B.E.First Year

# Engineering Graphics & Design

Dedicated Faculty Committed Education

Darshan

Institute of Engineering & Technology

Department of Mechanical Engineering

**GUJARAT TECHNOLOGICAL UNIVERSITY**

**ENGINEERING GRAPHICS & DESIGN**
**1st YEAR**

**Type of course:** Engineering Science

**Prerequisite:** Zeal to learn the subject

**Rationale:** Engineering Drawing is an effective language of engineers. It is the foundation block which strengthens the engineering & technological structure. Moreover, it is the transmitting link between ideas and realization.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE Viva (V) | PA (I) | |
| 2 | 0 | 4 | 4 | 70 | 30 | 30 | 20 | 150 |

**Content:**

| Sr. No. | Topics | Teaching Hrs. | Module Weightage |
|---|---|---|---|
| 1 | **Introduction to Engineering Graphics:** Drawing instruments and accessories, BIS – SP 46. Use of plane scales, Diagonal Scales and Representative Fraction | 2 (Lab teaching) | 20% |
| 2 | **Loci of Points:** Path of the points moving on Simple mechanisms, Slider crank mechanism, Four bar mechanism | 2 | |
| 3 | **Engineering Curves:** Classification and application of Engineering Curves, Construction of Conics, Cycloidal Curves, Involutes and Spirals along with normal and tangent to each curve | 6 (Lab teaching) | |
| 4 | **Projections of Points and Lines:** Introduction to principal planes of projections, Projections of the points located in same quadrant and different quadrants, Projections of line with its inclination to one reference plane and with two reference planes. True length and inclination with the reference planes | 8 | 30% |
| 5 | **Projections of Planes:** Projections of planes (polygons, circle and ellipse) with its inclination to one reference plane and with two reference planes, Concept of auxiliary plane method for projections of the plane | 6 | |
| 6 | **Projections of Solids, Section of Solids and Development of Surfaces:** Classification of solids. Projections of solids (Cylinder, Cone, Pyramid and Prism) along with frustum with its inclination to one reference plane and with two reference planes, Section of such solids and the true shape of the section, Development of surfaces | 10 | 15% |
| 7 | **Orthographic Projections:** Fundamental of projection along with classification, Projections from the pictorial view of the object on the | 2 | 25% |

| | | | |
|---|---|---|---|
| | principal planes for view from front, top and sides using first angle projection method and third angle projection method, full sectional view | | |
| **8** | **Isometric Projections and Isometric View or Drawing:** Isometric Scale, Conversion of orthographic views into isometric projection, isometric view or drawing of simple objects | 2 (Lab teaching) | |
| **9** | **Computer Aided Drawing:**<br>Introduction to AutoCAD, Basic commands for 2D drawing like : Line, Circle, Polyline, Rectangle, Hatch, Fillet, Chamfer, Trim, Extend, Offset, Dim style, etc.. | 4 (Lab teaching) | 10% |

**Suggested Specification table with Marks (Theory):**

| **Distribution of Theory Marks** | | | | | |
|---|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level | C Level |
| | | | | | |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**Reference Books:**


1. A Text Book of Engineering Graphics by P.J.Shah S.Chand & Company Ltd., New Delhi
2. Elementary Engineering Drawing by N.D.Bhatt Charotar Publishing House, Anand
3. A text book of Engineering Drawing by R.K.Dhawan, S.Chand & Company Ltd., New Delhi
4. A text book of Engineering Drawing by P.S.Gill, S.K.Kataria & sons, Delhi
5. Engineering Drawing by B. Agrawal and C M Agrawal, Tata McGraw Hill, New Delhi


**Course Outcome:**

After learning the course the students will be able to

1. Understand the standards and common cases as well as dimensioning in technical drawings development.
2. Able to develop multi-aspect sketches, sectional views and geometries of the development of design projects.
3. Visualize objects in all dimensions and learn displaying techniques for graphical communication in design process.
4. Use computer software for engineering drawing.

**List of Practical:**

Students must prepare sketch book and drawing sheets on the following topics. **Minimum three problems must be given for sheet number 3 to 9.**

1. Practice sheet (which includes dimensioning methods, different types of line, construction of different polygon, divide the line and angle in parts, use of stencil)
2. Plane scale and diagonal scale

3. Loci of points (only sketch book)
4. Engineering curves
5. Projection of line
6. Projection of plane
7. Projection of solid, section of solid and development of surfaces
8. Orthographic projection
9. Isometric projection
10. At least one orthographic drawing (three views) using above mentioned AutoCAD commands.

**Major Equipment:**

**List of Open Source Software/learning website:**

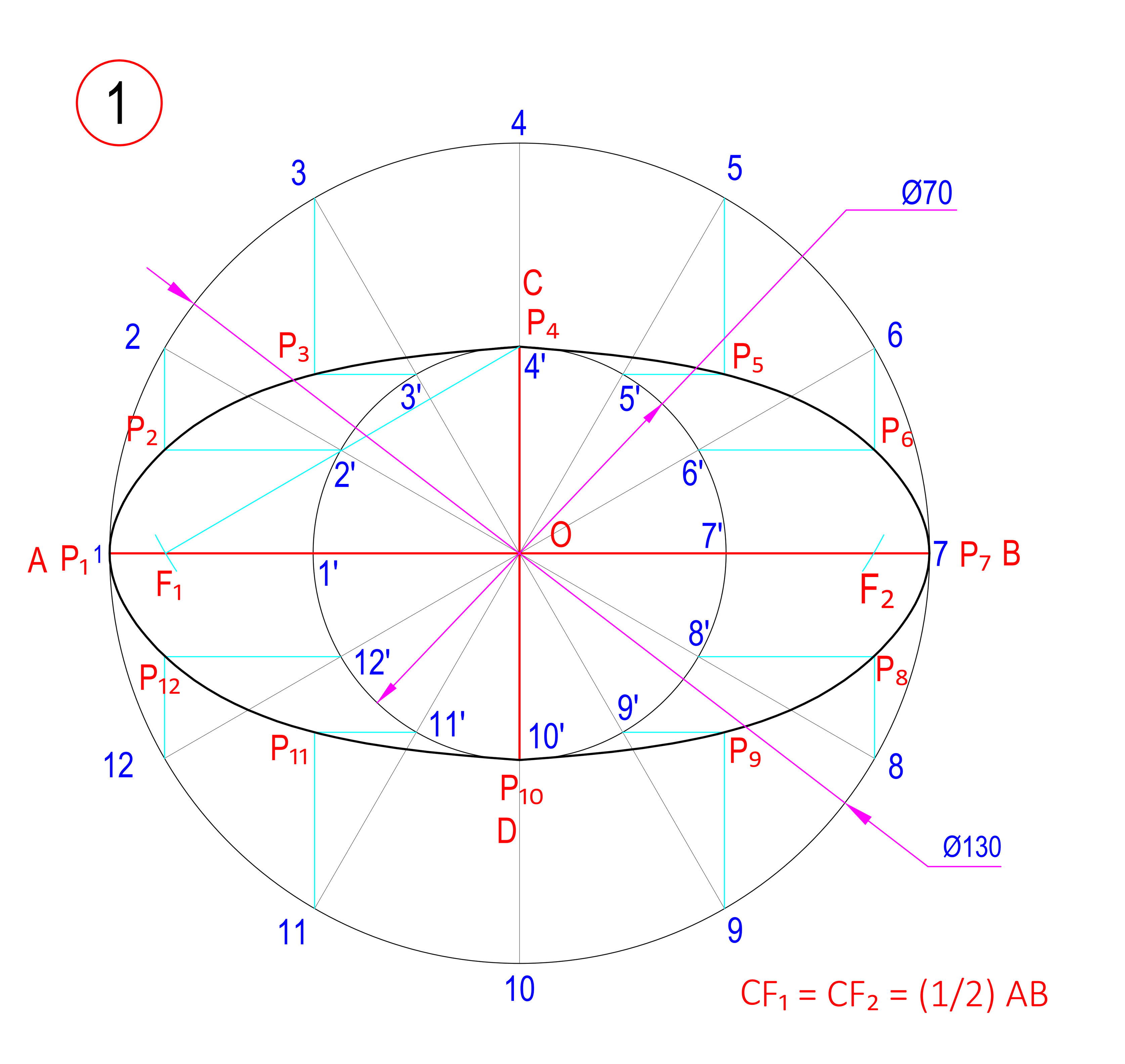
# Drawing Sheet Examples

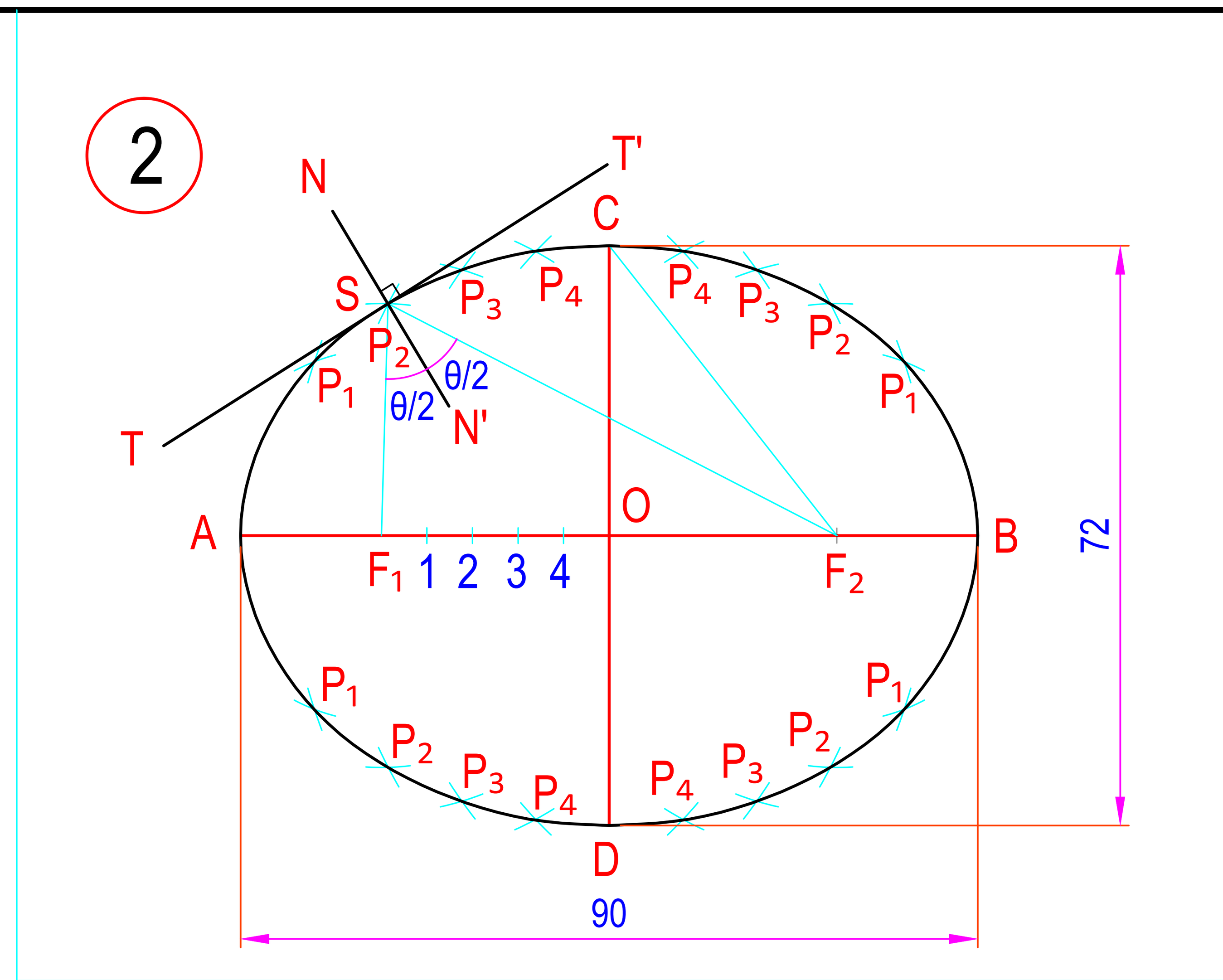
| Sheet No. | Title | Sheet Problem |
|---|---|---|
| 1 | Practice Sheet | SP - 46 |
| 2 | Plain and Diagonal Scale | 8,10,15,19,22 |
| 3 | Loci of Point | 2,6,8,11,14,17 |
| 4 | Engineering Curve | 5,15,18,24,39,44 |
| 5 | Projection of Line | 3,9,11,13,16,31 |
| 6 | Projection of Plane | 4,6,11,20 |
| 7 | Projection, Section of Solid & Development of surfaces | 8,30,45,53 |
| 8 | Orthographic Projection | 5,14,19 |
| 9 | Isometric Projection and View | 4,5,7,8,10 |
| 10 | Drawing sheet by using AutoCAD Command | Any Problem of Orthographic Projection |

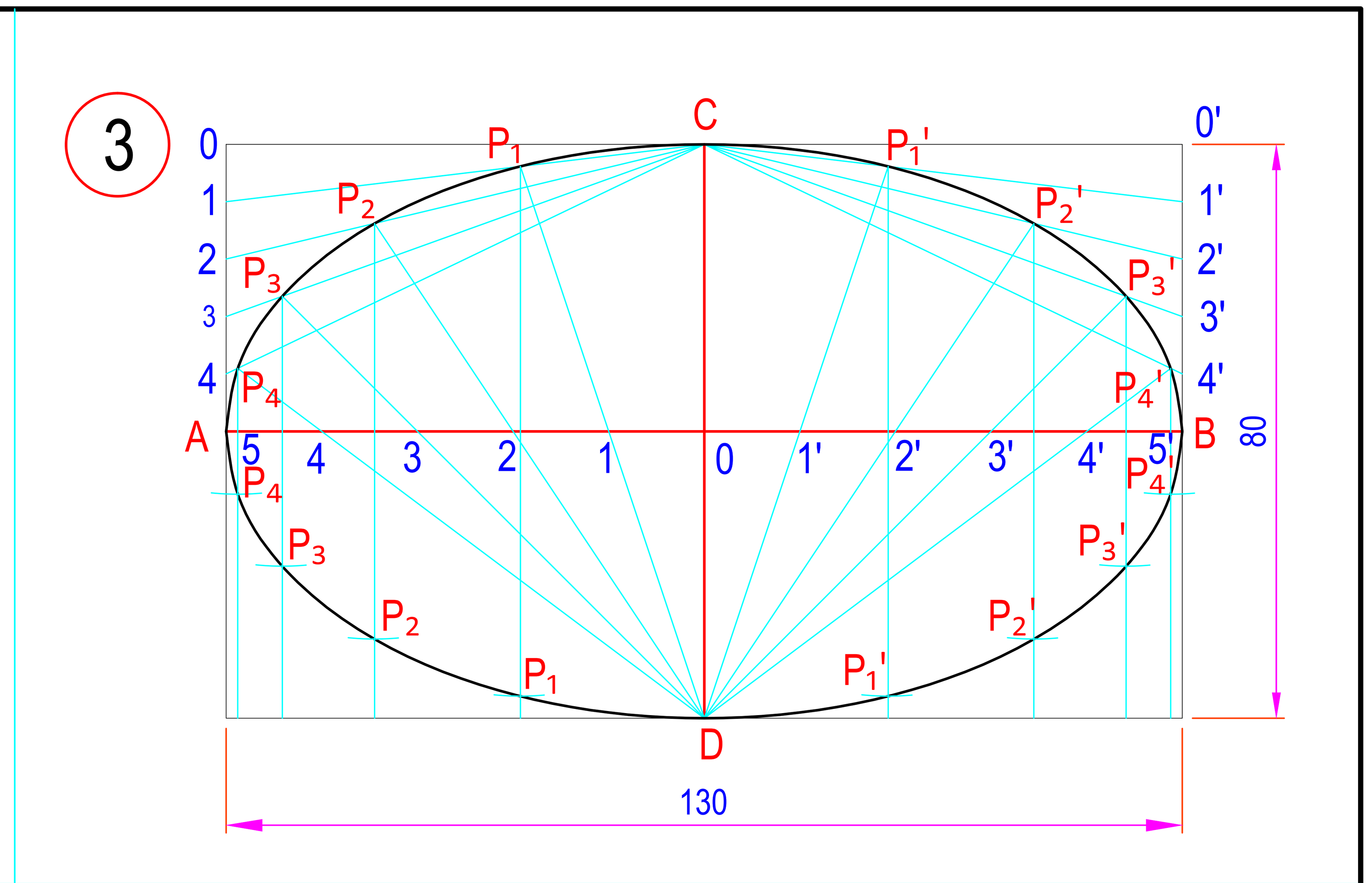
# Sketchbook Examples

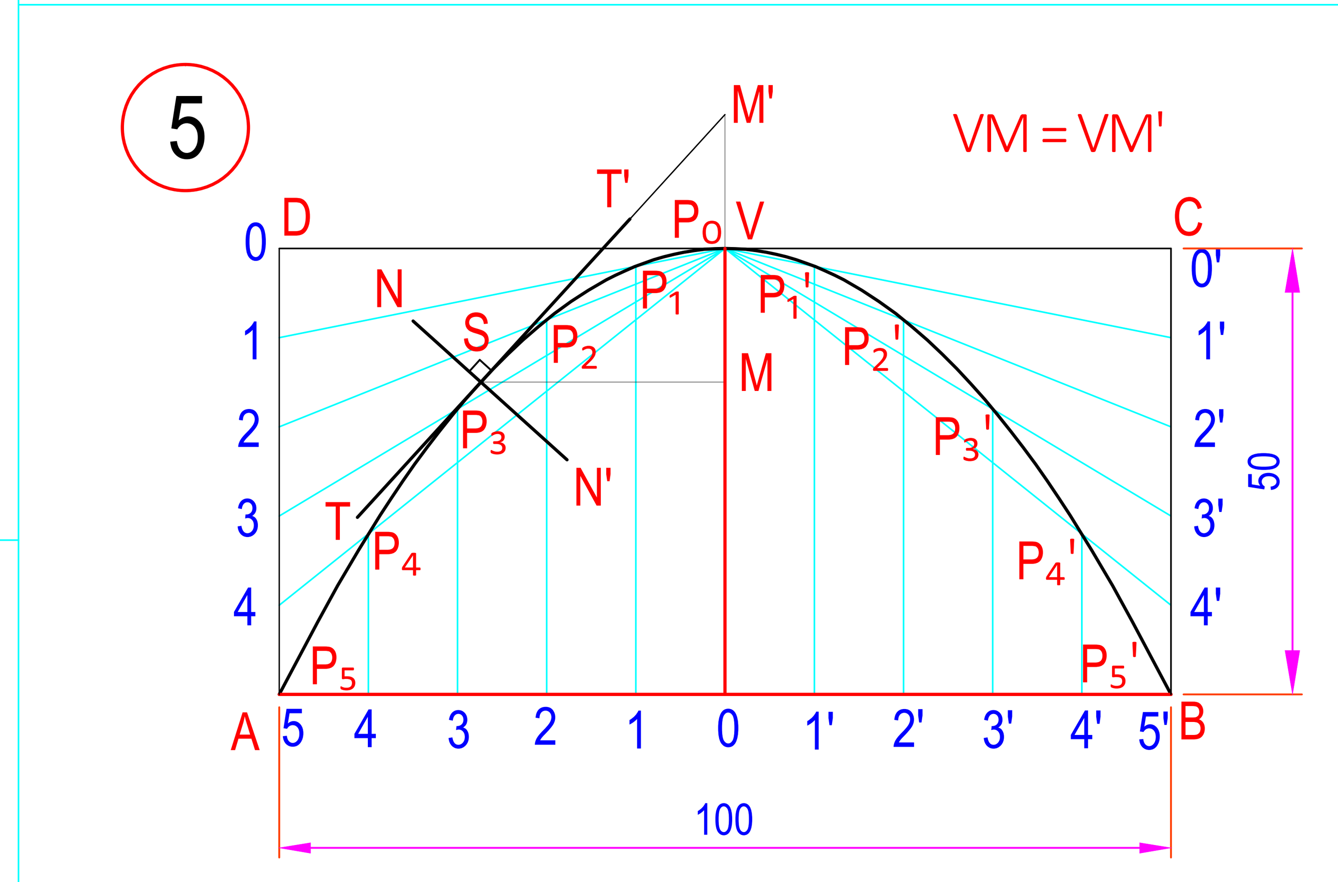
| Unit No. | Title | Problem Numbers |
|---|---|---|
| 1 | Plain and Diagonal Scale | 7 to 22 & 24 |
| 2 | Loci of Point | 1, 2, 3, 4, 5, 6,8,9,10,11,12,14,16, 17,18 |
| 3 | Engineering Curve | 3, 5, 6,8,13,15,17,18,19,22,23,24, 27,30,34,38,39,41,42,43,44 |
| 4 | Projection of Line | 1,2,3,5,7,8,9,11,13,16, 18, 20, 22, 31,35 |
| 5 | Projection of Plane | 1, 3, 4, 5,6,7,9,10,11,13,16,18,20, 21,24 |
| 6 | Projection, Section of Solid & Development of surfaces | 3,4,5,6,8,9,10,11,13,14,15,16,20, 23, 24, 25, 26, 29,30,32,34,35,37, 44,45,49,50,51,52,53,54,56,59,61 |
| 7 | Orthographic Projection | 5 to 20 |
| 8 | Isometric Projection and View | 4,5,7,8,10 |

