how to come up with an isometric drawing. The main difference between

Isometric and Free hand sketching is that for Isometric drawings, we use drawing instruments and the dimensioning is precise. Therefore, proceed to draw the objects drawn earlier under free hand sketching but using isometric drawing this time. Equally draw the practice questions in isometric too. The circular part of an isometric circle is illustrated below;

Step 1;

Given a circle of a certain Radius 'R', you proceed to construct the isometric square shown below and locate centres C1, C2, C3 and C4 by drawing the lines as shown below.

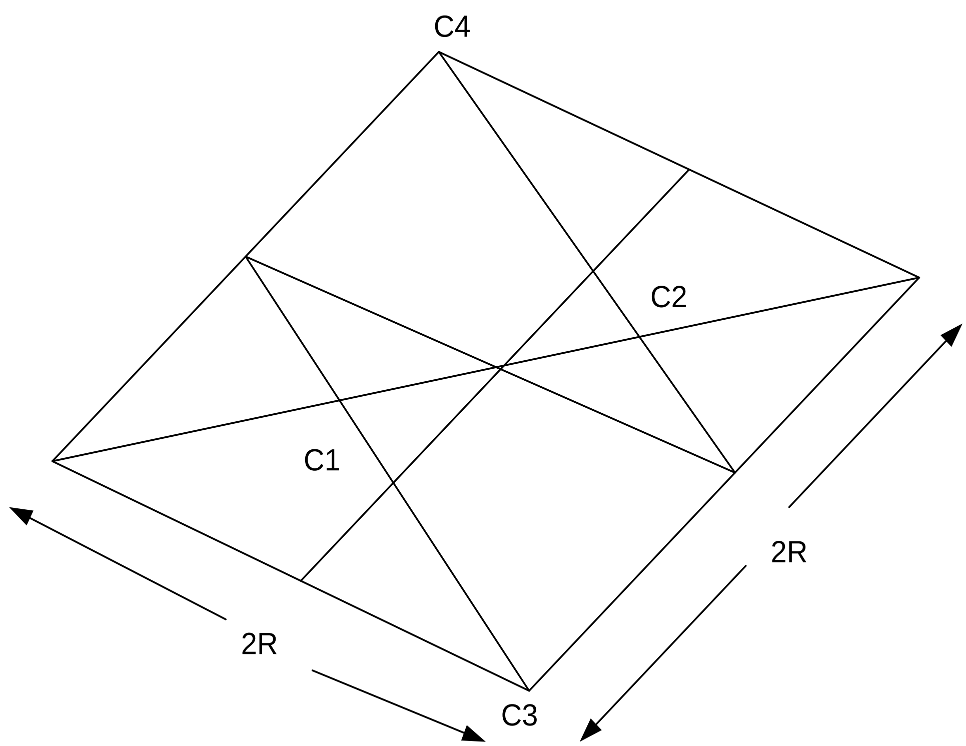


Figure 4.14. Isometric drawing

Step 2;

Proceed to draw the circular curves of the circle using your instruments. C1 and C2 are used for the curves shown below

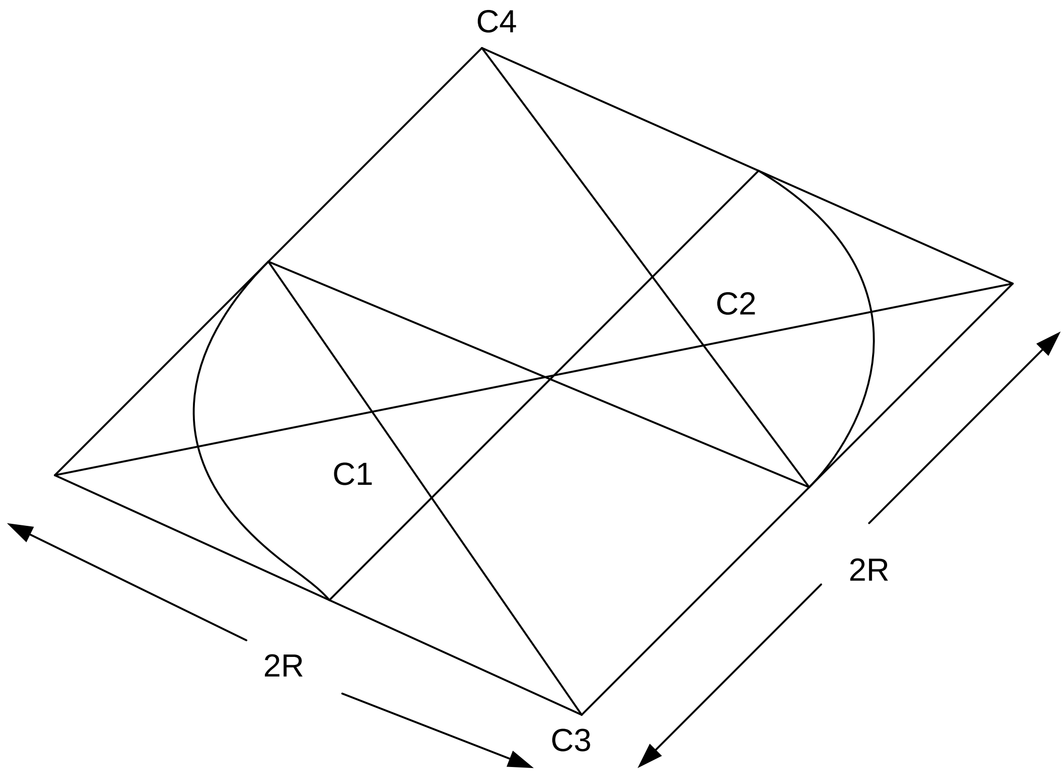


Figure 4.15. Isometric drawing

Step 3;

Proceed to draw the circular curves of the circle using your instruments. C3 and C4 are used for the curves shown below;