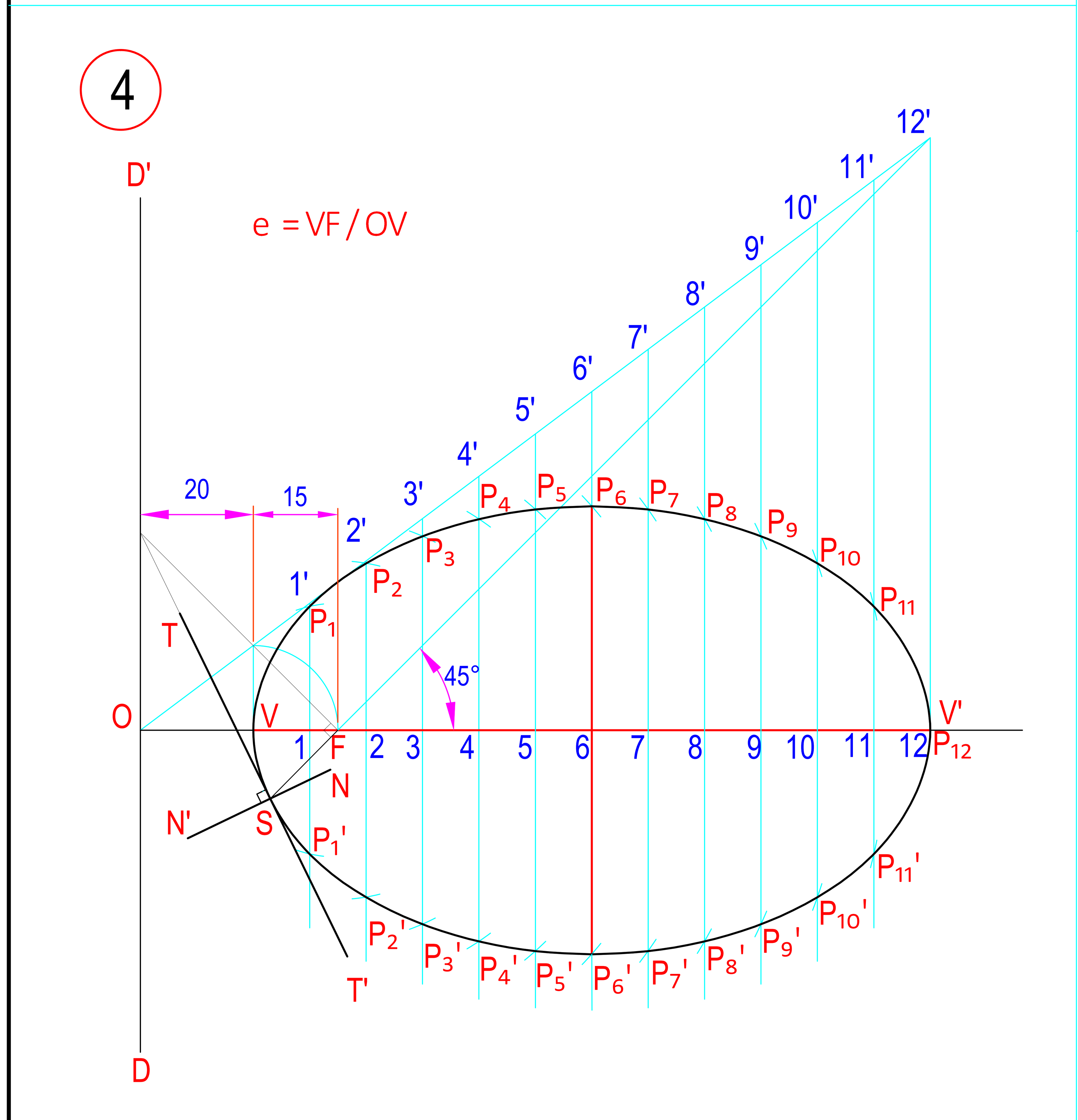

1 VARIOUS ANGLES (USING SETS SQUARE)
30° 45° 60° 30°+ 45° 90°
45°+ 60° 30°+ 90° 45°+ 90° 60°+ 90°
30° 45° 60° 75° 90° 105° 120° 135° 150°
2 ALPHABETS & NUMBERS
A B C D E F G H I J K L M N
O P Q R S T U V W X Y Z
1 2 3 4 5 6 7 8 9 0
10
3 POLYGONES
60° 90° 72° 108° 60°
20 20 20 20
4 DIMENSIONING SYSTEM
ALIGNED SYSTEM
20 Ø20 30 50 60° R20 50
UNIDIRECTIONAL SYSTEM
20 Ø20 30 50 60° R20 50
5 TYPES OF LINES
CONTINUOUS THICK (0.5)
CONTINUOUS THIN (0.2)
DASHED LINE (0.3)
4 or 6
2 or 3
CENTER LINE (0.2)
2 or 3
2 or 3
10 or 20
CUTTING LINE (0.2 & 0.5)
THIN WAVY LINE (0.2)
SHORT ZIGZAG THIN (0.2)
DIMENSION - ARROW (0.2)
X 3X
(VALUES IN BRACKET SHOWS THICKNESS IN mm)
6 USES OF LINES
BORDER LINE
DIMENSION LINE
OUTER LINE
EXTENSION LINE
HIDDEN LINE
CENTER LINE
SECTION LINE
30 20 40 30 70 Ø15
A A
CUTTING PLANE LINE
LEADER LINE
PROJECTION LINE
ALL DIMENSIONS ARE IN mm.
DATE SIGN
STD.
CKD.
COMP.
B.E. 1st SEM ME
B. R. DABHI
090540119000
SCALE - 1:1
DARSHAN INSTITUTE OF ENGG. & TECH. RAJKOT
SP 46
PRACTICE SHEET
DRG NO. 1

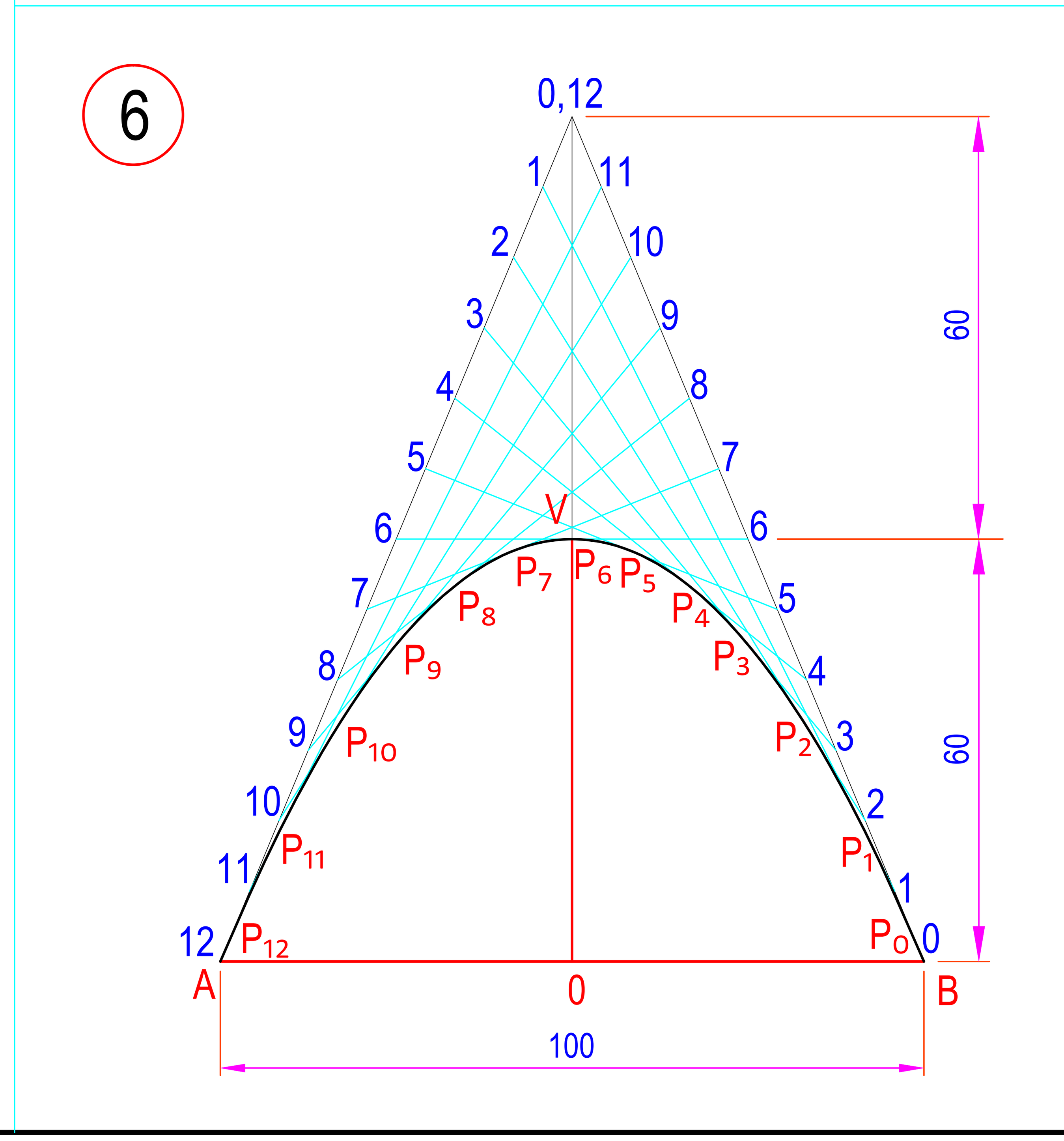


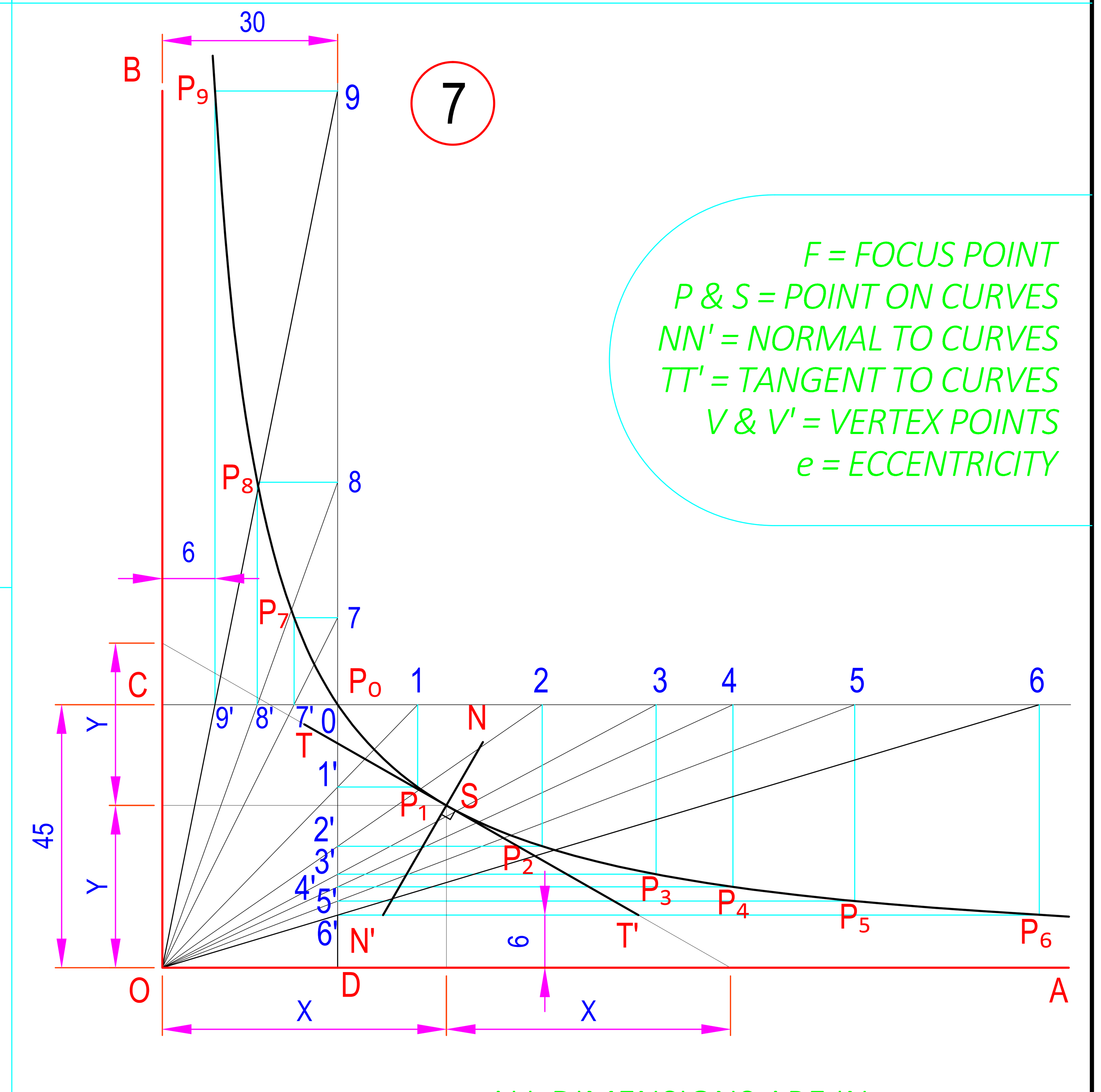




*F = FOCUS POINT*
*P & S = POINT ON CURVES*
*NN' = NORMAL TO CURVES*
*TT' = TANGENT TO CURVES*
*V & V' = VERTEX POINTS*
*e = ECCENTRICITY*

ALL DIMENSIONS ARE IN mm.

| | DATE | SIGN | DARSHAN INSTITUTE OF ENGG. & TECH. RAJKOT |
|---|---|---|---|
| STD. | | | |
| CKD. | | | ENGINEERING CURVES |
| COMP. | | | CONICS |
| B.E. 1st SEM ME | | | |
| D. A. SOLANKI | | | DRG NO. 2 |
| 090540119000 | | | |
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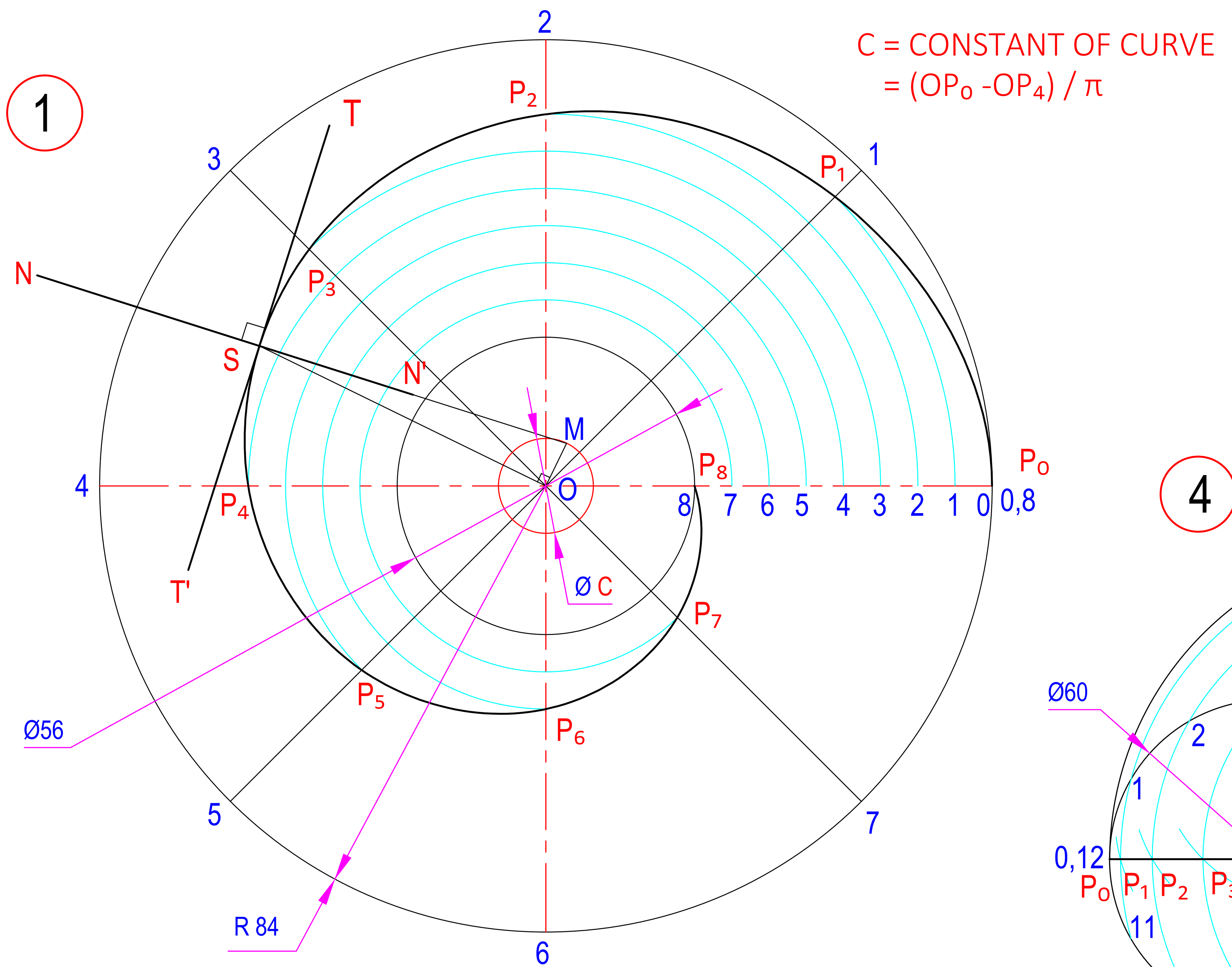
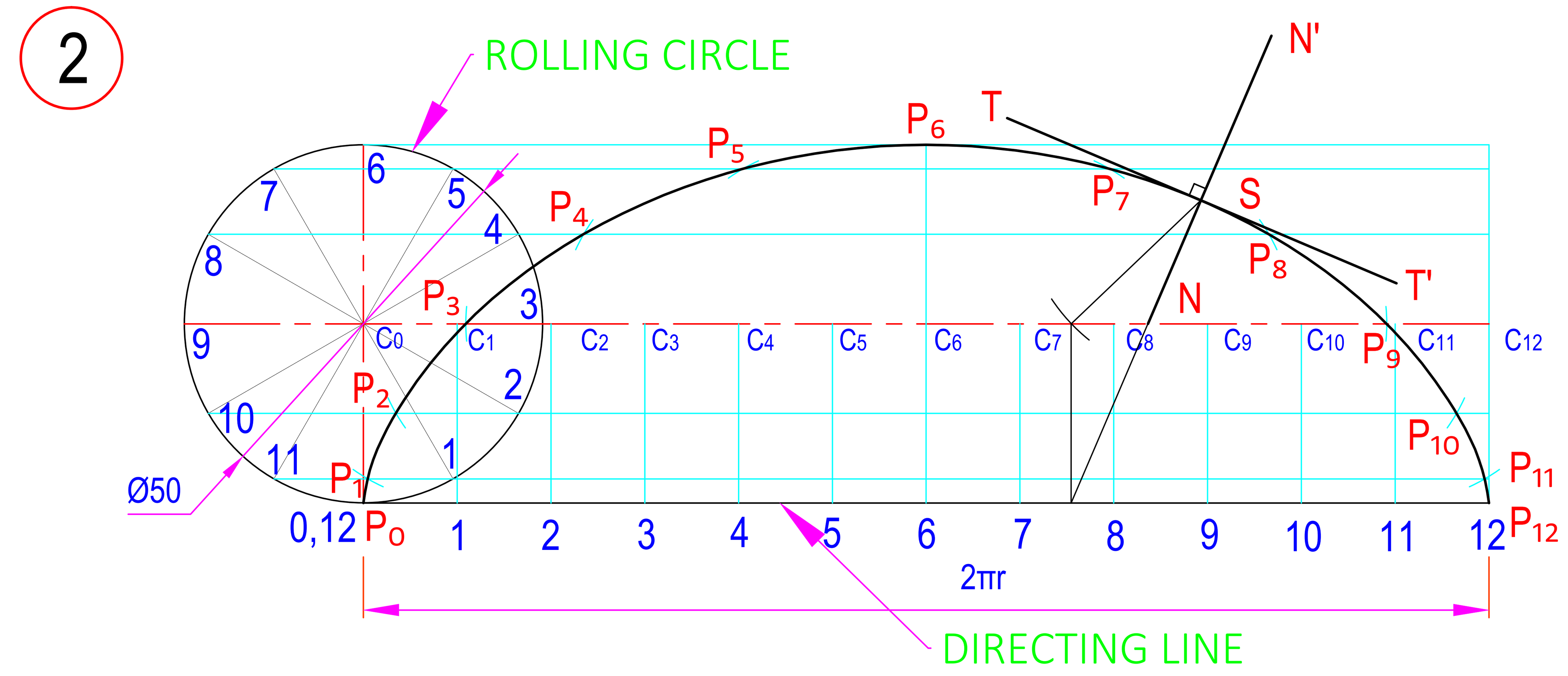
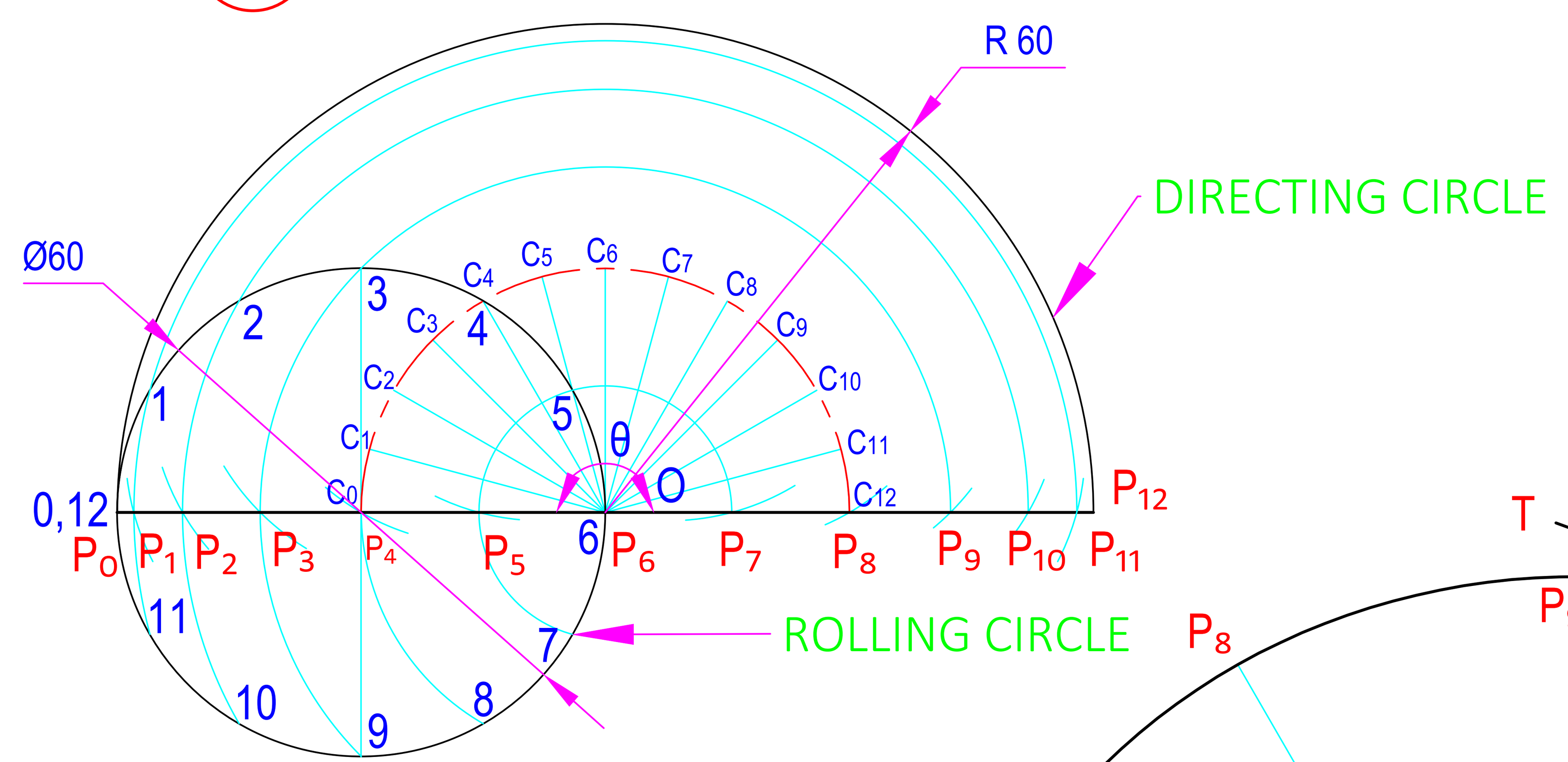
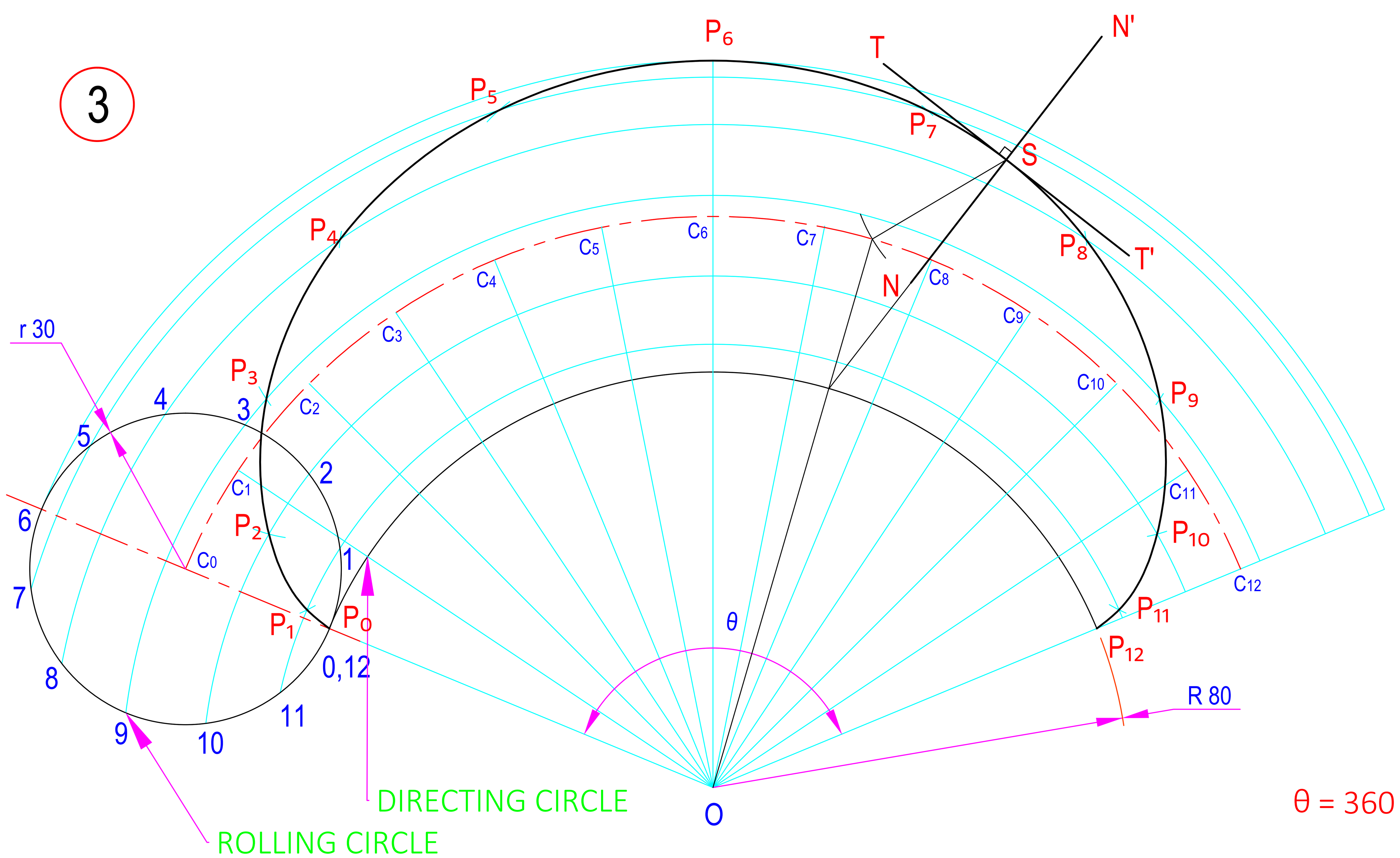
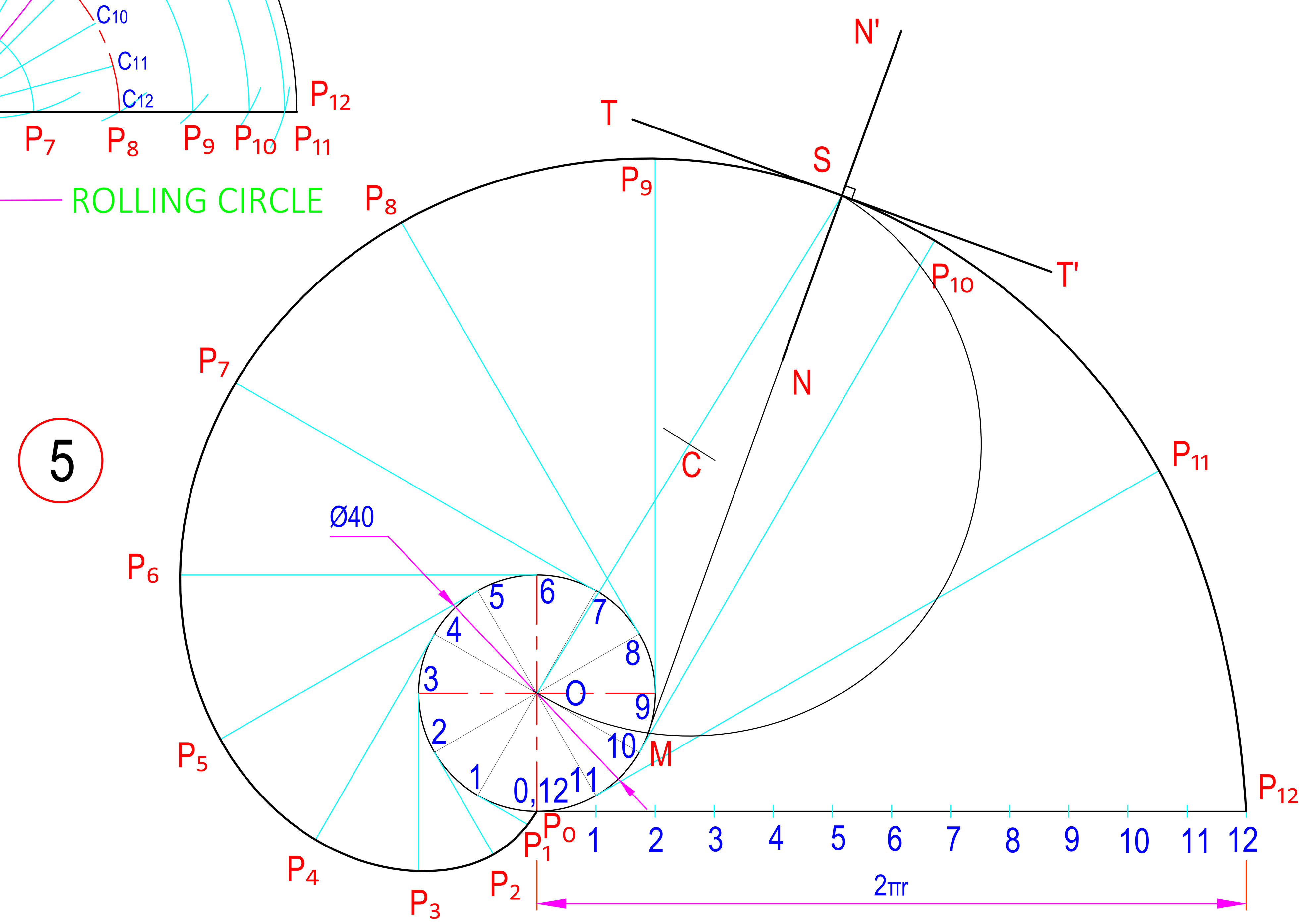


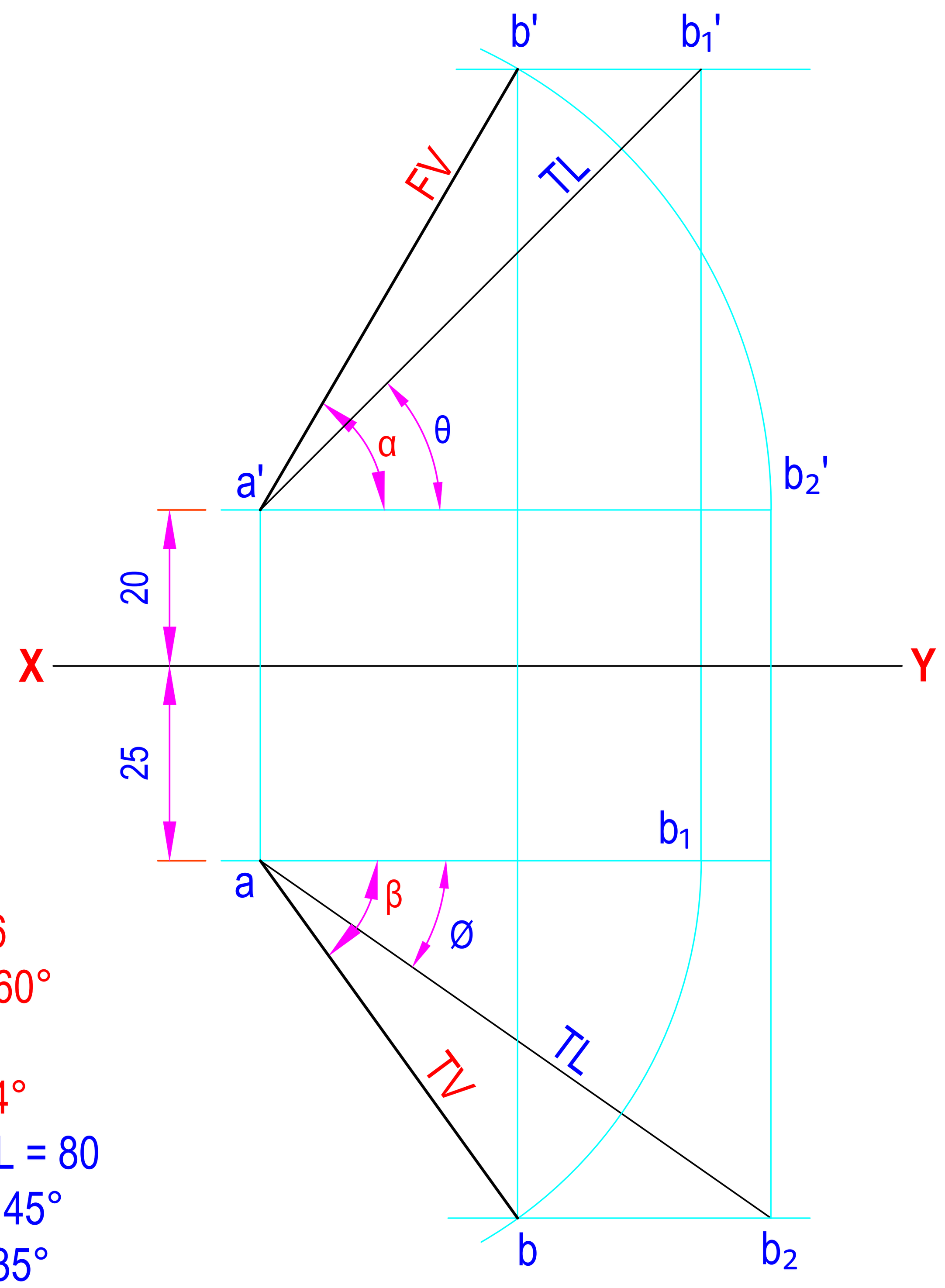




ALL DIMENSIONS ARE IN mm.

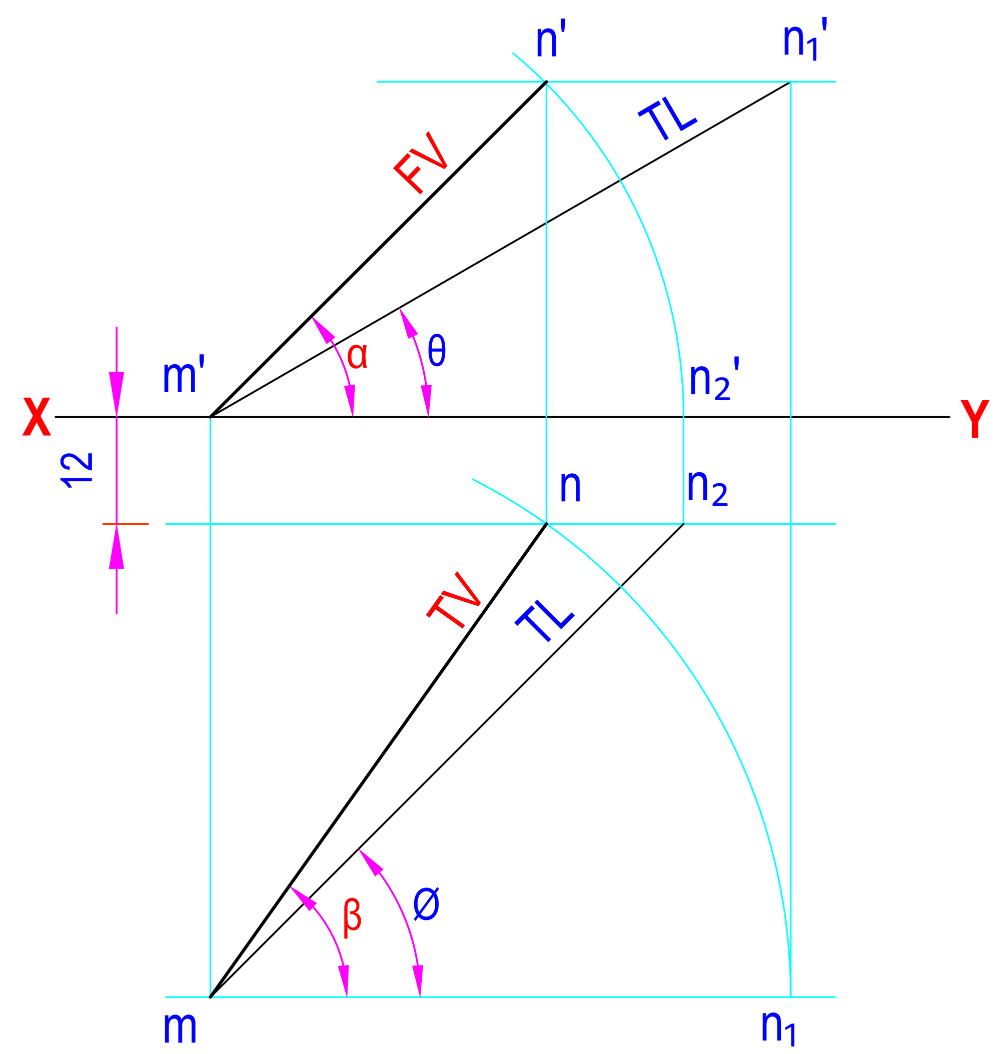
| | DATE | SIGN | DARSHAN INSTITUTE OF ENGG. & TECH. RAJKOT |
|---|---|---|---|
| STD. | | | ENGG. CURVES:CYCLOID INVOLUTE & SPIRAL |
| CKD. | | | |
| COMP. | | | |
| B.E. 1st SEM ME | | | |
| S. P. PANSURIA | | | DRG NO. 3 |
| 090540119000 | | | |
| SCALE - 1:1 | | | |

1




$a'b' = LFV = 66$
$\angle b'a'b_2' = \alpha = 60°$
$ab = LTV = 57$
$\angle bab_1 = \beta = 54°$
$a'b_1' = ab_2 = TL = 80$
$\angle b_1'a'b_2' = \theta = 45°$
$\angle b_2ab_1 = Ø = 35°$

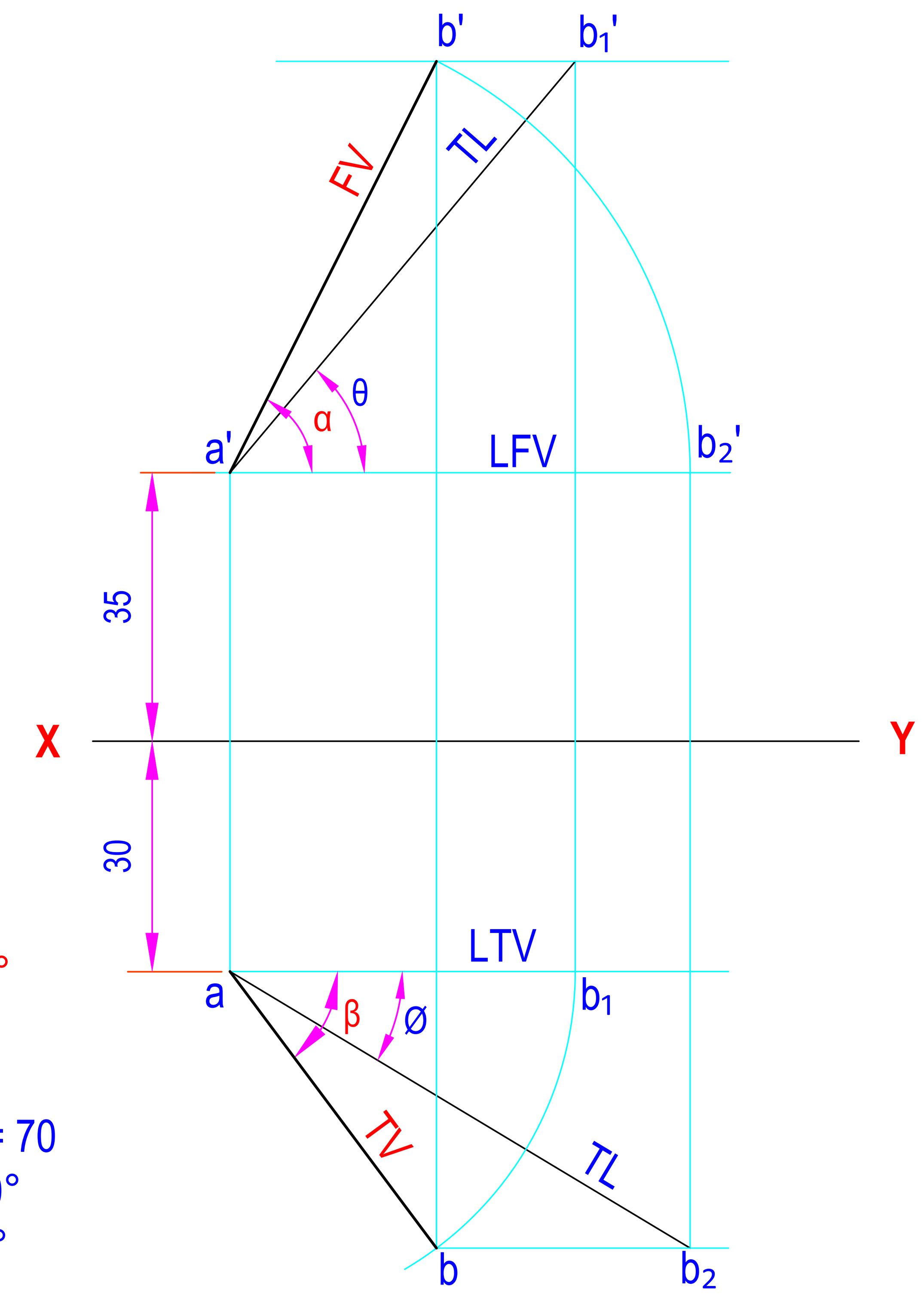
2




$m'n' = LFV = 53$
$\angle n'm'n_2' = \alpha = 45°$
$mn = LTV = 65$
$\angle nmn_1 = \beta = 55°$

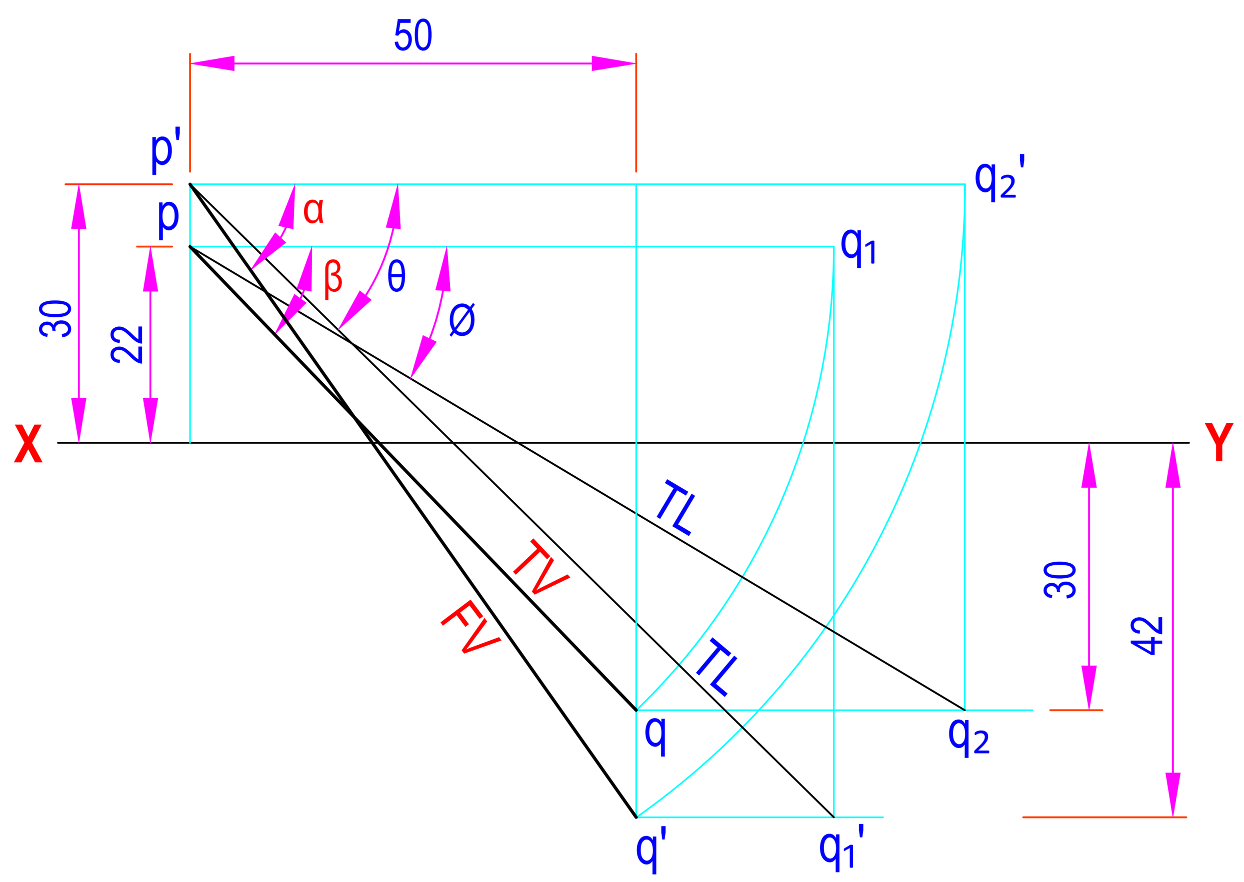
$m'n_1' = mn_2 = TL = 75$
$\angle n_1'm'n_2' = \theta = 45°$
$\angle n_2mn_1 = Ø = 30°$

3




$a'b' = LFV = 60$
$\angle b'a'b_2' = \alpha = 63°$
$ab = LTV = 45$
$\angle bab_1 = \beta = 53°$
$a'b_1' = ab_2 = TL = 70$
$\angle b_1'a'b_2' = \theta = 50°$
$\angle b_2ab_1 = Ø = 30°$