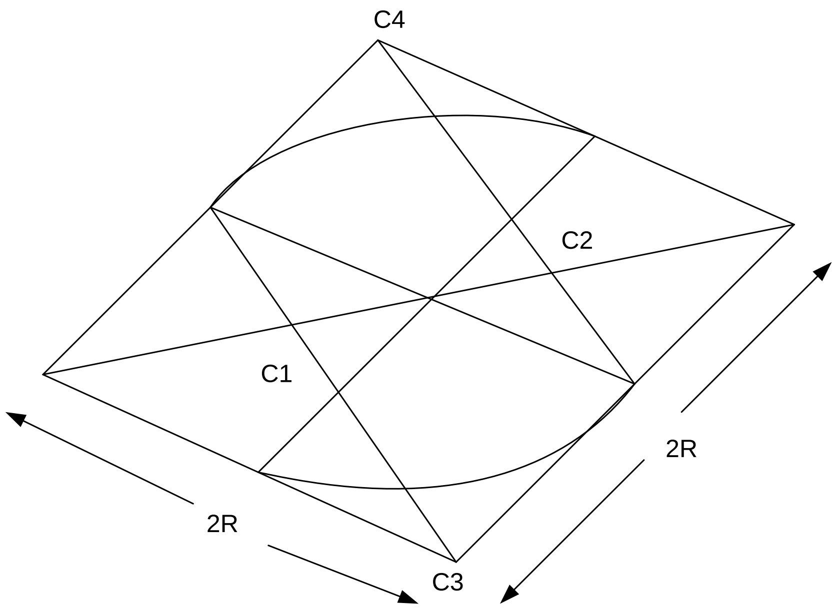
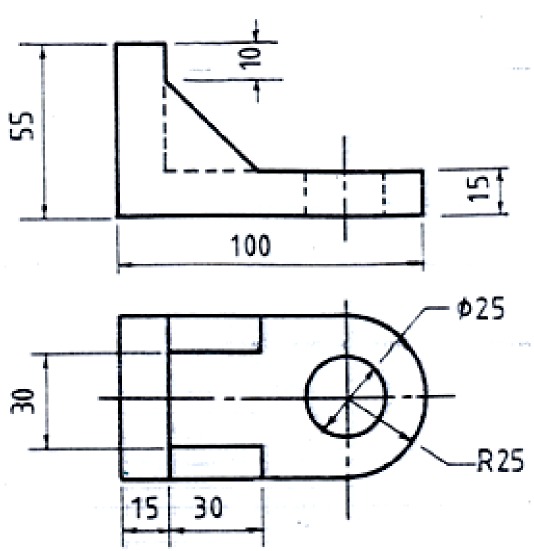


Figure 4.16. Isometric drawing

Exercise 13

Orthographic views of a bracket are shown in first angle projection in the figure below.an isometric drawing, approximately full size that gives a shape description of the bracket. Hidden details are not required.



NB; for further reading refer to pages 12- 18 of reference text 3

Unit 4.3; Orthographic Projections - Freehand

Unit Overview

This unit covers **orthographic projections** using **freehand sketching**. Freehand sketching is important to an Engineer. Before an actual design is done, one must be able to produce a freehand sketch and get to have a view of the object before the actual drawing is done using instruments. Orthographic projection refers to the representation of an object using 3 views. There are 2 methods of representing the 3 views namely the Front view, Plan view and End elevation. These methods are the 1st angle and 3rd angle projection. They are illustrated below;

Unit Objective

This unit will enable the student to produce orthographic projections using freehand

4.3 ORTHOGRAPHIC PROJECTION - FREEHAND

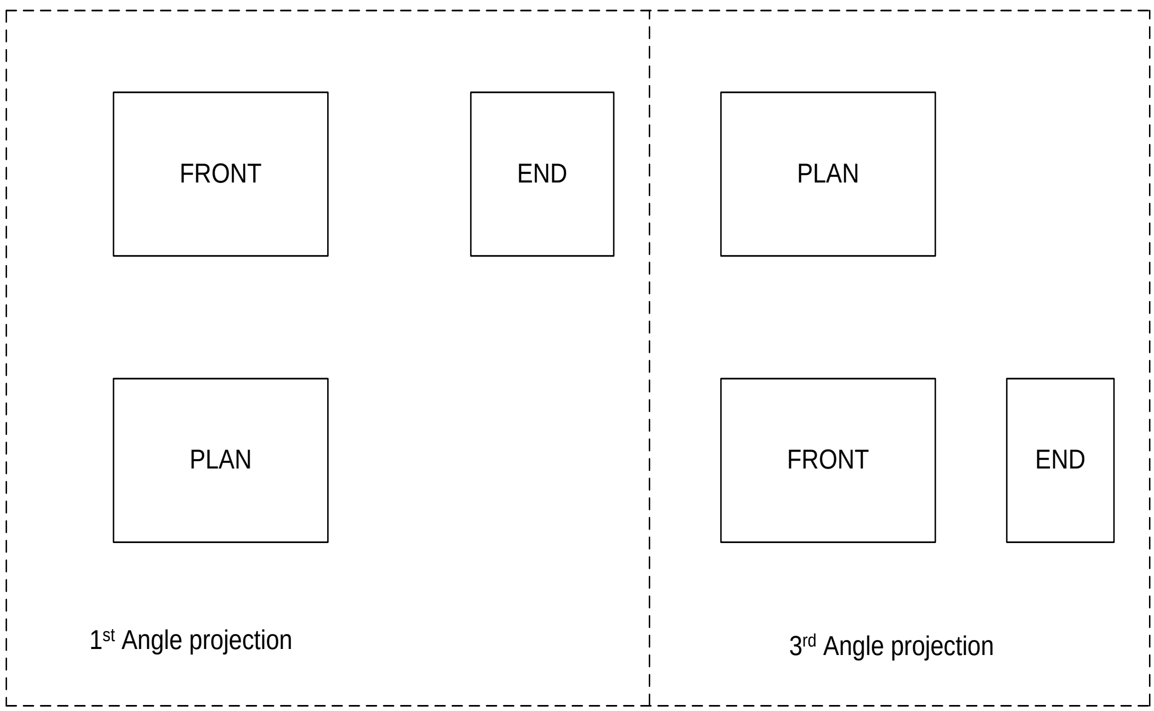


Figure 4.17. Orthographic Projection

In our case, we will use the 3rd angle projection method. Equally orthographic projection can be done using free hand and by drawing using actual instruments. The drawing method will be illustrated in the 2 examples below. Before that is done, it is necessary to prepare the drawing space of the paper accordingly so that the objects can be represented in an orderly way. This is illustrated below. The object to be drawn is shown below;

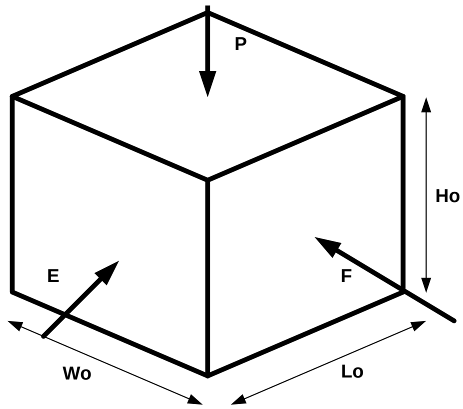


Figure 4.18. Orthographic Projection

To draw the 3 views for the object shown above using freehand, proceed as follows;

Steps

- Get the given dimensions for the required drawings
- Given your experience of distances from the plane geometry part, approximate the required distance and sketch the required views
- The front view is a representation of the object from the direction of arrow F
- The plan view is a representation of the object from the direction of arrow P
- The end view is a representation of the object from the direction of arrow E
- **It is a strict rule that you SHOULD NOT use instruments when doing freehand**
- Sketch the object below using freehand.