4

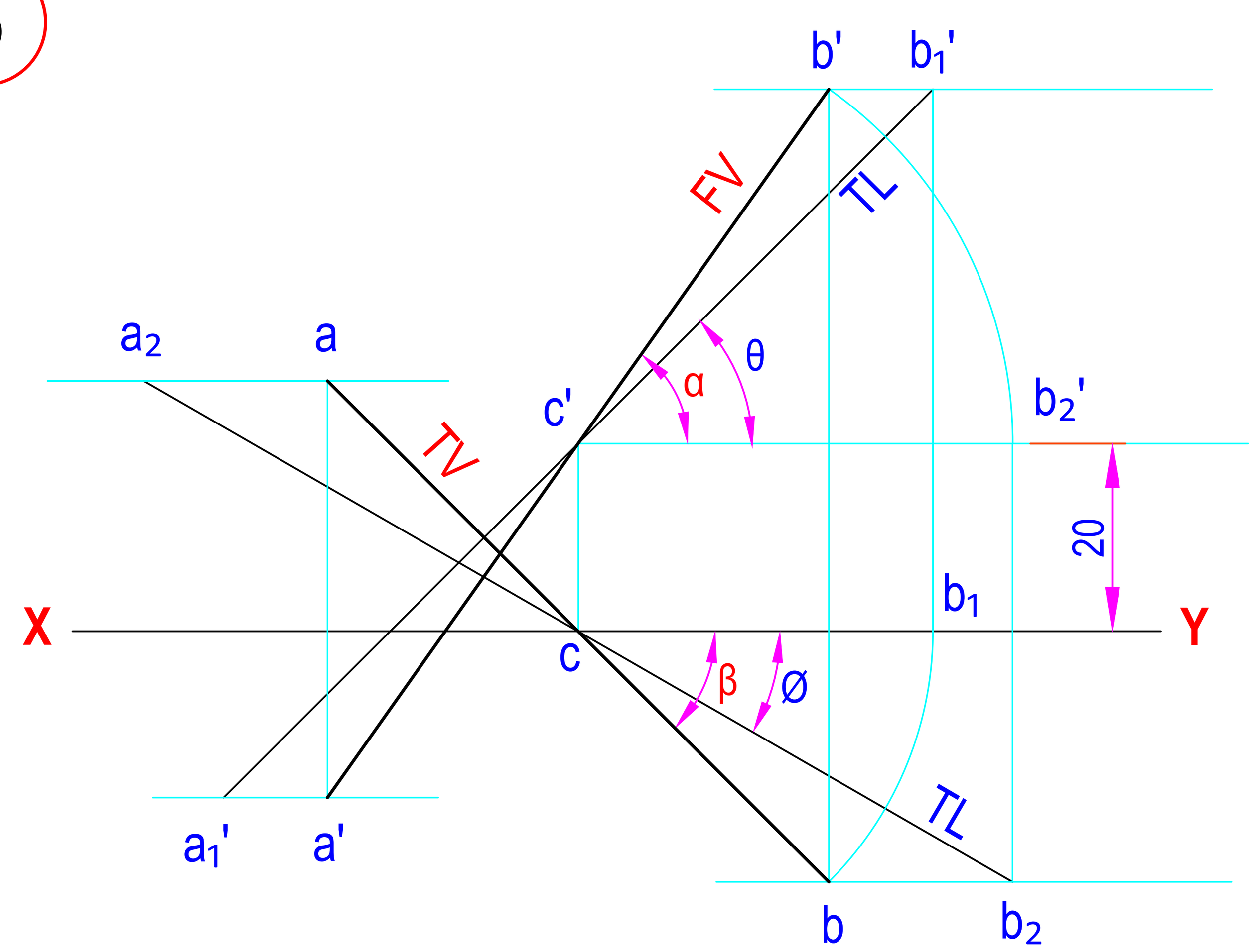



$p'q' = LFV = 90$
$\angle q'p'q_2' = \alpha = 55°$

$pq = LTV = 72$
$\angle qpq_1 = \beta = 46°$

$p'q_1' = pq_2 = TL = 105$
$\angle q_1'p'q_2' = \theta = 45°$
$\angle q_2pq_1 = Ø = 30°$

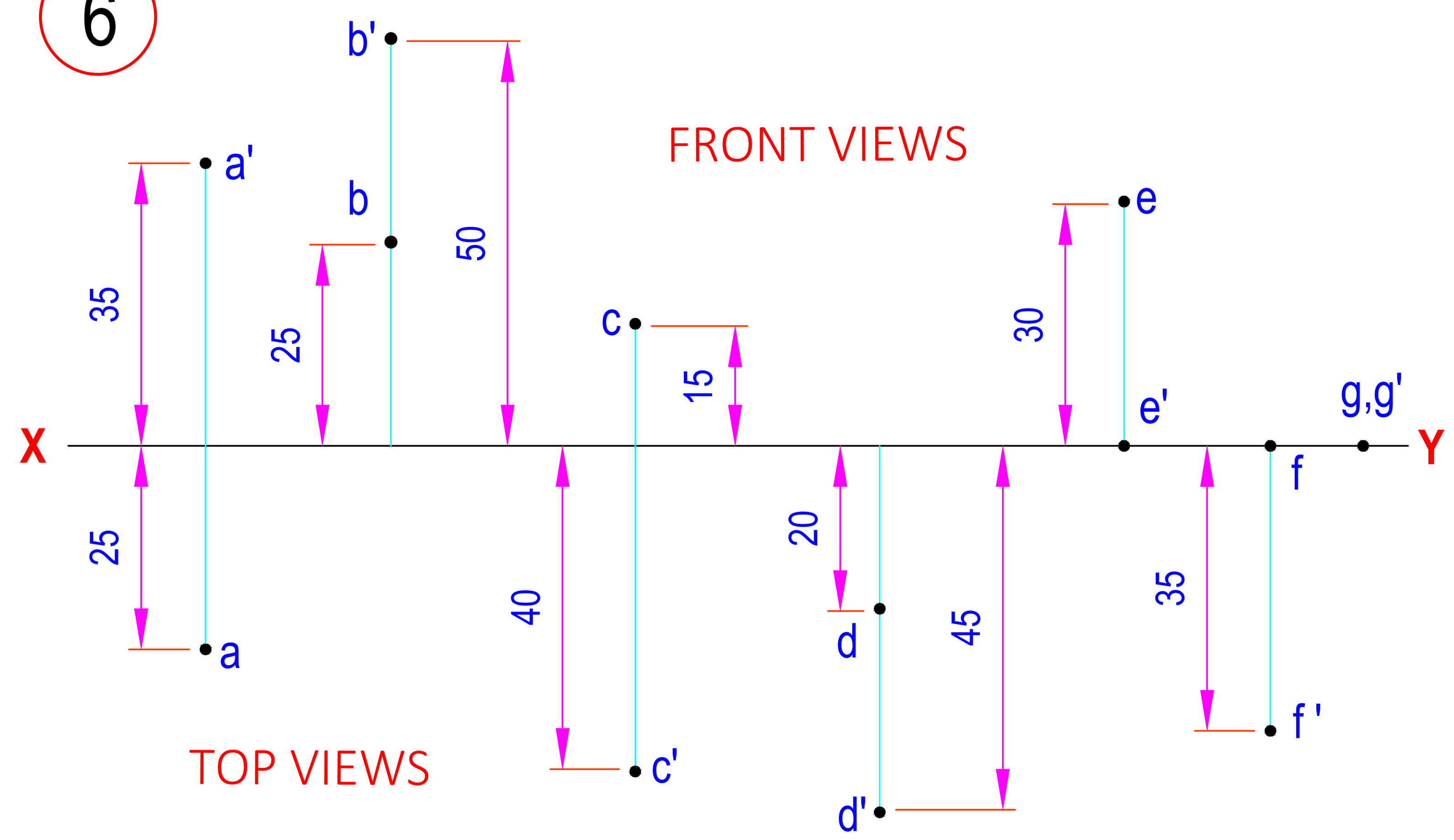
5




$a'b' = LFV = 97$
$\angle b'c'b_2' = \alpha = 55°$
$ab = LTV = 80$
$\angle b_1cb_2 = \beta = 45°$

$a_1'b_1' = a_2b_2 = TL = 112$
$\angle b_1'c'b_2' = \theta = 45°$
$\angle b_1cb_2 = Ø = 30°$

6




ALL DIMENSIONS ARE IN mm.

*LFV = LENGTH OF FRONT VIEW*
*LTV = LENGTH OF TOP VIEW*
*θ = INCLINATION OF TL WITH HP*
*Ø = INCLINATION OF TL WITH VP*
*α = INCLINATION OF FV WITH HP*
*β = INCLINATION OF TV WITH VP*
*FV = FRONT VIEW*
*TV = TOP VIEW*

| | DATE | SIGN | DARSHAN INSTITUTE OF ENGG. & TECH. RAJKOT |
|---|---|---|---|
| STD. | | | |
| CKD. | | | PROJECTIONS OF POINTS & LINES |
| COMP. | | | |
| B.E. 1st SEM ME | | | |
| P. B. PATEL | | | |
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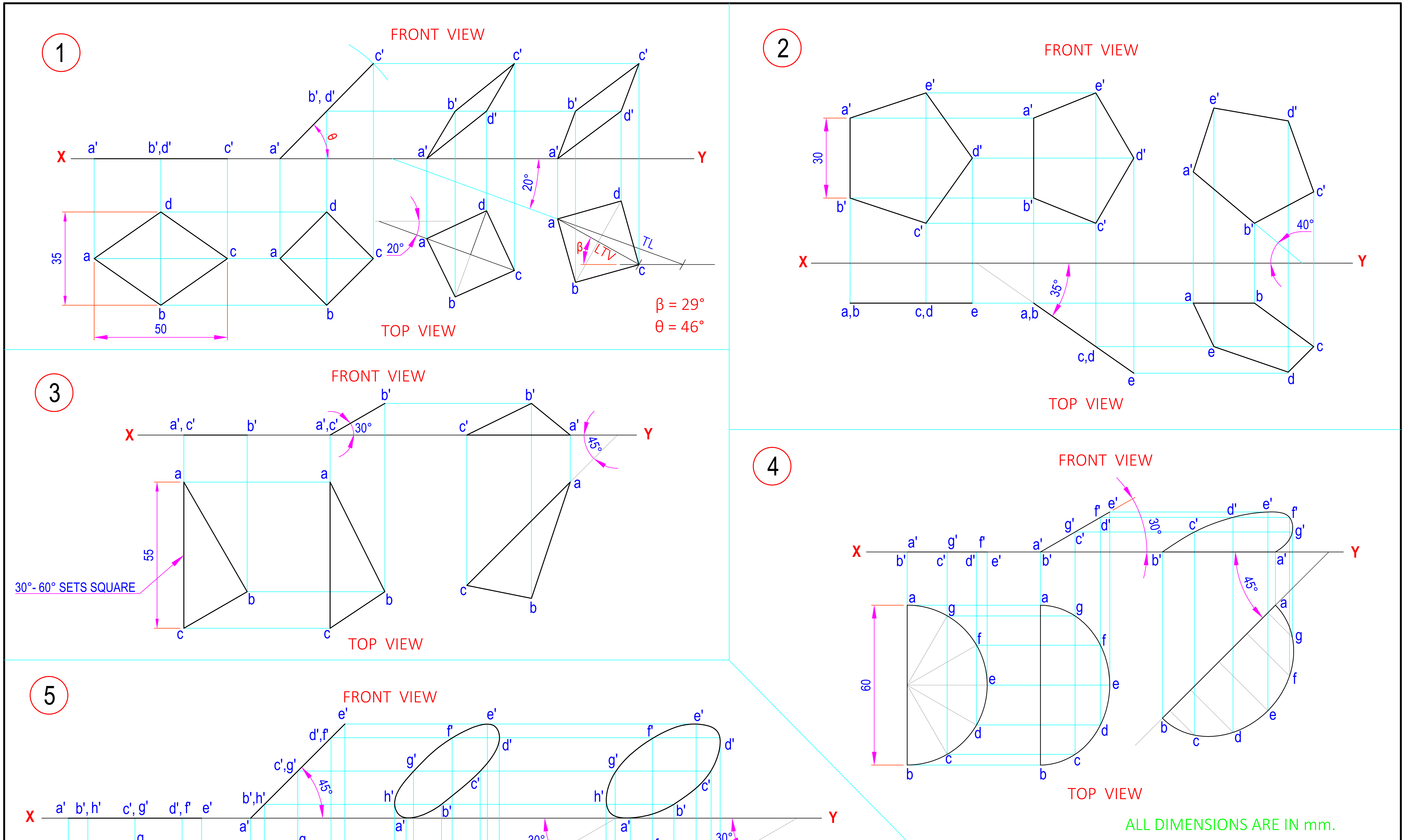
| SCALE - 1:1 | | | |

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|---|---|---|---|
| STD. | | | |
| CKD. | | | PROJECTIONS OF PLANES |
| COMP. | | | |
| B.E. 1st SEM ME | | | |
| D. S. DADHANIYA | | | |
| 090540119000 | | | DRG NO. 5 |
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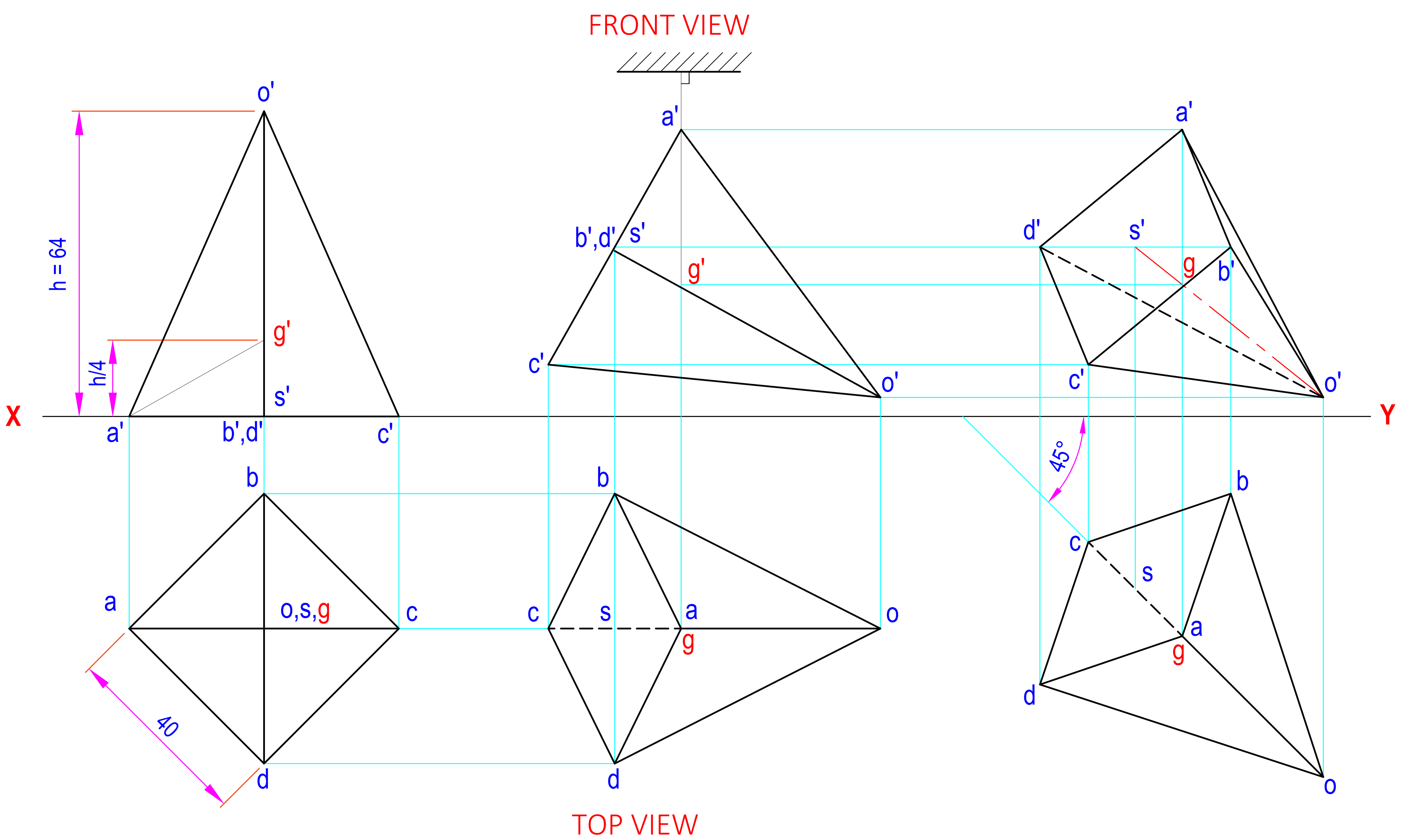
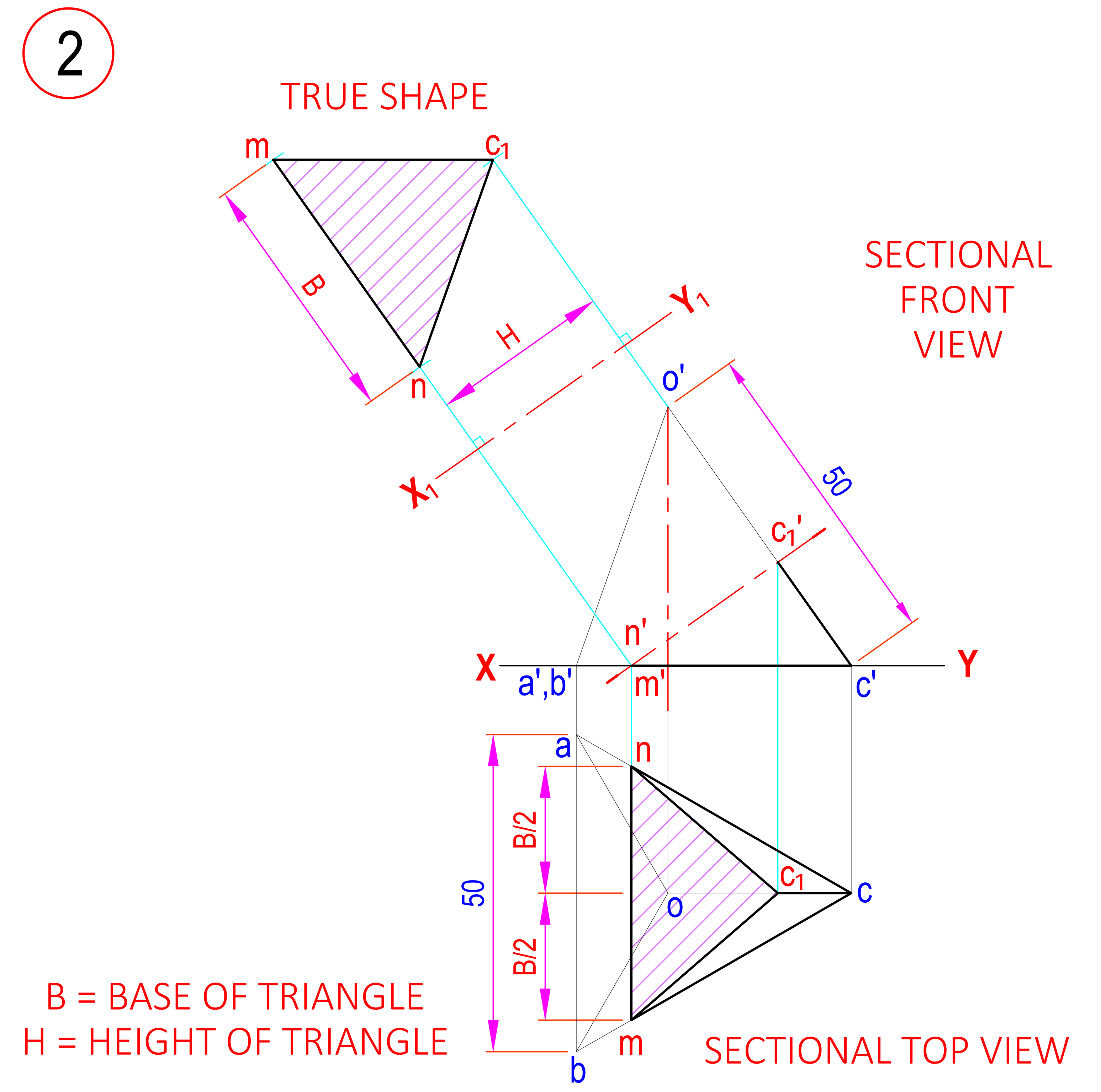
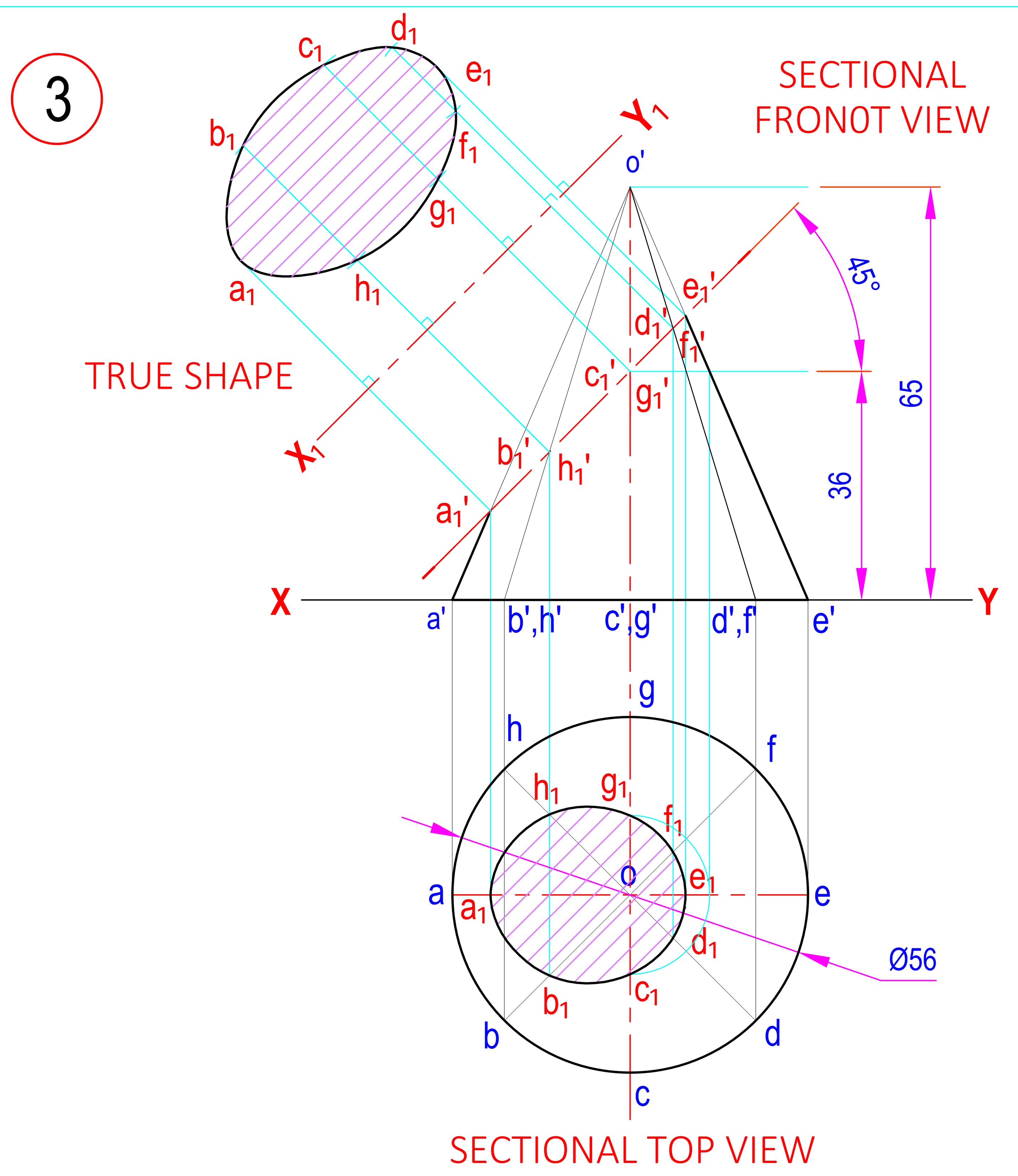
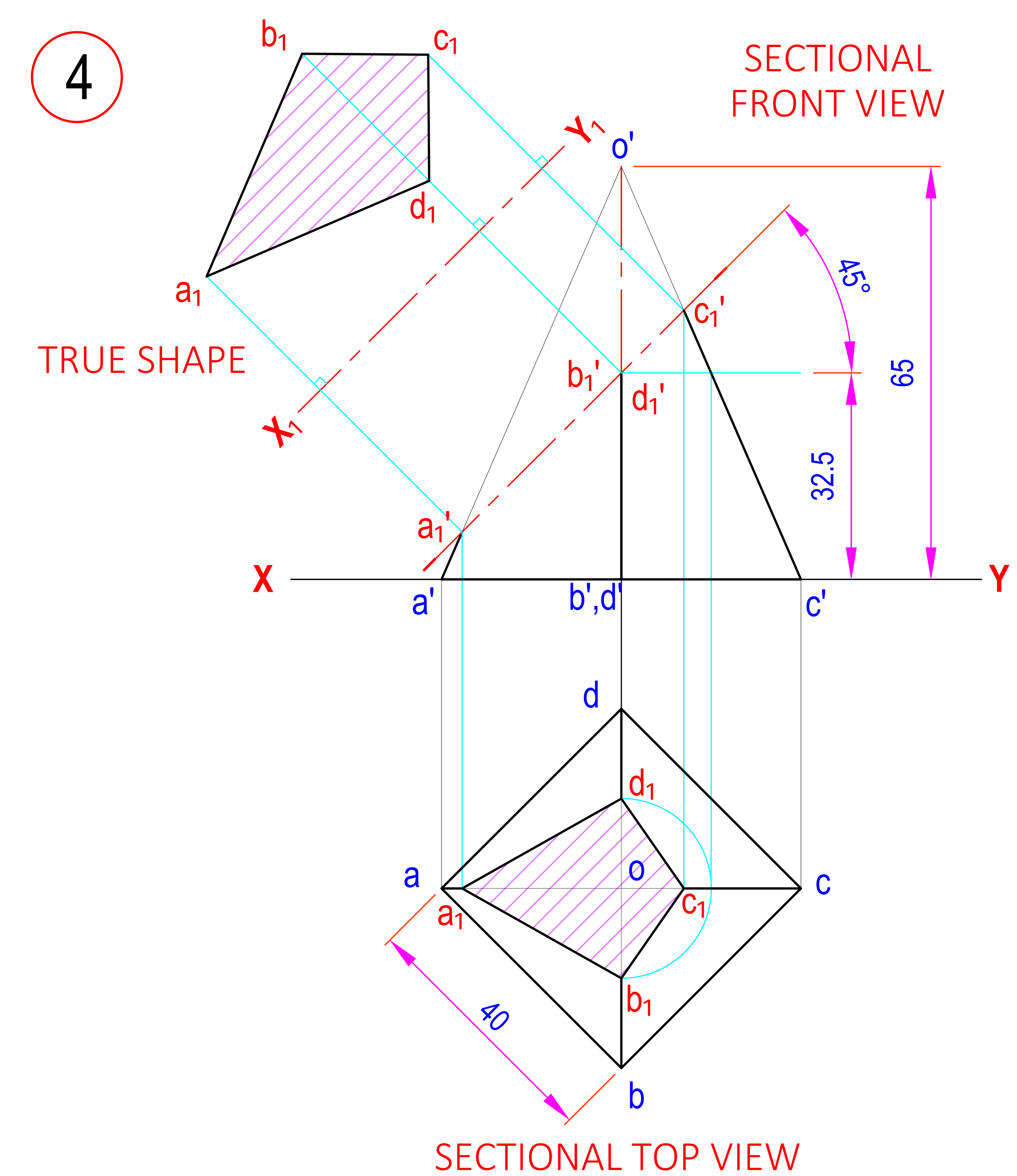
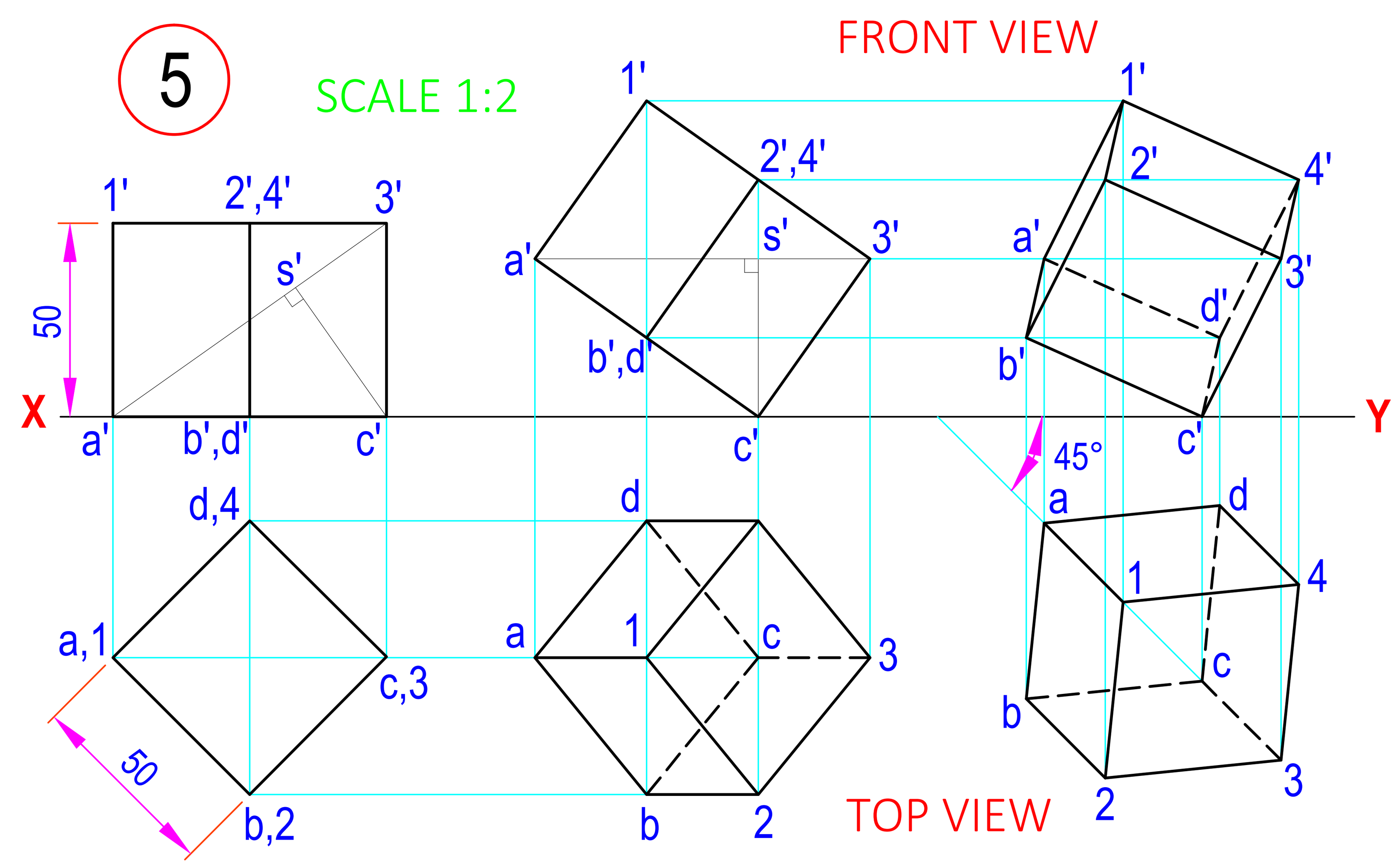


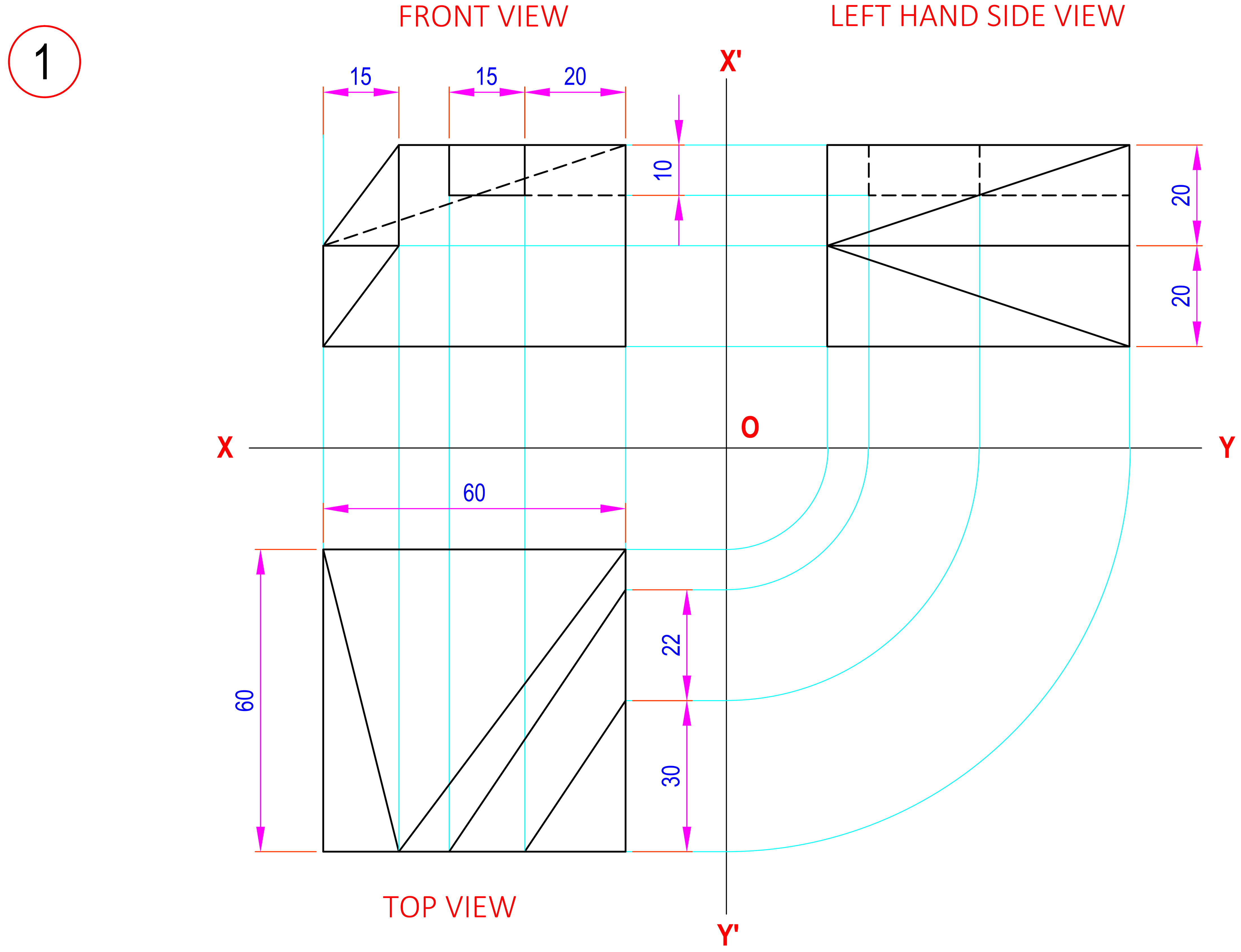



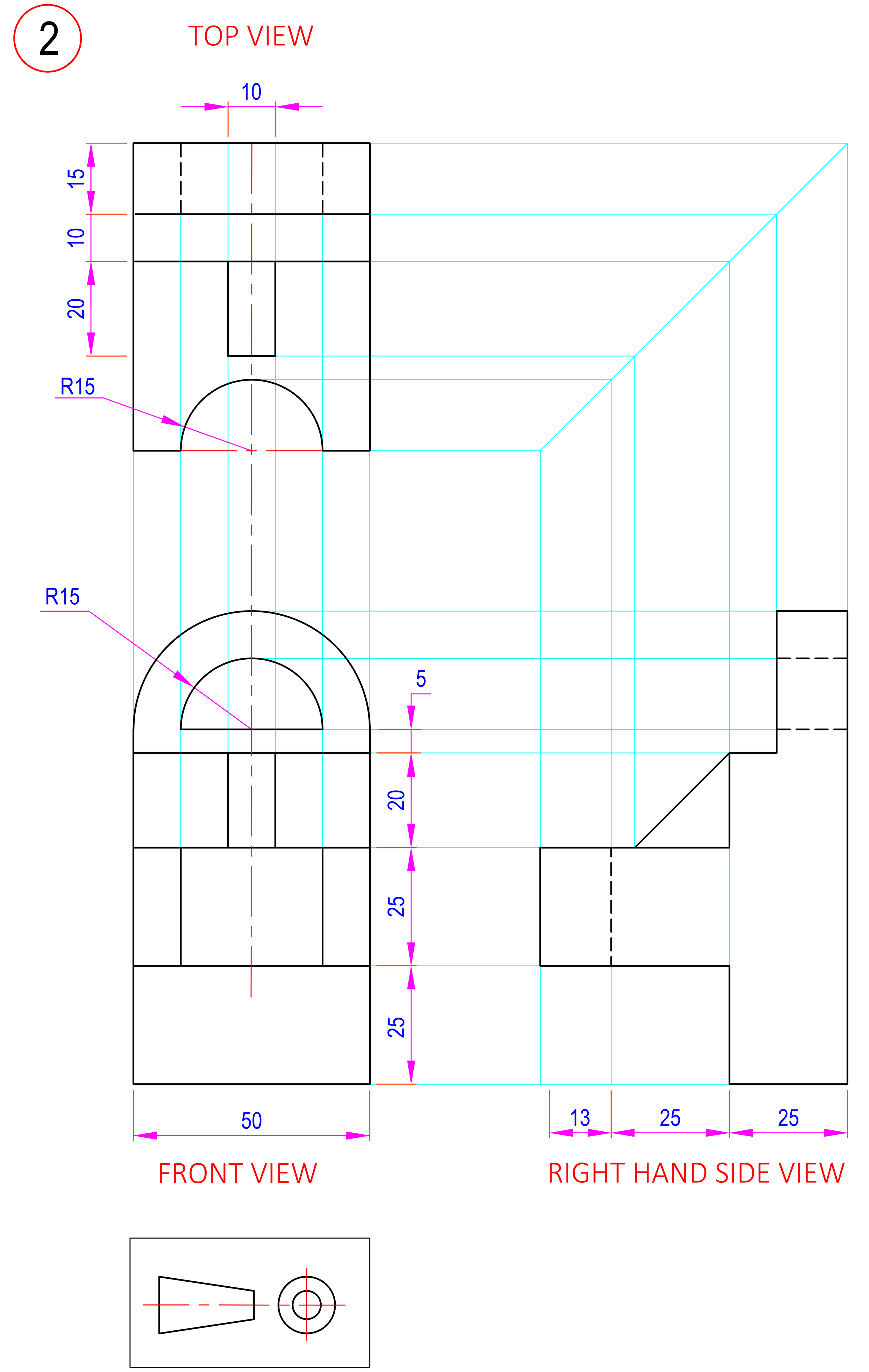



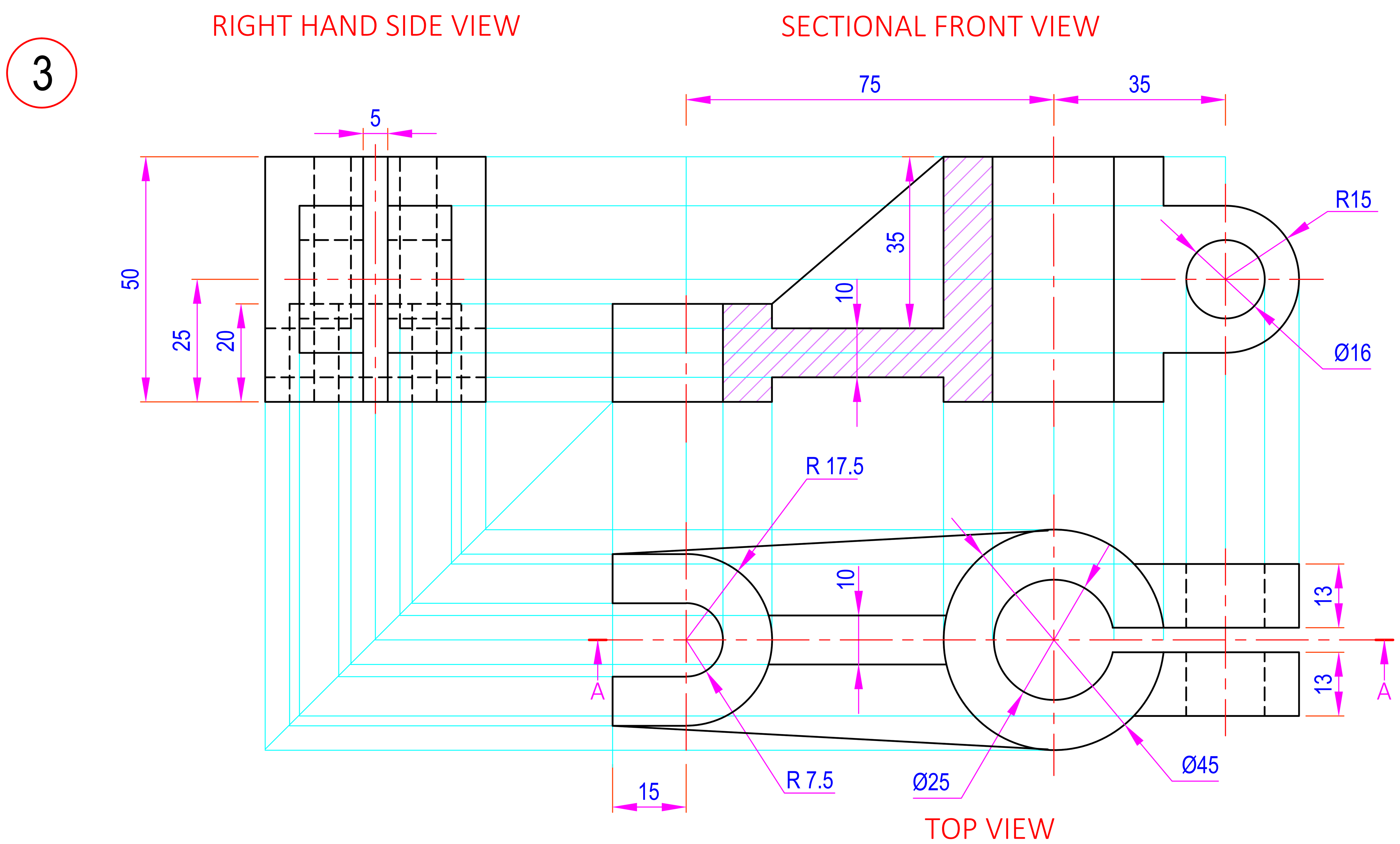




ALL DIMENSIONS ARE IN mm.

| | DATE | SIGN | DARSHAN INSTITUTE OF ENGG. & TECH. RAJKOT |
|---|---|---|---|
| STD. | | | |
| CKD. | | | |
| COMP. | | | PROJECTIONS & SECTIONS OF SOLIDS |
| B.E. 1st SEM ME | | | |
| K. R. PADSUMBIYA | | | |
| 090540119000 | | | DRG NO. 6 |
| SCALE - 1:1 | | | |



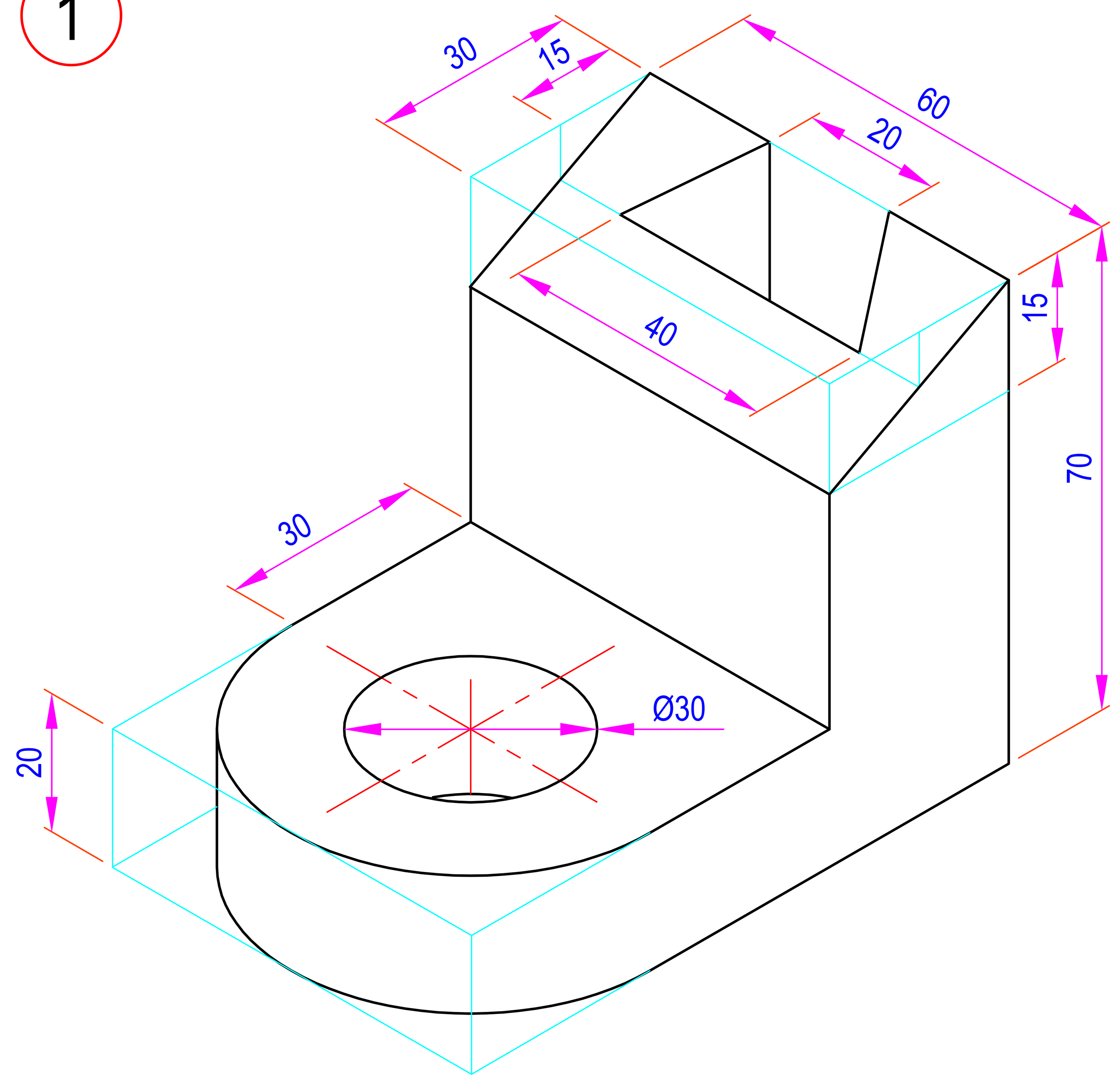




ALL DIMENSIONS ARE IN mm.