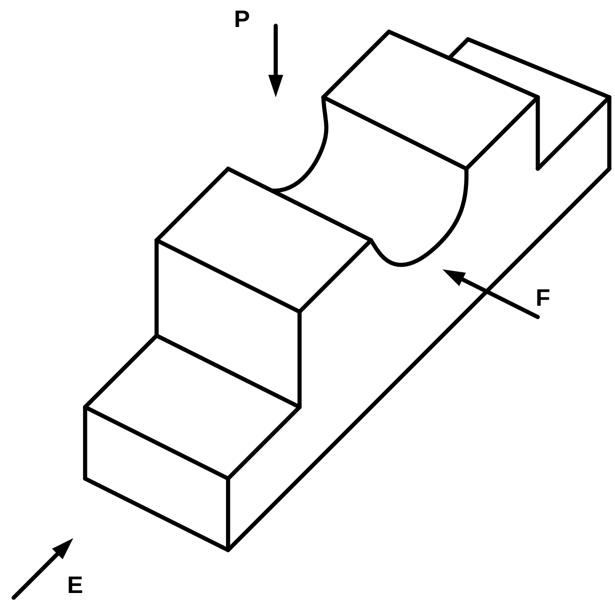


Figure 4.19. Free hand sketching

- The solution is given below;

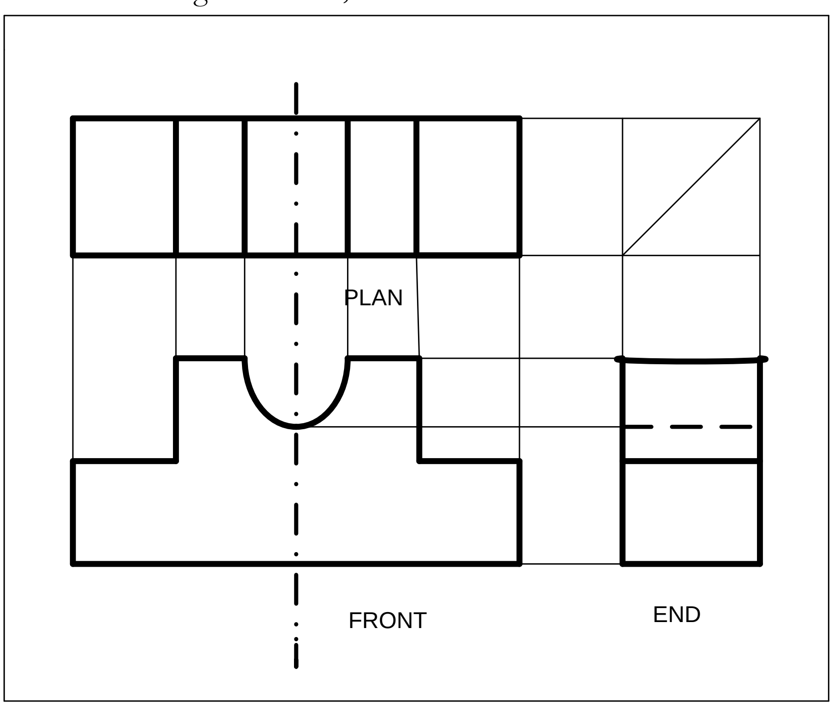


Figure 4.20. Freehand sketching

Unit 4.4: Orthographic Projections – Using instruments

Unit Overview

This unit covers free **orthographic projections** using **Instruments.** Here drawings are done and the objects represented using 3 views just like in freehand but using instruments. Before the actual drawings can be done, there is need to carry out an activity called **spacing.** This is illustrated in the following steps;

Unit Objective

This unit will enable the student to produce orthographic projections using instruments

4.4 ORTHOGRAPHIC PROJECTION – USING INSTRUMENTS

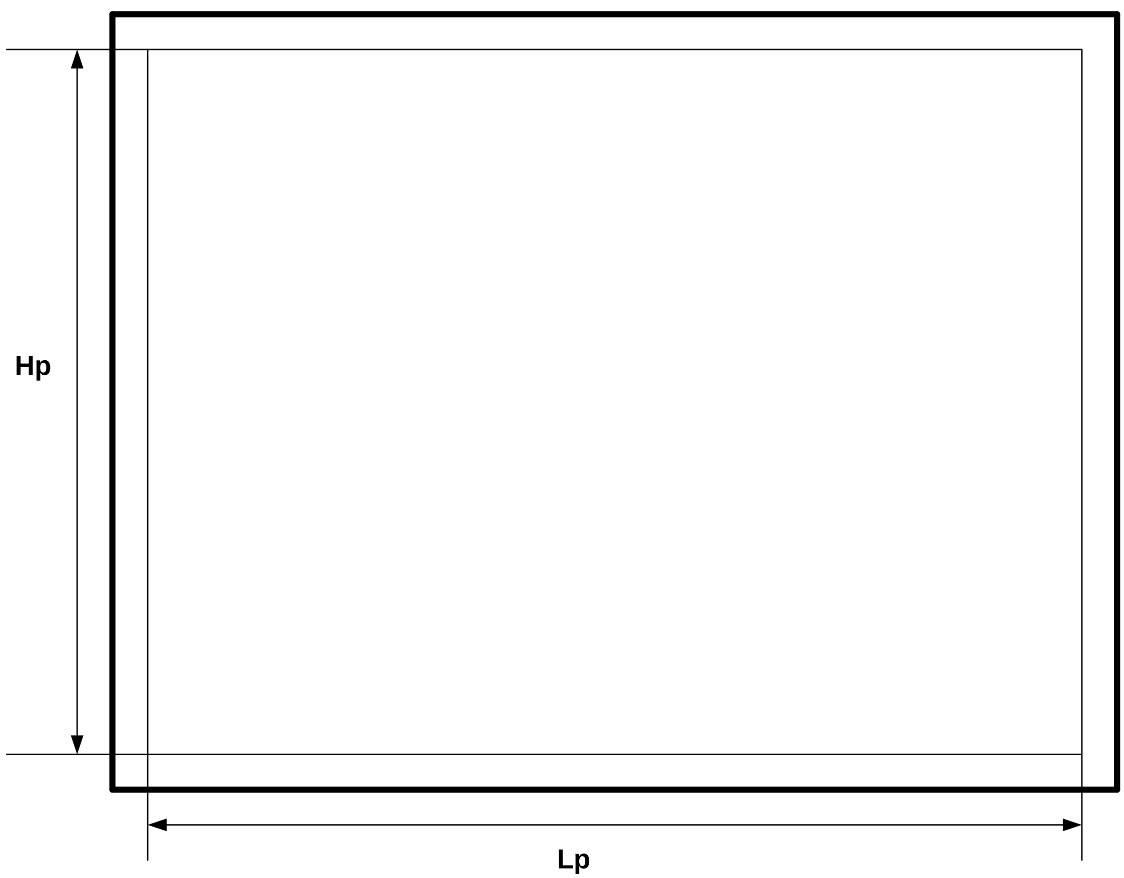


Figure 4.21. Orthographic Projection

1. Measure the **length** of your drawing space
2. Measure the **Height** of your drawing space
3. Take the 3 outer dimensions of the object to be represented in orthographic namely the length, width and height.

4. Proceed to calculate the spacing required between the objects as follows;

$$\mathbf{a = \{Hp - (Wo + Ho)\}/3}$$

Where Hp = Height of paper

Ho = Height of object

Wo = Width of object

$$\mathbf{b = \{Lp - (Lo + Wo)\}/3}$$

Where Lp = length of paper

Lo = length of object

Wo = Width of object

* See the figure below for the illustrations of the distances a and b on your drawing paper.