| | DATE | SIGN | DARSHAN INSTITUTE OF ENGG. & TECH. RAJKOT |
|---|---|---|---|
| STD. | | | |
| CKD. | | | ORTHOGRAPHIC PROJECTIONS |
| COMP. | | | |
| B.E. 1st SEM ME | | | |
| A. N. TANK | | | |
| 090540119000 | | | DRG NO. 7 |
| SCALE - 1:1 | | | |

1

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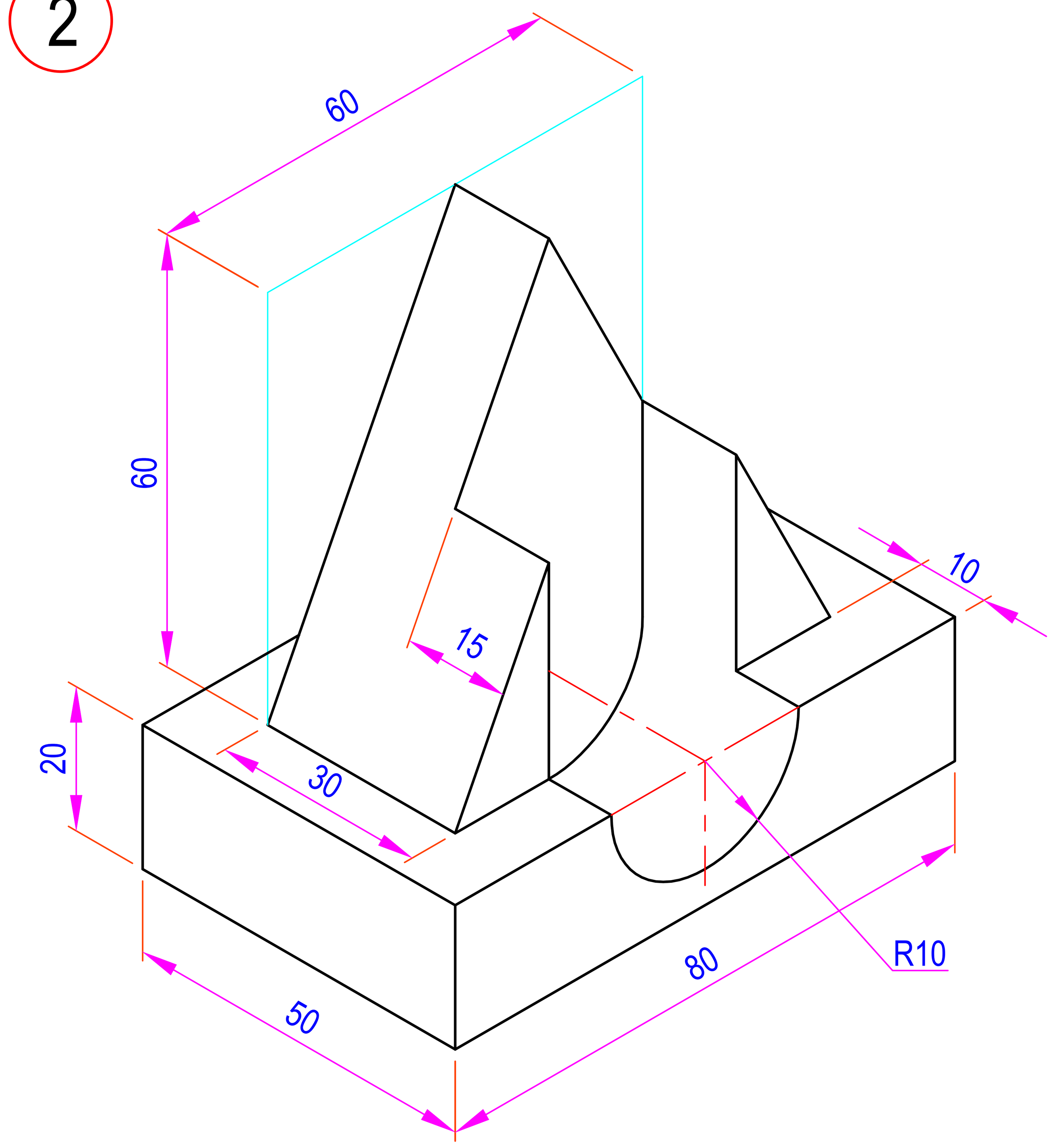


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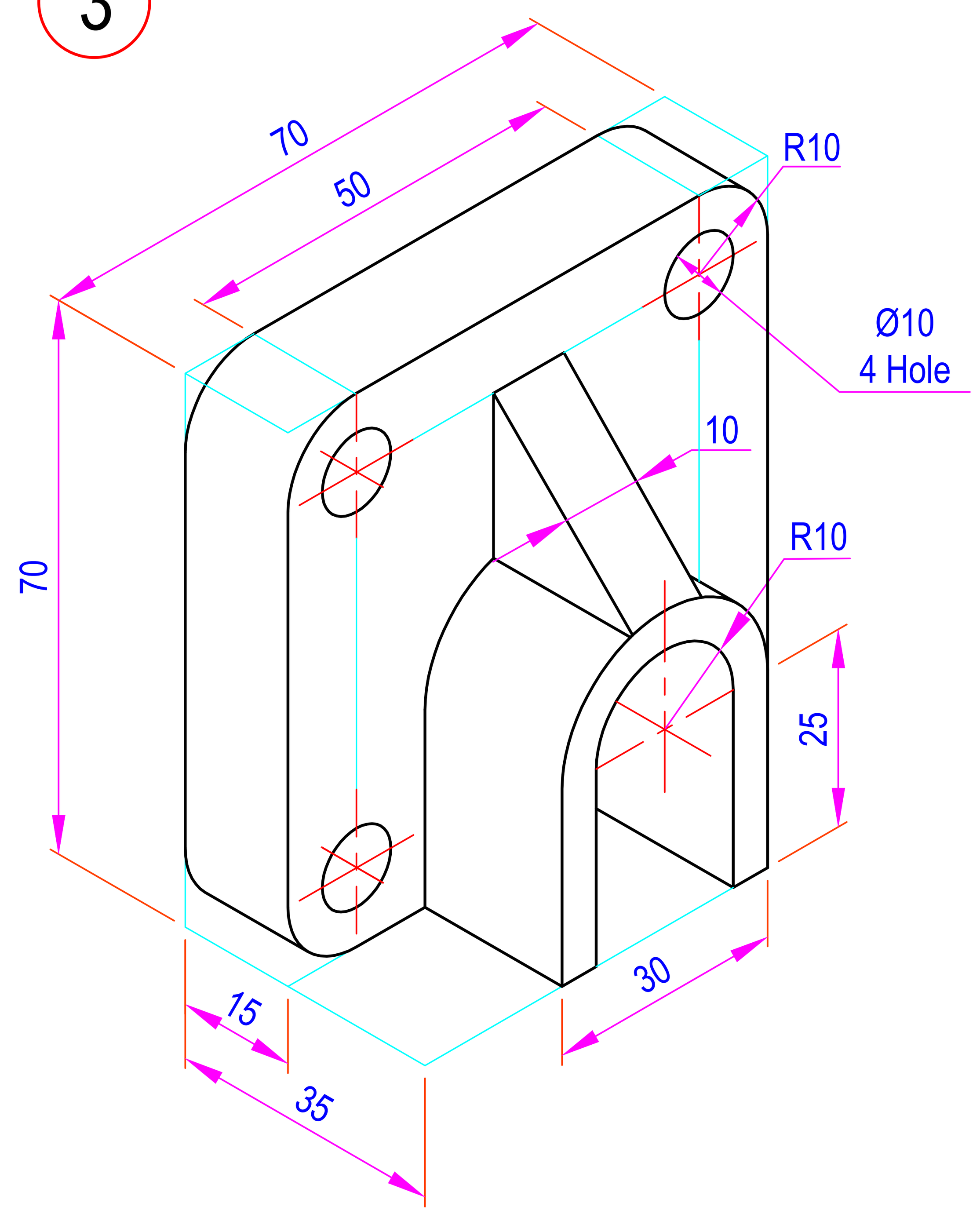
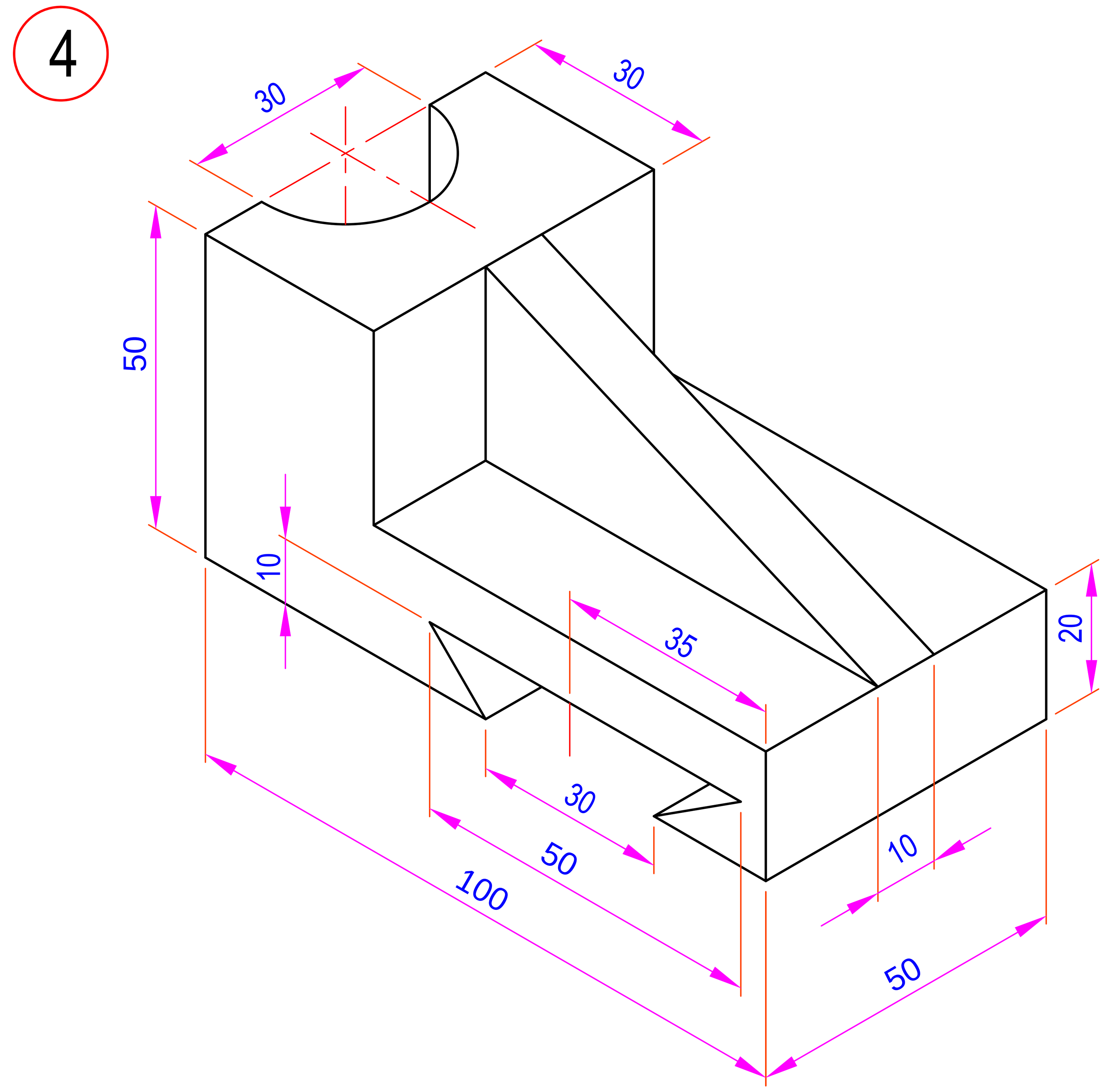
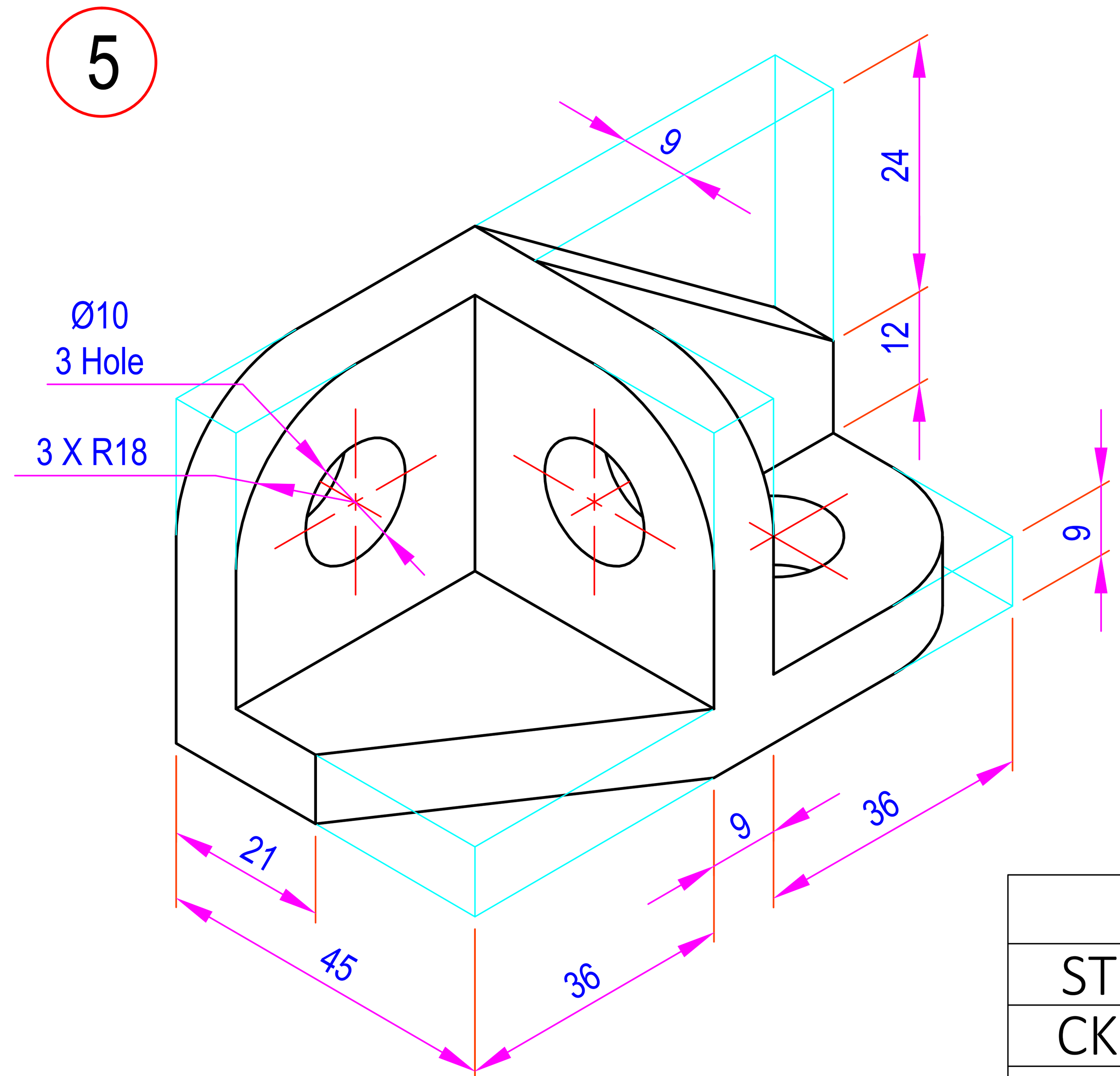


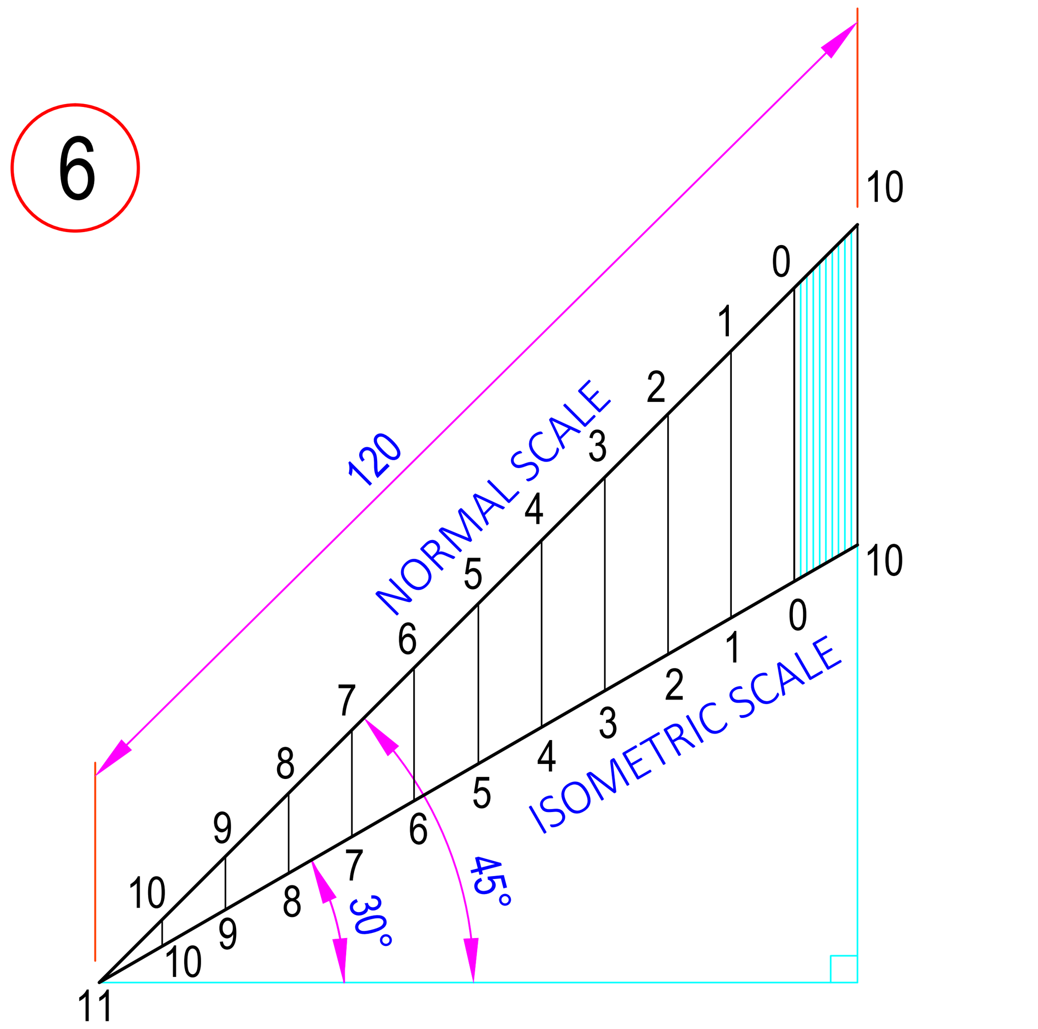

4




5




6




ALL DIMENSIONS ARE IN mm.

| | DATE | SIGN | DARSHAN INSTITUTE OF ENGG. & TECH. RAJKOT |
|---|---|---|---|
| STD. | | | |
| CKD. | | | ISOMETRIC PROJECTIONS |
| COMP. | | | |
| B.E. 1st SEM ME | | | |
| A. G. GUNJARIYA | | | |
| 090540119000 | | | DRG NO. 8 |
| SCALE - 1:1 | | | |

# 0. Introduction to Engineering Graphics

When you are in engineering profession you create something what has never been. For an effective change of ideas with others, an engineer must be proficient in the three means of communication

- Oral and written
- Symbols associated with the basics sciences
- The graphic language Communication

Engineering design Communicate information clearly and independently of spoken language, like Form, Proportions, Dimensions, Relationships and Material.

**What is a Drawing?**

The art of representing something by lines made on a surface with a pencil, pen, etc. A picture, design, sketch, etc. thus made

**What is Engineering Graphics?**

Drawings for technical use: engineering and science. It's a (relatively) exact method of representing a 3-D object on a 2-D medium (paper). Represents design and specifications for physical objects and data relationships.

A drawing drawn by an engineer having engineering knowledge for the drawing purposes is an engineering drawing. It is meant for communicating his ideas, thoughts and designs to others. Engineering drawing is a starting point of all engineering branches such as Mechanical, Production, Civil, Electrical, Electronics, Computer science, Chemical etc. It is spoken, read, and written in its own way.

**Importance of Graphics Language**

The design department develops the ideas into a shape, which is communicated to the shop floor by spoken or written words. The shop tries to comprehend the words and to fabricate the shape on a pilot or experimental basis. This shape is sent back to the design department where it is tried for its suitability. If it is not satisfactory whole sequence of operations repeated. This method of developing new objects without the help of a graphic language involves a lot of time and labor and lot of scope of errors also. So without drawings, it would have been almost impossible to produce various engineering objects such as aircraft, the automobile etc.

An engineering drawing is a type of drawing that is technical in nature, used to fully and clearly define requirements for engineered items, and is usually created in accordance with standardized conventions for layout, nomenclature, interpretation, appearance, size, etc. Engineering drawings are often referred to as "blueprints."

Engineering drawing is the language of engineers. It is meant for communicating your ideas, thoughts and designs to others. A drawing drawn by engineer, having engineering knowledge for the engineering purposes is an engineering drawing. Like every language has its own rules of grammar also Engineering drawing also has its theory of projections, its idioms in conventional practices, and its punctuation in the types of lines, its abbreviations, symbols and its descriptions in the constructions.

**Difference between Artistic graphics and Engineering graphic**

Freehand sketches are used by designers to transfer mental images to paper. Ideas are constantly changing as new thoughts occur. Artist uses cursive writing to write anything on drawing. It is often unreadable after sometime such drawings are called as artistic drawings. Artistic ability is an asset but ability to sketch quickly and accurately to proportion is an important skill for all technical workers.

Words cannot describe three dimensional technical design information accurately. Compared with Verbal or Written Description, Drawings offer far better idea about the Shape, Size & Appearance of any object or situation or location, that too in quite a less time. Quick 2D or 3D sketches clearly represent the shapes of objects and the thoughts of the designers. In short 2D or 3D views of an object with the purpose of manufacturing it is known as Engineering Graphics.

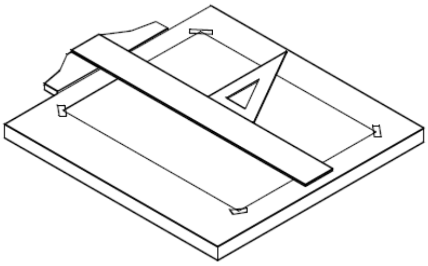
A graphical language used by engineers and other technical personnel associated with the engineering profession. The purpose of engineering drawing is to convey graphically the ideas and information necessary for the construction or analysis of machines, structures, or systems.

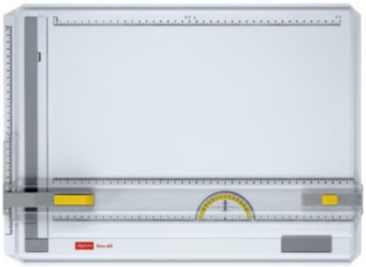
**List of Drawing Instruments**

Before commencing the course of engineering drawing, it is essential that a student should obtain the following drawing instruments. Following is the list of drawing instruments that required making engineering drawings on paper with perfection.

1. Drawing Board
2. Mini drafter
3. Set-squares (45° – 45° & 60° – 90°)
4. T-square
5. Protractor (180°, 360°)
6. Scales
7. Roll & Draw
8. Compass (drafting)
9. Drawing Instruments Box
10. Circle Master
11. French Curves
12. Drawing paper & drawing sheet
13. Drawing pencil
14. Sharpener
15. Eraser
16. Drawing pins & clips
17. Drawing paper box
18. Duster or handkerchief
19. Erasing Shield
20. Drawing Sheet

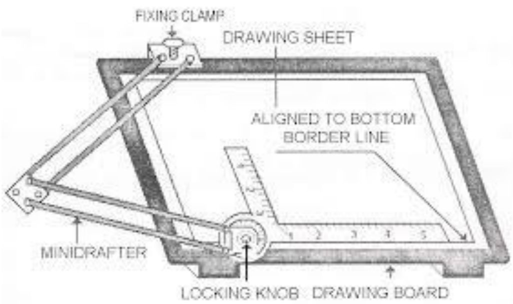
**1. Drawing Board**





Drawing board is a desk or flat surface with proper dimensions used to support sheet and make it flat and ready to for technical drawing. More recently engineers and draftsmen use the drawing board for making and modifying drawings on paper with ink or pencil. Some drafting tables incorporate electric motors to provide the up and down and angle adjustment of the drafting table surface.

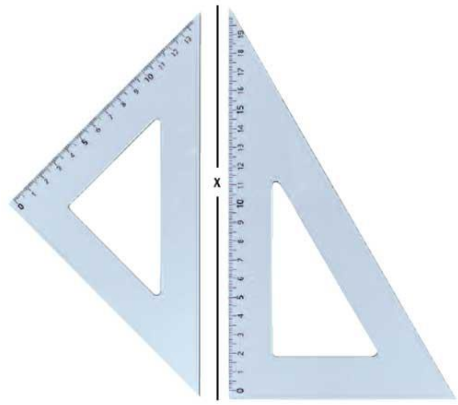
**2. Mini Drafter**

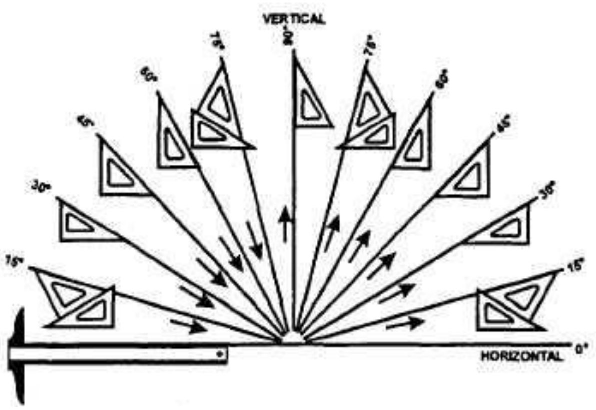


It is an instrument used to draw geometrical shapes and figures with great precision. It does not require any other instrument like scale or set squares. The mini-drafter is a versatile tool and can be used to draw almost everything because the built in protractor allowed the drawing of angles to the closest 5 minutes of one degree. Vertical and horizontal scales reduced the need for triangles.

It can be used to draw parallel lines, perpendiculars, inclined lines of any degree with unmatched speed. It consists of one long scale and one small scale and the scales are in 'L' shaped which can be fit on any drawing board easily.

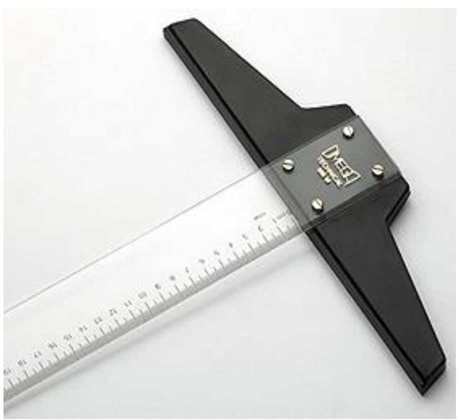
### 3. Set-squares (45° – 45° & 60° – 90°)






A set square is an object used in engineering and technical drawing, with the aim of providing a straightedge at a right angle or other particular planar angle to a baseline. These set squares come in two usual forms, both right triangles: one with 90-45-45 degree angles, the other with 30-60-90 degree angles. Sets square were aligned to draw angles in 15 degree increments.

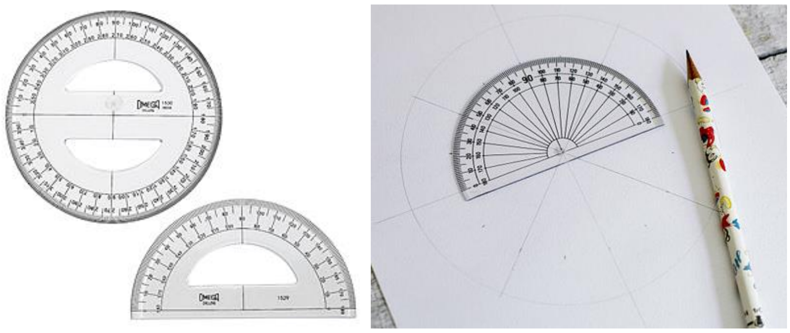
### 4. T-square



A T-square is a technical drawing instrument used by draftsmen primarily as a guide for drawing horizontal lines on a drafting table. T-squares and drawing boards were used for many years to create accurate drawings. Paper or cloth material was aligned with the T-square and held in place with tacks or tape. Skill was required to keep all the tools in place while drawing.

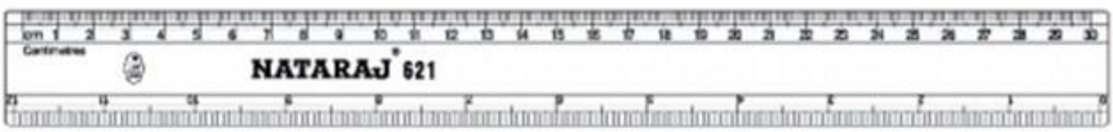
It may also guide a set square to draw vertical or diagonal lines. Its name comes from its resemblance to the letter T. The top of the T-square hangs off of the drafting table and is called the head; the blade is the part that stays on the drafting table. The T-square usually has a transparent edge made of plastic which should be free of nicks and cracks in order to provide smooth, straight lines.

**5. Protractor (180°, 360°)**



A protractor is a square, circular or semicircular tool, typically made of transparent plastic, for measuring angles. Most protractors measure angles in degrees (°). Radian-scale protractors measure angles in radians. Semi-circular protractor is of 180° and full circle protractor is of 360°. More advanced protractors, such as the bevel protractor, have one or two swinging arms, which can be used to help measure the angle.

**6. Scales (Ruler)**




A ruler, sometimes called a rule or line gauge, is an instrument used in geometry, technical drawing, printing and engineering/building to measure distances and/or to rule straight lines. The scales are available in plastic, wooden and steel material. Generally steel rule is used to draw engineering drawings.

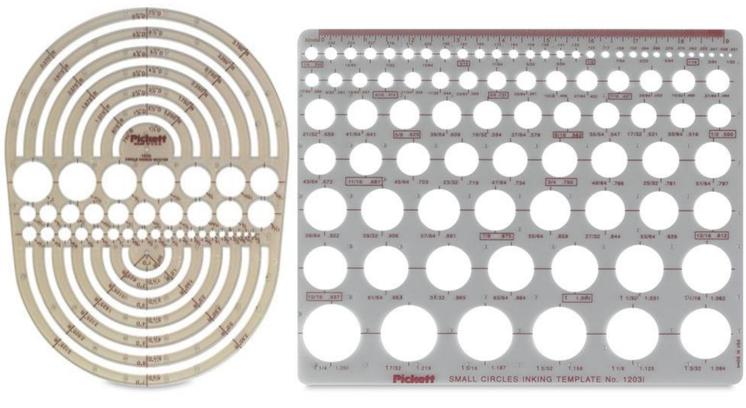
**7. Roll & Draw**


Roll & Draw is most handy instrument for making charts & parallel lines at super-fast speed. It is also popular as “A draftsman's best friend”. Furthermore, it is a multipurpose drawing instrument that lets you measure in centimeters and draw quadrants, squares, circles, angles, crosshatching, and vertical and horizontal parallel lines, quickly and easily.

**8. Compass (Drafting)**

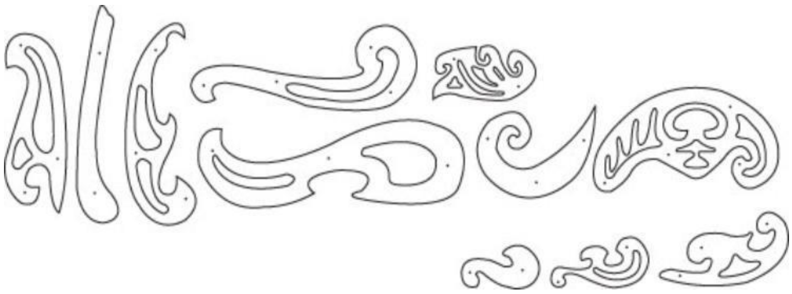
A compass is a technical drawing instrument that can be used for inscribing circles or arcs. A typical compass is consists of two legs. One pencil lead is added to a leg and a tip point to pivot on paper is provided to another leg. Drafting compass is available in different variants that can be selected as per drawing requirement.

9. Circle Master



Circle Master is very helpful template type drawing instruments which helps to draw circles of different radius at high speed. It eliminates use of compass as circle of fixed radius can be drawn. It is a flat plate or circular plate with different sized holes punched at surface as shown in figure. If you want to draw circle of radius other than circle radius punched then it is required to use other drafting instrument as radius of circle cannot adjusted. Circle masters are best for small diameter circles.

**10. French Curves**



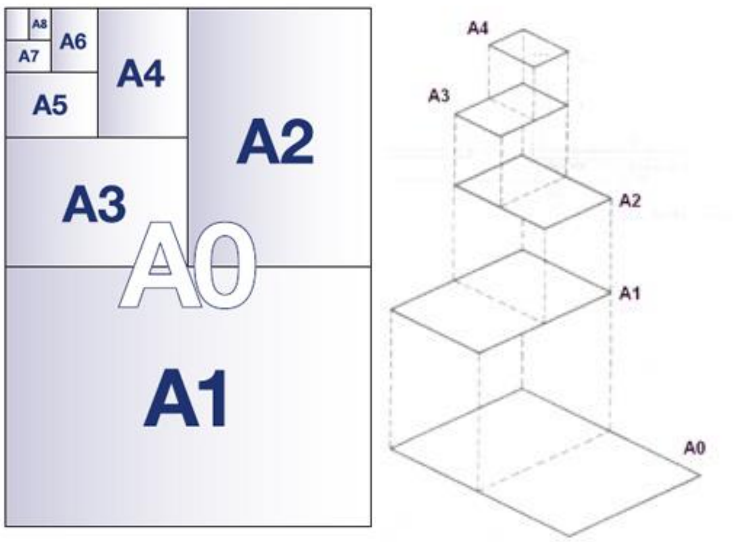
A French curve is a template made out of metal, wood or plastic composed of many different curves. It is used in manual drafting to draw smooth curves of varying radii. The curve is placed on the drawing material, and a pencil or other implement is traced around its curves to produce the desired result.

**11. Drawing Paper & Drawing Sheet**

**INTERNATIONAL PAPER SIZES**

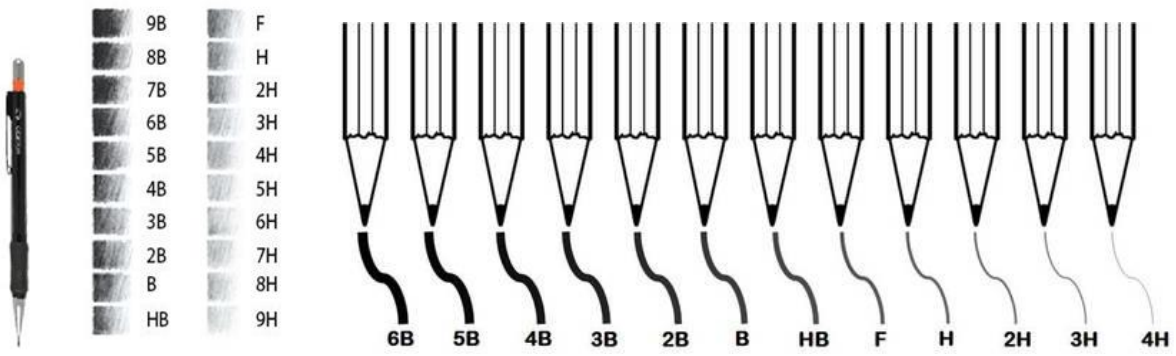
**A series**

| Size | mm x mm | in x in |
|---|---|---|
| 0 | 841 x 1189 | 33.1 x 46.8 |
| 1 | 594 x 841 | 23.4 x 33.1 |
| 2 | 420 x 594 | 16.5 x 23.4 |
| 3 | 297 x 420 | 11.7 x 16.5 |
| 4 | 210 x 297 | 8.3 x 11.7 |
| 5 | 148 x 210 | 5.8 x 8.3 |
| 6 | 105 x 148 | 4.1 x 5.8 |
| 7 | 74 x 105 | 2.9 x 4.1 |
| 8 | 52 x 74 | 2.0 x 2.9 |
| 9 | 37 x 52 | 1.5 x 2.0 |
| 10 | 26 x 37 | 1.0 x 1.5 |




The standard sizes of sheets according to I.S.I. are A0, A1, A2, A3, A4 and A5. Drawing sheet of size 594 X 420 i.e. A2 size is generally used by engineering students as it is very handy and easy for drawing work in class. Sizes comply with metric or U.S. standards.

### 12. Drawing Pencil (Lead pencil or mechanical pencil, wooden pencil)




| Softer (Darker) | | | | | | | | | | Harder (Lighter) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9B | 8B | 7B | 6B | 5B | 4B | 3B | 2B | B | HB | F | H | 2H | 3H | 4H | 5H | 6H | 7H | 8H | 9H |

A mechanical pencil is a pencil with a replaceable and mechanically extendable solid pigment core called a lead. It is designed such that the lead can be extended as its point is worn away. Drawing pencil comes in wooden material too that are useful to draw sketches in shades. 0.5MM fine lead pencils have become popular replacing the thicker wood and lead holder type leads. Thicker leads are stronger but require frequent sharpening. Select the lead hardness which suits the film or paper being used.

### 13. Sharpener

A pencil sharpener is a device for sharpening a pencil's writing point by shaving away its worn surface. It is mostly used when wooden pencil is selected to draw sketches as used writing point of wooden pencil may blur the drawing that results in black damage to paper.

### 14. Eraser

An eraser is used for removing pencil markings on paper or sheet. It is very helpful in removing unnecessary line of drawing by rubbing it on unwanted lines and points.

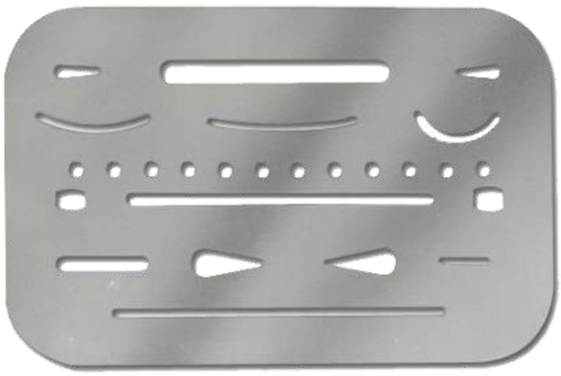
### 15. Drawing pins & clips


Drawing clips are used to hold drawings on drawing boards which remove sheet movement while working. They are inserted and removed by hand, hence the terms "thumbtack" and "push pin" is also used. The term drawing pin comes from their being used to hold drawings.

### 16. Duster or handkerchief

Duster or handkerchief is often used to clean paper on which drawing is going on. Maximum dust is possible when you use eraser to erase something on paper. The duster is very helpful at that time as removal of dust from hand leads to more black spots on drawing paper.

### 17. Erasing Shield

An erasing shield helps to do a cleaner job of erasing. Each time the eraser crosses an edge, it creates a fresh eraser surface.

**BIS-SP 46 Standards**

In Brief About BIS – SP 46 Standards of Engineering Drawings & Other Commonly Used Standards in Engineering Drawing Practice. The BIS-SP 46 – 1988 is the standard which is for "Engineering Drawing Practice for Schools & Colleges". And used in the educational institution for engineering drawing or graphics. It was recently revised as SP – 46 – 2003. Other than this the following standards are commonly used in engineering drawing practice:

- IS 1444:1989 DRAWING BOARD SPECIFICATION
- IS 15021:2001 PROJECTION METHODS
- IS 3221:1966 DRAWING INSTRUMENTS
- IS 10713:1983 SCALES IS 10714:2001 LINES
- IS 9609:2001 LETTERING
- IS 11669:1986 DIMENSIONING
- IS 10711:2001 SIZE & LAYOUTS OF DRAWING SHEETS

**Types of Lines used in Engineering Graphics**

Engineering graphics is subject full of lines. Not a single engineering drawing is possible without use of line types. There are different line types for different purposes. All the types of lines with its symbol and applications discussed here.

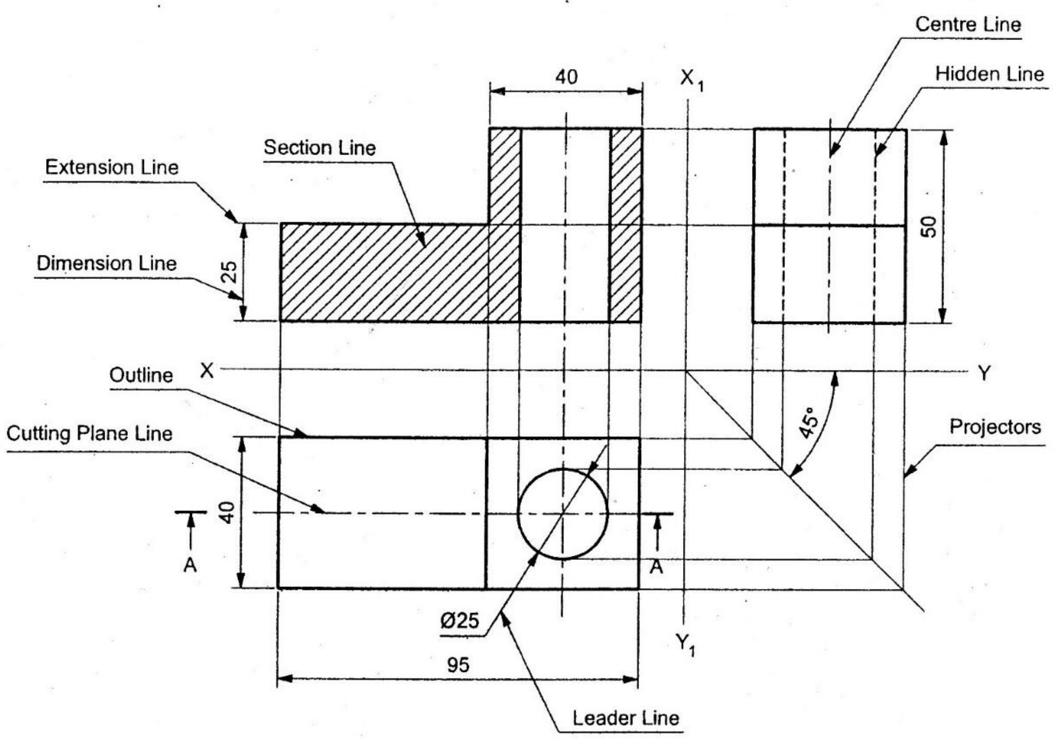



Table for types of Lines used in Engineering Graphics as per given below.

| Type | Illustration | Application |
|---|---|---|
| A – Continuous Thick | | Visible Outlines |
| B – Continuous Thin | | Dimension Lines,<br>Leader Lines<br>Extension Lines<br>Projection Lines<br>Hatching Lines |
| C – Continuous Thin-Wavy | | Irregular Boundary Lines, Short Break Lines |
| D – Short Dashes Medium | | Hidden Outlines & Edges |
| E – Long Chain Thin | | Centre Lines<br>Locus Lines<br>Line of Symmetry |
| F – Long Chain Line Thick At Ends And Thin Elsewhere | | Cutting Plane Lines |
| G – Long Chain Thick | | To Indicate Surfaces Which Are To Receive Additional Treatment |
| H – Ruled Line & Short Zigzag Thin | | Long Break Lines |

**Order of Priority for coinciding line**

If two or more lines of different types coincide, the order of priority should be observed:

(i) Visible outlines and edges (Continuous thick lines, type A),

(ii) Hidden outlines and edges (Dashed line, type D),

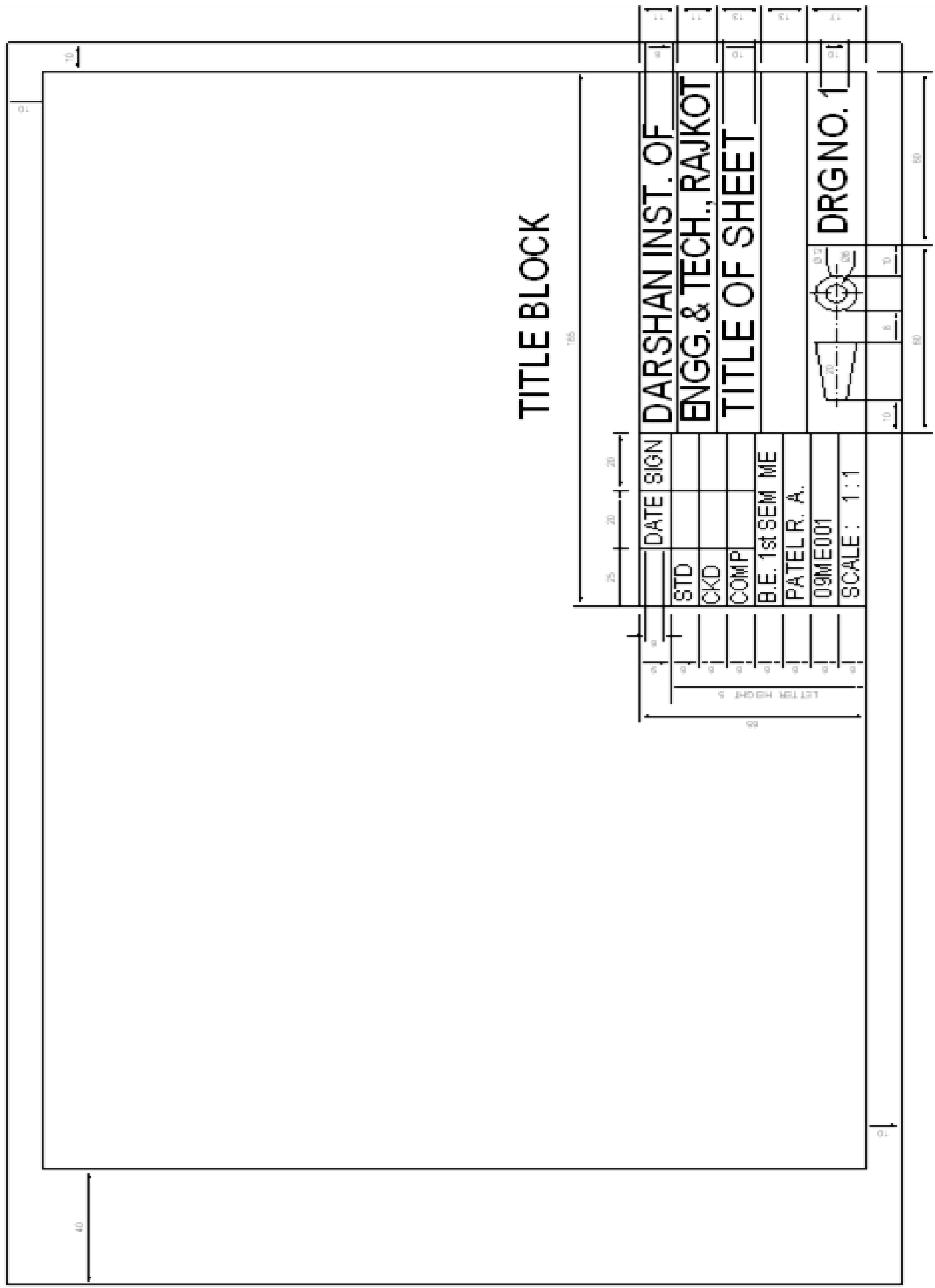
(iii) Cutting planes (Chain thin, thick at ends and changes of cutting planes, type F),

(iv) Centre lines and lines of symmetry (Chain thin line, type E),

(V) Projection lines (Continuous thin line, type B).