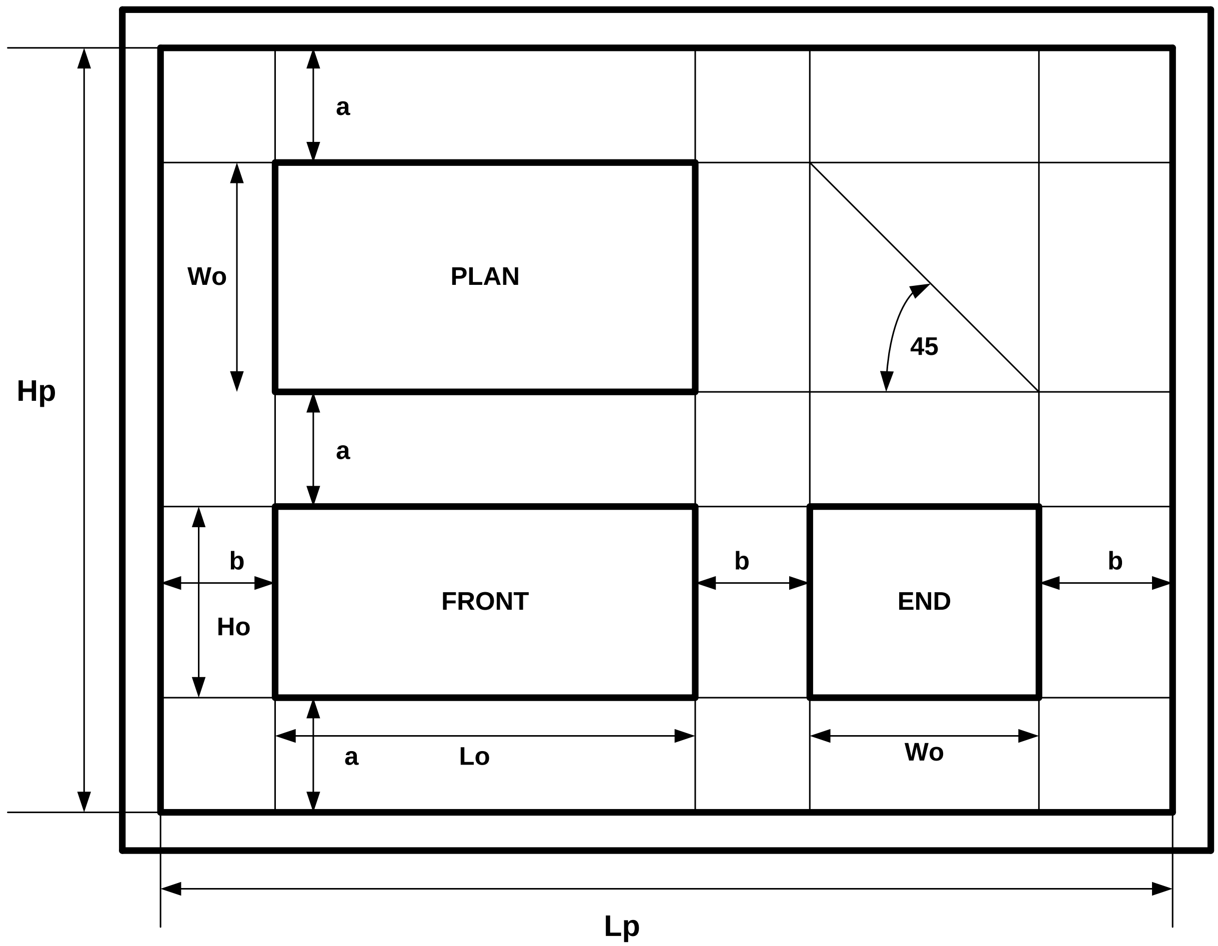


Figure 4.22. Orthographic Projection

Example 1.

Having been shown how to place your drawings on your paper, proceed to represent the object shown below in orthographic using 3rd angle projection.

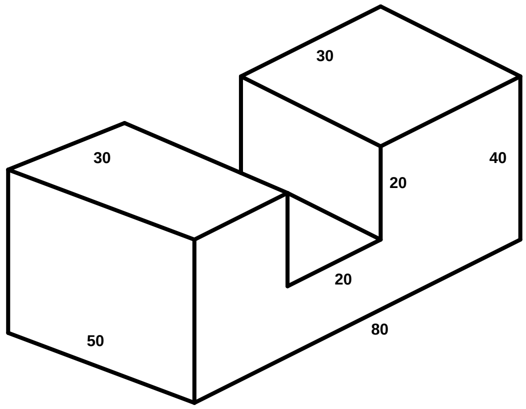


Figure 4.23. Orthographic Projection

The solution is shown below;

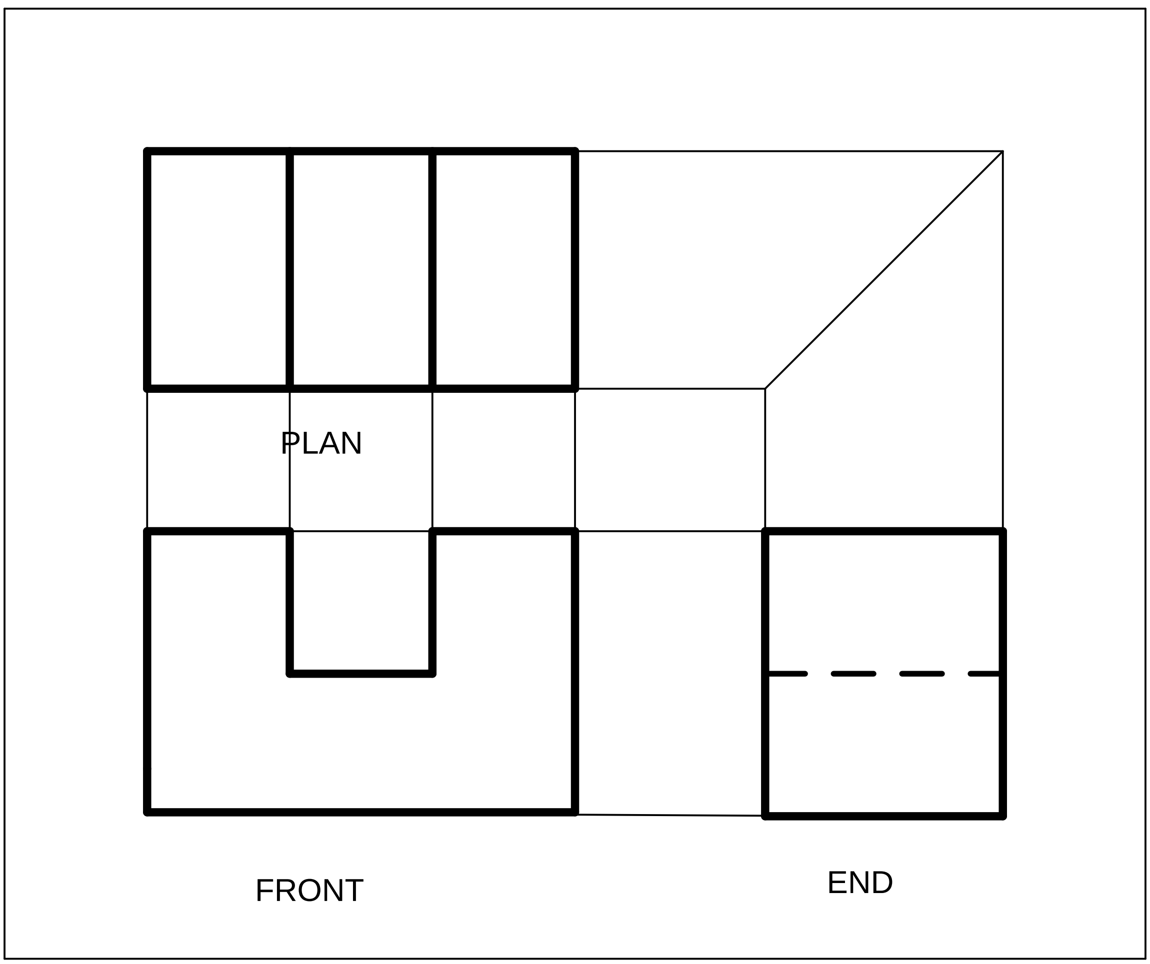


Figure 4.24. Orthographic Projection

Example 2.

Draw the orthographic projection of the object shown below;

* use any reasonable dimensions!

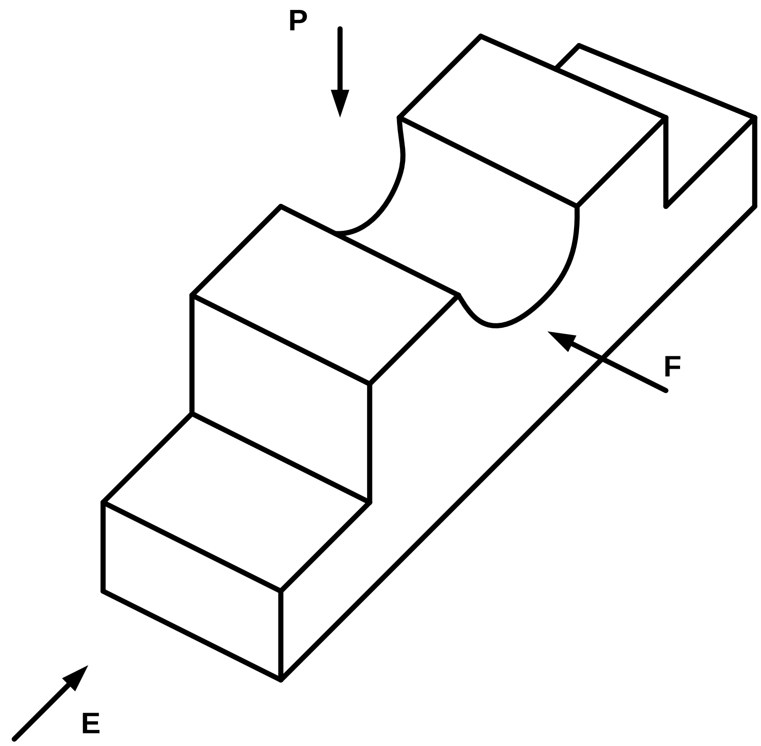


Figure 4.25. Orthographic Projection

The solution is shown below:

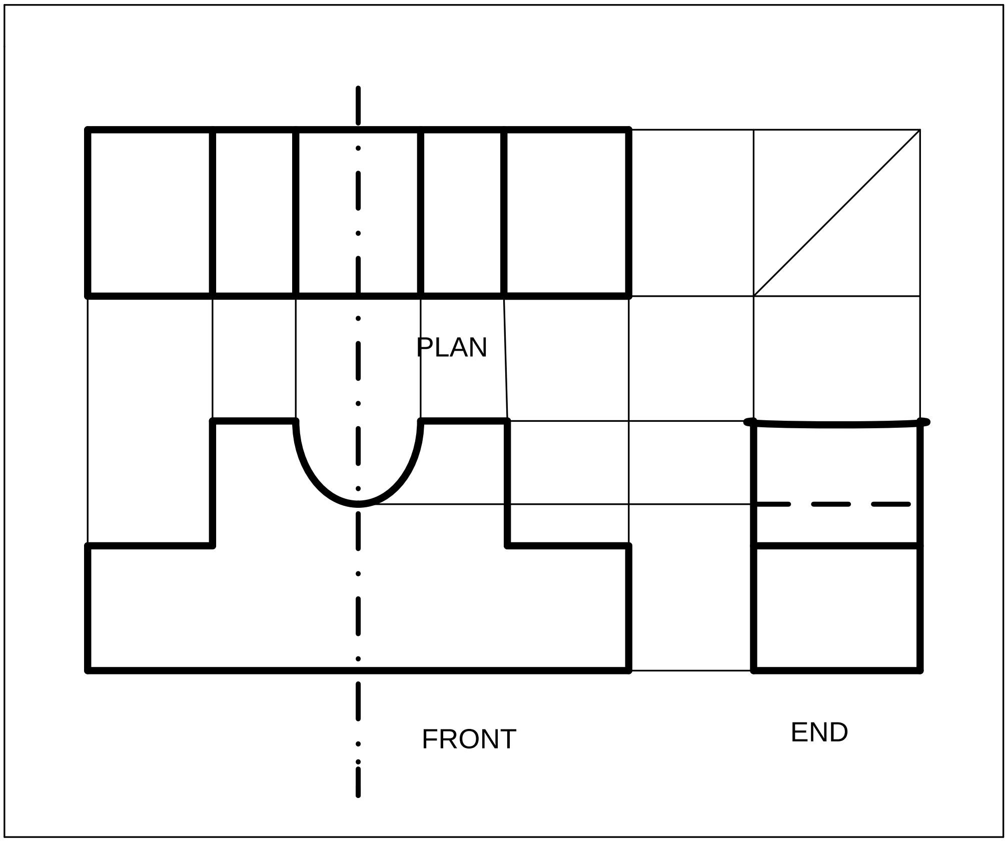


Figure 4.27. Orthographic Projection

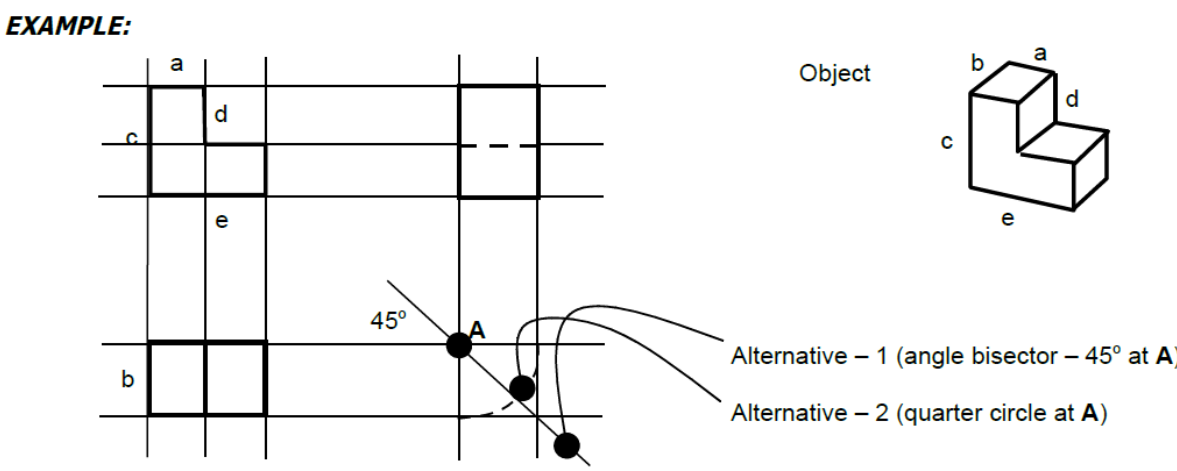


Figure 4.28. Orthographic Projection

Unit 4.5; Sectioning

Unit Overview

This unit covers **sectioning** Here drawings are done and the objects represented using 3 views just like using freehand. Before the actual drawings can be done,

Unit Objective

This unit will enable the student to produce sectioned orthographic projections using instruments and/or freehand.

4.5 SECTIONING

Sectioning is one part of Engineering drawing that enables the student to be able to appreciate how an object looks like when it is cut through. Thus the student is equipped with skills of being able to represent an object using three views one of which is the sectioned view.

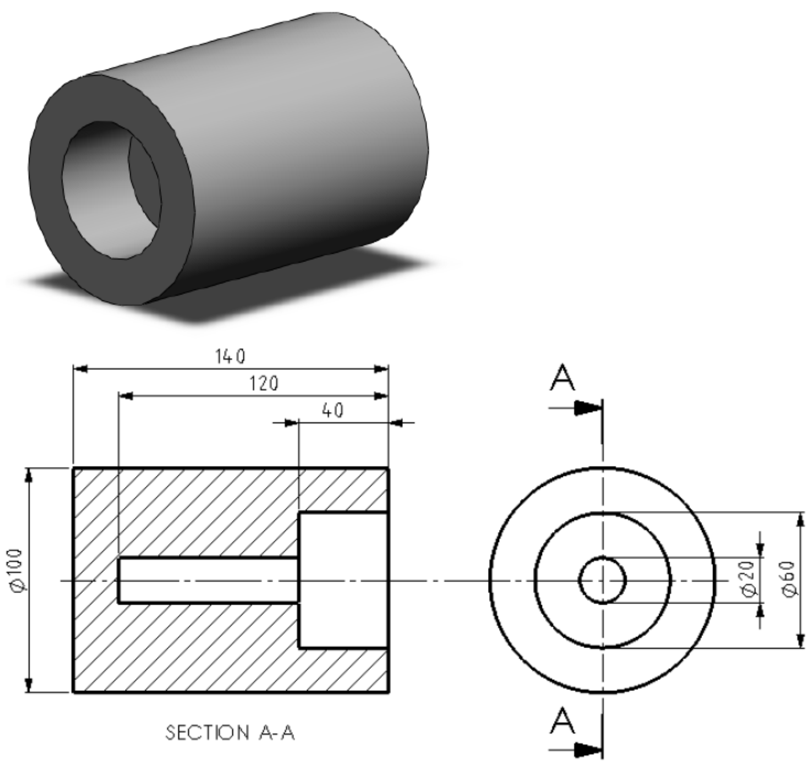


Figure 4.29. Orthographic Projection

Unit 4.6; Dimensioning

Unit Overview

This unit covers **Dimensioning.** The purpose of dimensioning is to provide a clear and complete description of an object. A complete set of dimensions will permit only one interpretation needed to construct the part. Dimensioning should follow these guidelines.

Unit Objective

This unit will enable the student to dimension isometrics and/or orthographic projections.

4.6 DIMENSIONING

Dimensioning

1. Accuracy: correct values must be given.
2. Clearness: dimensions must be placed in appropriate positions.
3. Completeness: nothing must be left out, and nothing duplicated.
4. Readability: the appropriate line quality must be used for legibility.

The Basics: Definitions and Dimensions

The **dimension line** is a thin line, broken in the middle to allow the placement of the dimension value, with arrowheads at each end (figure 4.30).

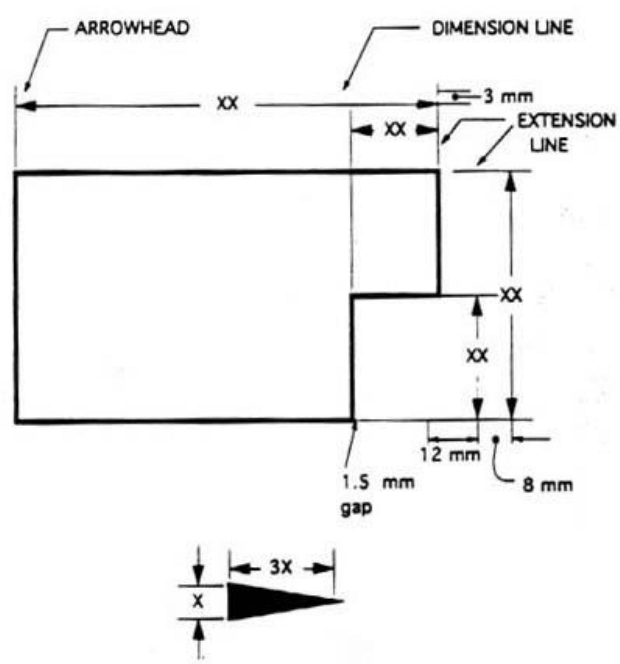


Figure 4.30.Dimensioned Drawing

An **arrowhead** is approximately 3 mm long and 1 mm wide. That is, the length is roughly three times the width. An **extension line** extends a line on the object to the dimension line. The first dimension line should be approximately 12 mm (0.6 in) from the object. Extension lines begin 1.5 mm from the object and extend 3 mm from the last dimension line. A leader is a thin line used to connect a dimension with a particular area (figure 4.31).

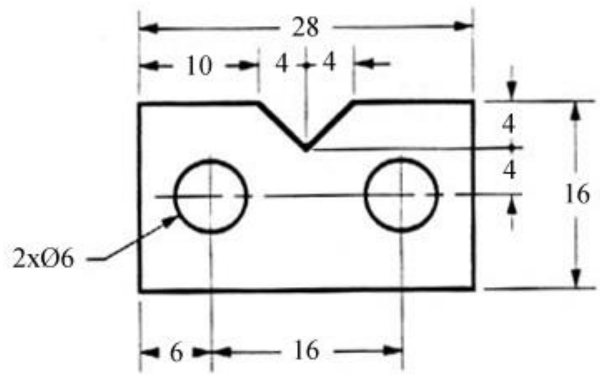


Figure 4.31. Example drawing with a leader

A leader may also be used to indicate a note or comment about a specific area. When there is limited space, a heavy black dot may be substituted for the arrows, as in figure 4.30. Also in this drawing, two holes are identical, allowing the "2x" notation to be used and the dimension to point to only one of the circles.

Where To Put Dimensions

The dimensions should be placed on the face that describes the feature most clearly. Examples of appropriate and inappropriate placing of dimensions are shown in figure 4.32.

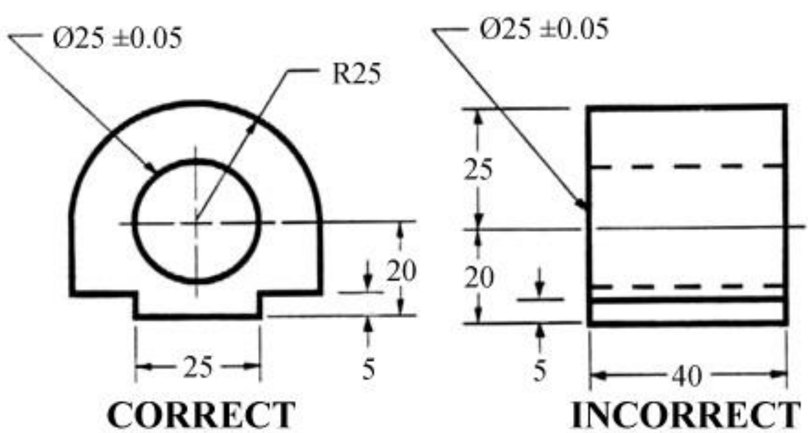


Figure. 4.32. Example of appropriate and inappropriate dimensioning

In order to get the feel of what dimensioning is all about, we can start with a simple rectangular block. With this simple object, only three dimensions are needed to describe it completely (figure 4.33). There is little choice on where to put its dimensions.

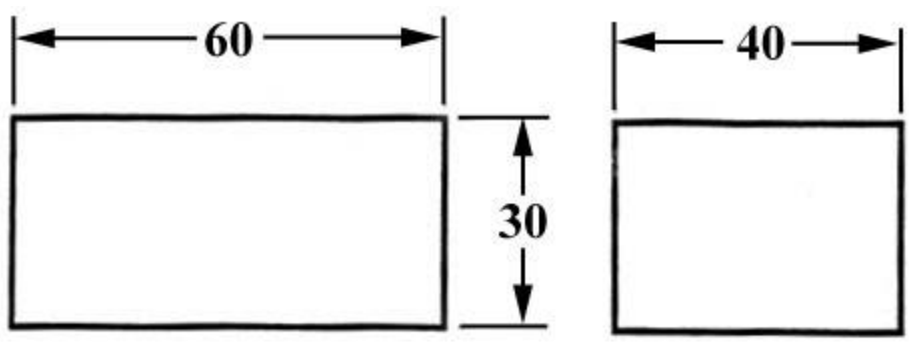


Figure 4.33 . Simple Object

We have to make some choices when we dimension a block with a notch or cutout (figure 4.34). It is usually best to dimension from a common line or surface. This can be called the datum line of surface [4]. This eliminates the addition of measurement or machining inaccuracies that would come from "chain" or "series" dimensioning. Notice how the dimensions originate on the datum surfaces. We chose one datum surface in figure 4.34, and another in figure 4.35. As long as we are consistent, it makes no difference. (We are just showing the top view).

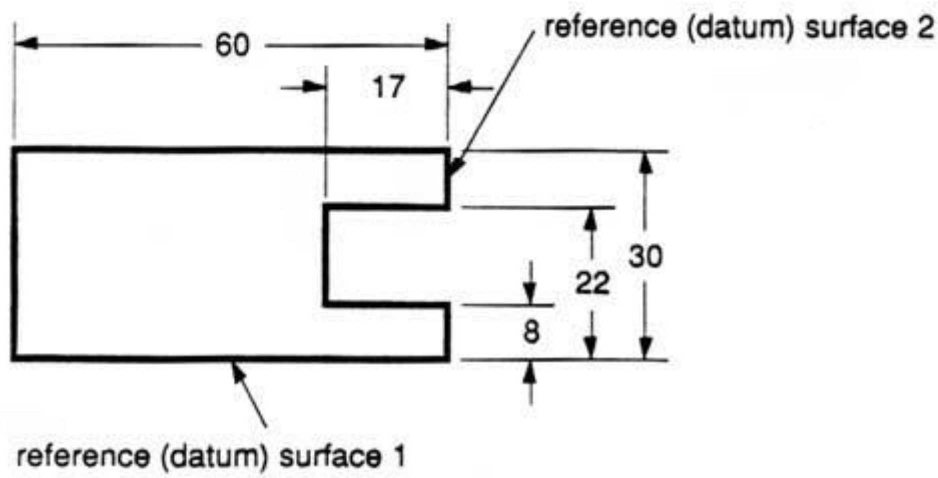


Figure 4.34. Surface datum example

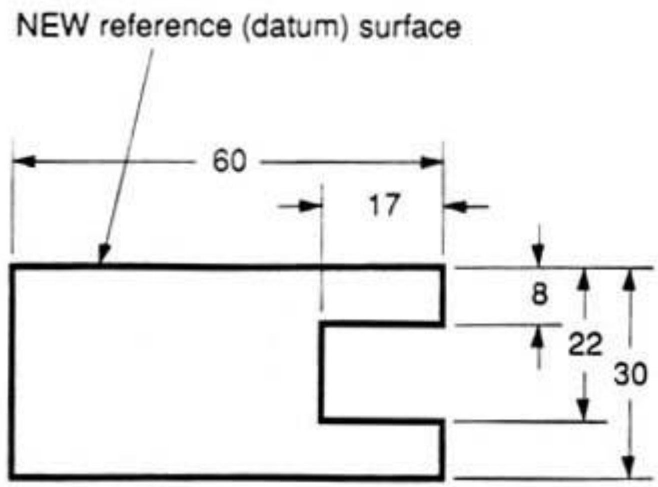


Figure 4.35. Surface datum

In figure 4.36 we have shown a hole that we have chosen to dimension on the left side of the object. The Ø stands for "diameter".

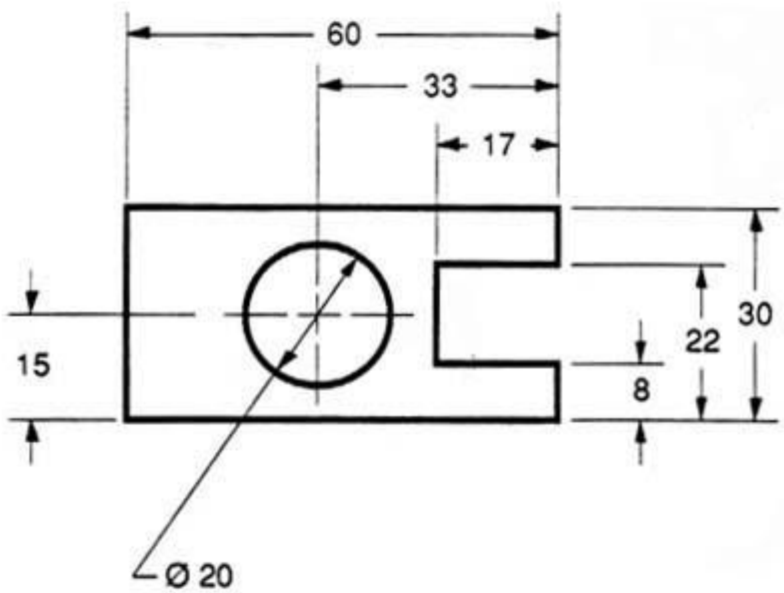


Figure 4.36. Exampled of a dimensioned hole

When the left side of the block is "radiuses" as in figure 4.37, we break our rule that we should not duplicate dimensions. The total length is known because the radius of the curve on the left side is given. Then, for clarity, we add the overall length of 60 and we note that it is a reference (REF) dimension. This means that it is not really required.

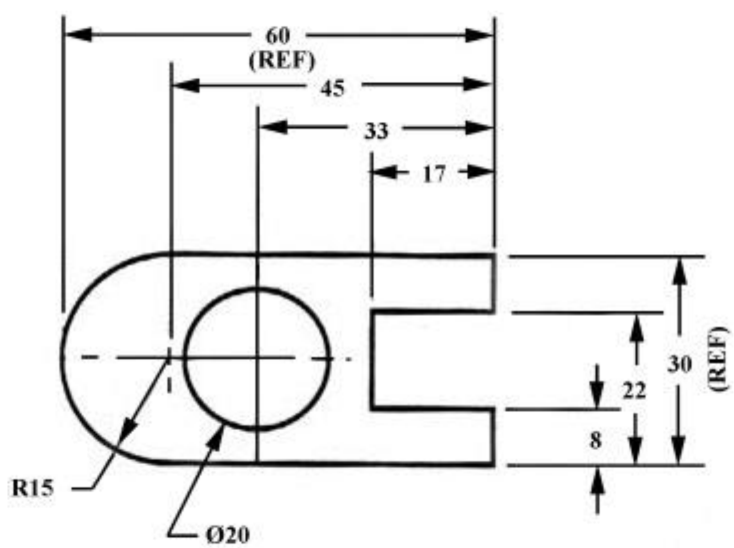


Figure 4.37. Example of a directly dimensioned hole

Somewhere on the paper, usually the bottom, there should be placed information on what measuring system is being used (e.g. inches and millimeters) and also the scale of the drawing[4].

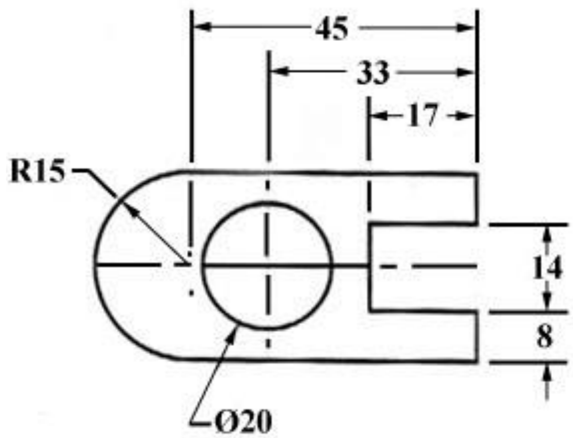


Figure 4.38 - Example of a directly dimensioned hole

This drawing is symmetric about the horizontal centerline. Centerlines (chain-dotted) are used for symmetric objects, and also for the center of circles and holes. We can dimension directly to the centerline, as in figure 4.38. In some cases this method can be clearer than just dimensioning between surfaces.

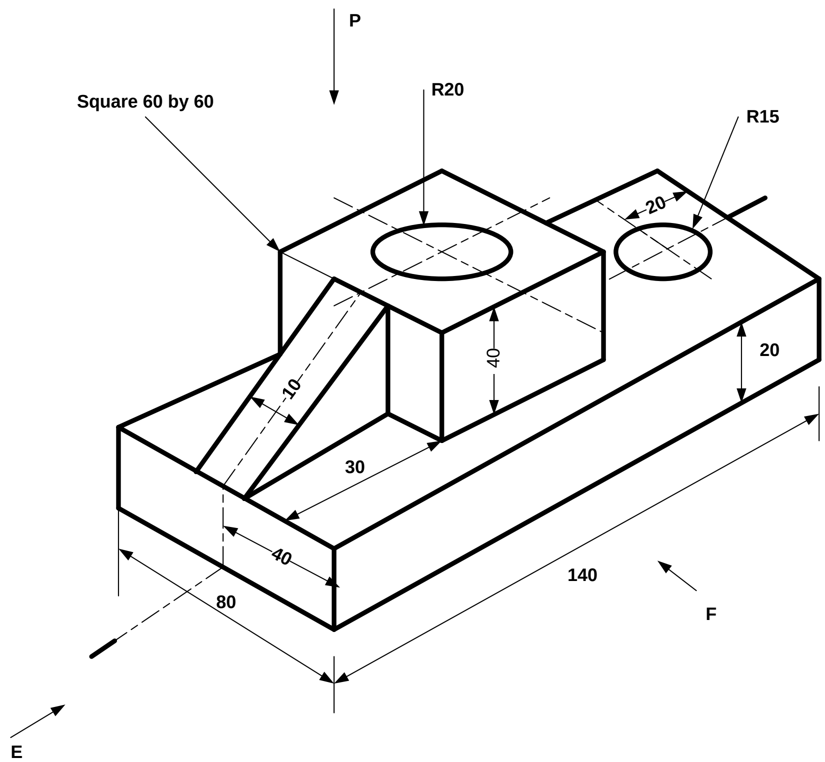
Exercise 13

(i) For the Machine Bracket shown in the figure below, Using instruments draw the following;

(a) A **Front** view in the direction of arrow F

(b) A **Plan** viewed in the direction of arrow P

(c) An **End elevation** viewed in the direction of arrow E



(ii) Draw the Machine Bracket given in Question (i) above using Isometric Drawing.

(iii) Using Free hand, draw the orthographic views and the isometric view for the Machine Bracket shown in (i)

(iv) Using bot free hand and instruments, sketch and draw the sectioned from view for the Bracket shown in (i) assuming the centre line as the cutting plane .

NB; for further reading refer to pages 41- 60 of reference text 3

Module Summary

The Module is has been written in a step by step easy to follow manner and the student is expected to be able to follow through the module and do the exercises at the end to selected units. The student must also follow through the exercises given in the reference texts. for purposes of further activity and reading. Latest trends in Engineering Drawing make use for Computer Aided Design (CAD).

References

1. Bertoline .G, Wiebe .E,Mohler .J, Miller.C, Technical Graphics Communication. (2nd Edition), New York: MaGraw-Hill, 1997.
2. Begg, D., S. Fischer and R. Dornbusch. Economics. (7th Edition). London: MaGraw-Hill, 2003.
3. Bland . S. Graded Exercises in Technical Drawing, (12th Edition),Edinburgh, Longman International, 2003