**Layout of drawing sheet?**

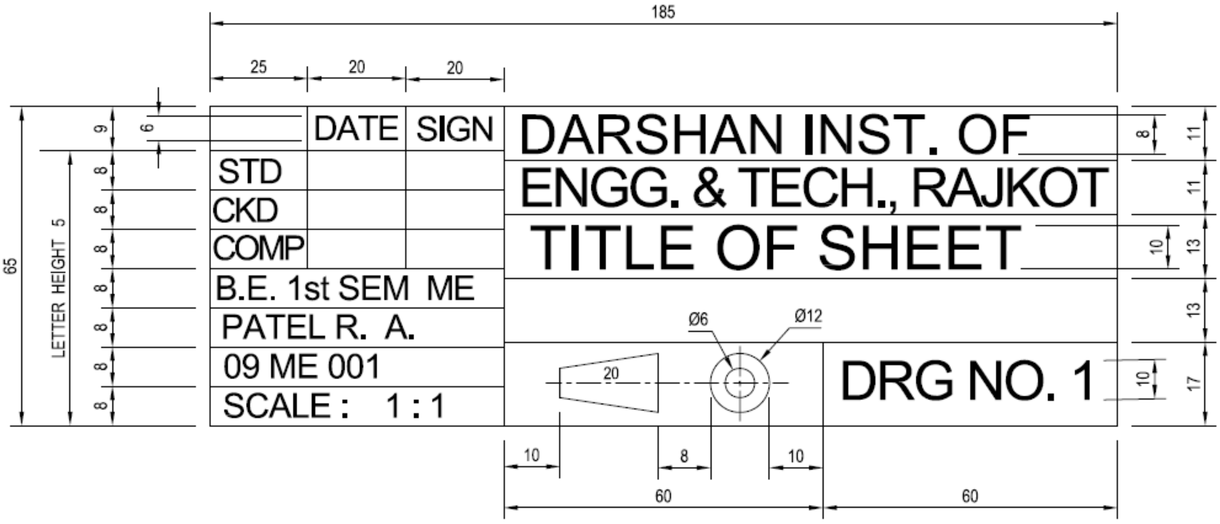
The selection of suitable scale and allotment of proper space for margin, title block, parts list, revision panel, folding marks etc. on the drawing sheet is known as layout of drawing sheet. Layout of the drawing on the drawing sheet is necessary in order to make its reading easy and speedy. The title blocks, parts list etc will provide all the required information.


TITLE BLOCK
DARSHAN INST. OF
ENGG.& TECH., RAJKOT
TITLE OF SHEET
DRG NO. 1
DATE
SIGN
STD
CKD
COMP
B.E. 1st SEM ME
PATEL R. A.
09ME001
SCALE : 1 : 1

**Title block for Sheets**

The title block should contain at least the following information.

- Name of the college (institution)
- Name of sheet (title of drawing)
- Name, Semester and Enrollment no. of the student
- Scale
- Drawing number
- Symbol denoting the method of projection
- Date of starting, checking and End of drawing




**Lettering**

Writing of titles, sub titles, dimensions, scale and other details on a drawing by the alphabets A, B, C,…….Z and numbers such as 1, 2, 3……0 etc is called lettering. It is an important feature of engineering drawing. The ability to letter freehand with speed, neatness, and beauty of form, uniformity and legibility is a skill very much desired by all engineers. HB and H grade pencils sharpened to a conical point should be used for lettering. To keep the stroke of the letters uniform, the pencils should be rotated between the thumb and fingers while lettering. Hard pencils such as 2H or 3H should be used to draw guidelines.

Single stroke letters-single stroke means that the width of the straight or curved lines that form the lettering is equal to that of the stroke of a pen or pencil. These are the simplest form of letters generally used in engineering drawings. Generally the word single stroke means that the letter should be made without lifting the pencil. Gothic (thick) letters are used for ink-drawings.

**Types of lettering:**

i. Vertical letters

a. Capital (upper case) letters

b. Small (lowercase) letters

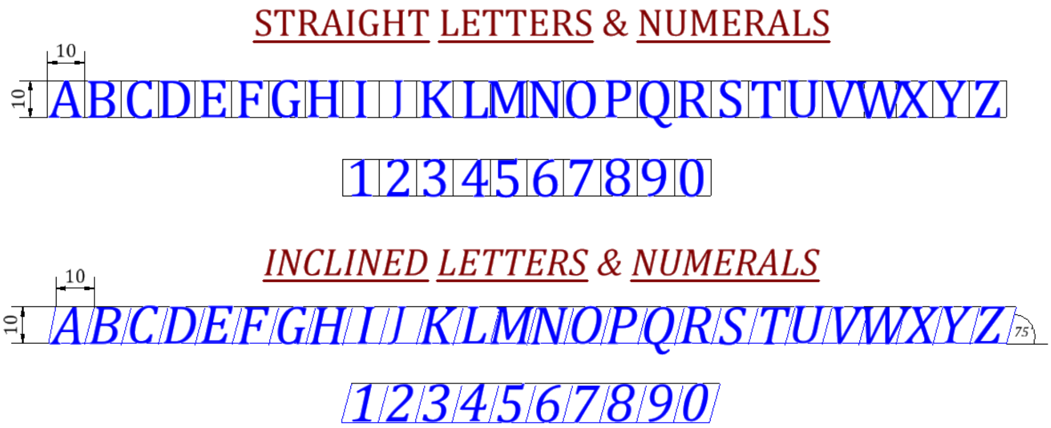
ii. Inclined letters (inclination of 75° is recommended with the horizontal))

a. Capital letters

b. Small letters

Size of letters is designated by the height of Capital letters. Standard heights for lettering are 3.5, 5, 7 and 10mm. Different sizes of letters are used for different purposes.

- Main title — 7 or 10mm
- Sub-titles — 5 or 7mm
- Dimensions, notes etc. - 3.5 or 5mm




**Dimensioning**

The art of writing the various sizes or measurements on the finished drawing of an object is known as dimensioning. The notation of dimensioning consists of dimension lines, extension lines, arrow heads, dimension figures, notes, symbols etc.

- Importance of Dimensioning

Dimensioning expresses all the sizes and other information necessary to define the object. It must be done with due regard to manufacturing processes and inspection requirements. The dimensioning also includes expression of tolerances necessary for the correct functioning of the part given to be assembled.

**Methods of Dimensions with Example Drawing**

To show dimensions of all parts of drawing is mandatory for engineer. All lines in drawing would have length, width or radius to indicate. The use of proper dimensioning method will tends to full marks for correct drawing. Now let us discuss methods of dimensioning in brief. There are two Methods of Dimensions. (1) Uni-directional System (2) Aligned System.

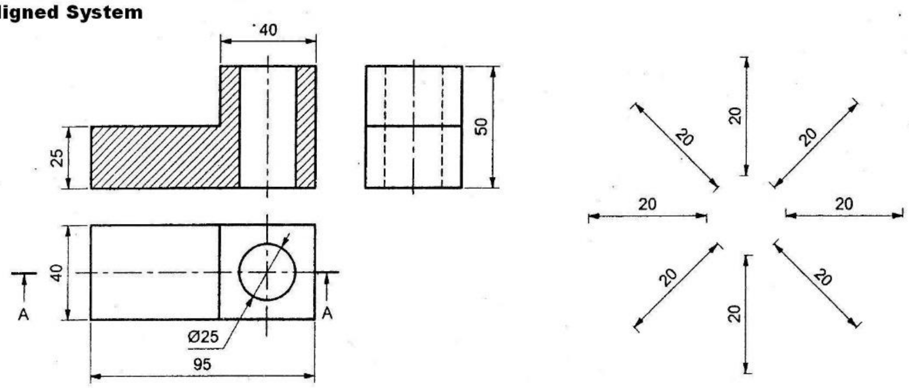
1. Aligned System

In aligned system, the dimensions shall be placed parallel to and above the dimension lines, preferably in the middle and not by interrupting the dimension lines. Here the dimensions can be read from the bottom or from the right side of the drawing.

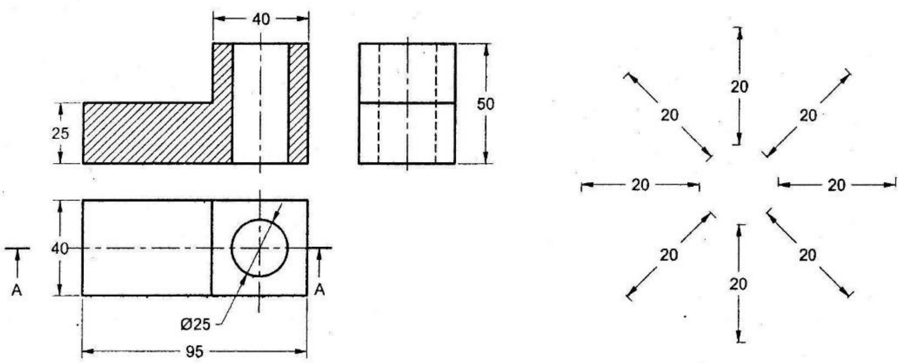
2. Unidirectional System

In this system dimensions shall be horizontally placed so that they can be read from the bottom of the drawing sheet. Here the dimension lines may be interrupted preferably near the middle for the insertion of dimensions.

**1. Aligned System**




**2. Unidirectional system :**

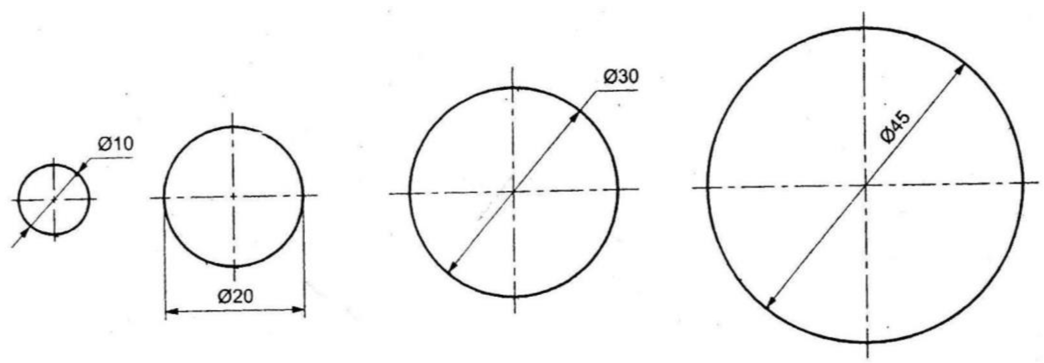


**General Rules for Dimensioning**

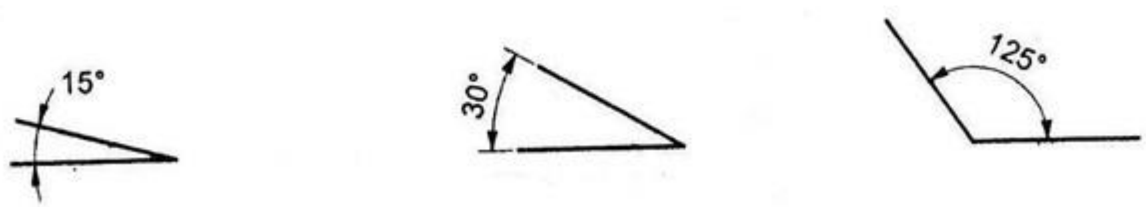
A neat drawing is not only required to achieve full marks in technical drawing but several rules for dimensioning must be followed.

1. Standard sizes of letters and figures should be used.
2. All dimensions should be specified in mm. The use of mm should be avoided by giving a general note "All dimensions are in mm".
3. As far as possible dimensions should be placed outside the views.
4. Dimension lines should not run in the direction included in the hatched area.
5. Dimensions should be taken from visible outlines rather than from dashed lines.
6. Dimensions should be given from a base line, a centre line, an important hole, or a finished surface which may be readily established.
7. Dimensions should be quoted only once in one view.
8. Overall dimensions should be placed outside the intermediate dimensions.
9. Dimensions should be placed outside a sectional view.
10. Zero should precede the decimal point when the dimension is less than unity.
11. Dimension line should not cross. Also dimension lines and extension lines should not cross.
12. When there are several dimension lines, the shorter dimension should be nearer the view.
13. Leaders should not be drawn curved or made free hand.
14. Do not use outlines for dimensions.
15. Same method of dimensioning should be used for all dimension lines.

Dimensioning of circle diameter

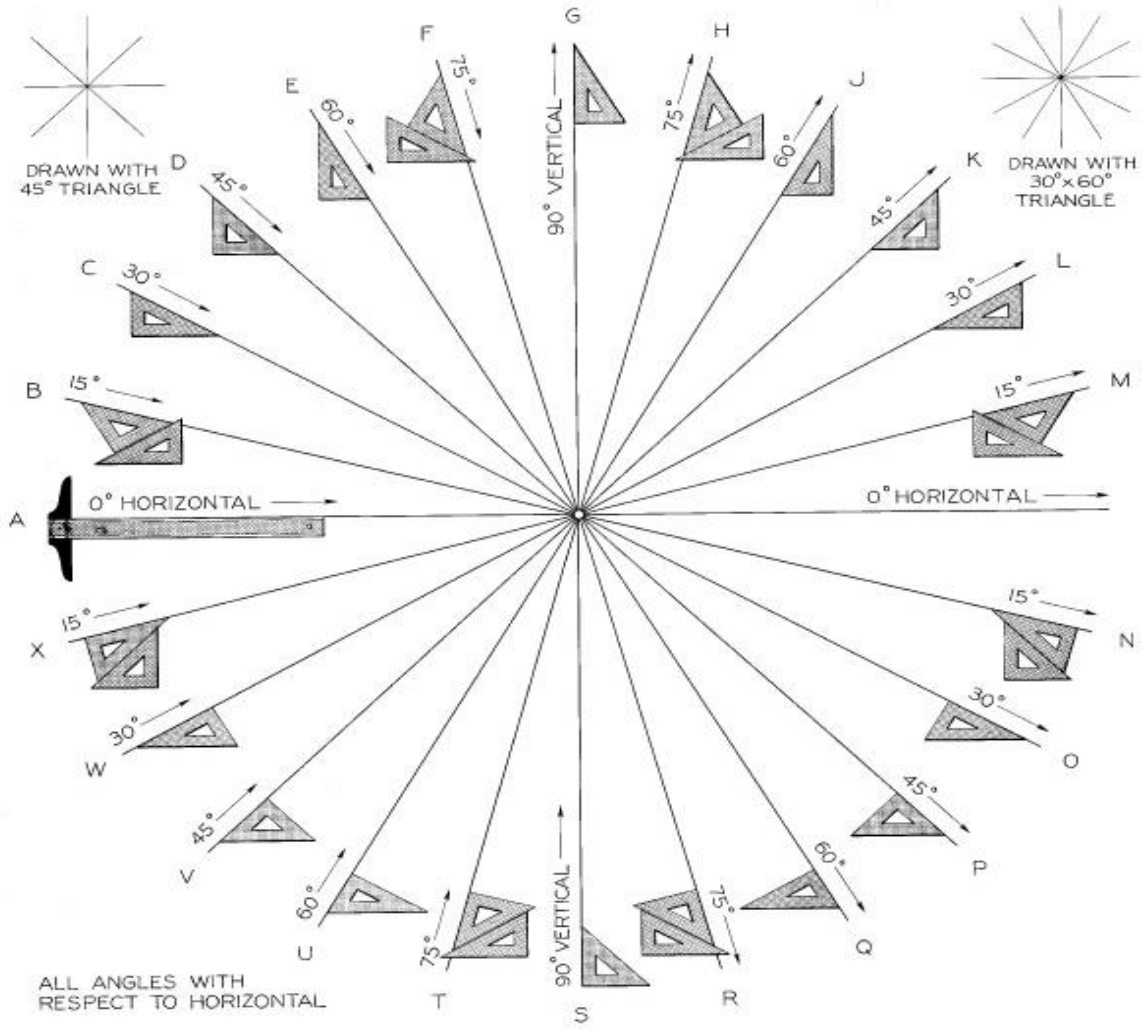



Dimensioning of Angle

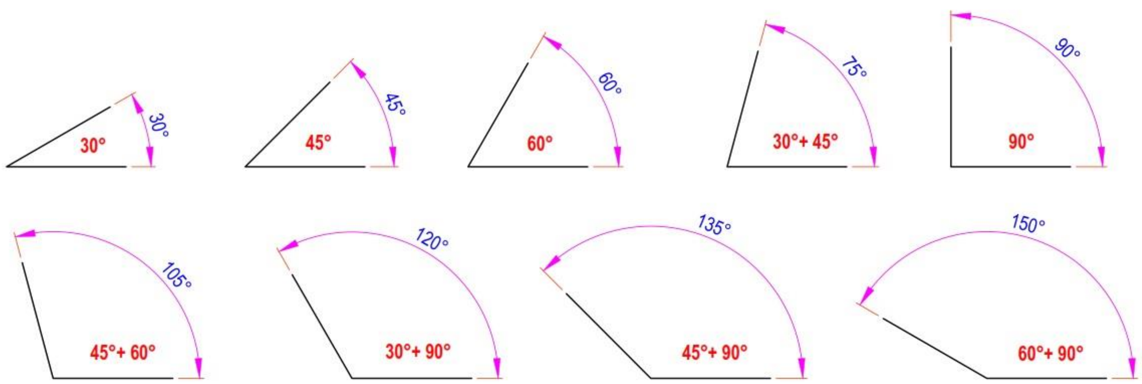


**Construction of Various Angles**

Most inclined lines are drawn at standard angles using the 45° x 45° triangle and the 30° x 60° triangle. In addition to drawing angles of 90°, 45°, 30°, and 60°, triangles can be combined to draw angles of 15° increments.




Some Examples of Various angles



**Geometric Shapes**

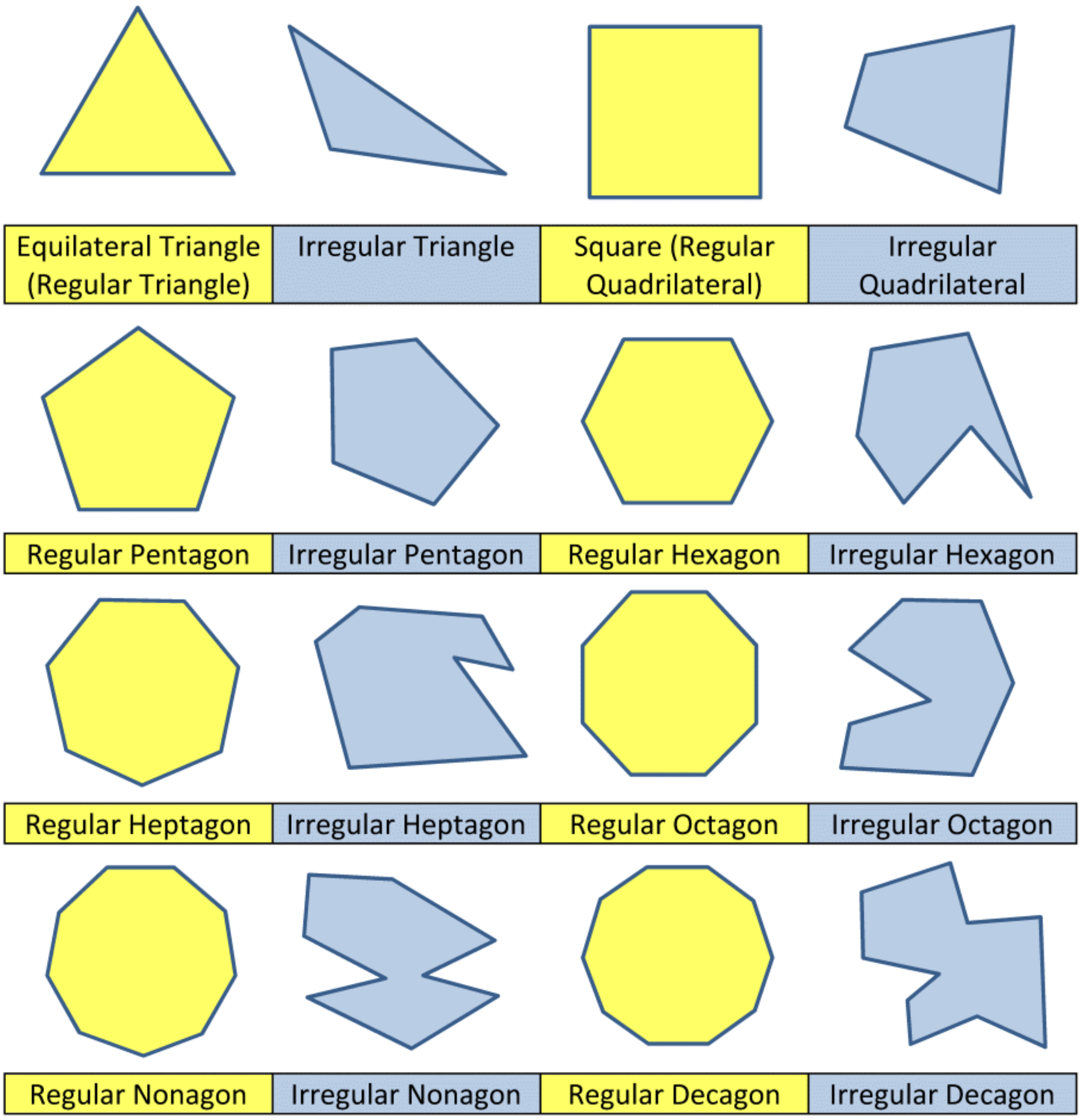
Triangle: A triangle is a plane figure bounded by three straight lines and containing three angles.

Quadrilateral – A quadrilateral is a plane figure bounded by four straight lines and containing four angles.

Polygon – A polygon is a plane figure bounded by more than four straight lines and containing more than four angles.

Regular polygon – A regular polygon is a plane figure in which all the sides and angles are equal.

Irregular polygon – An irregular polygon is a plane figure in which all the sides and angles are not equal.



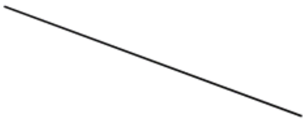
## Geometric Shapes

**Angle Types**

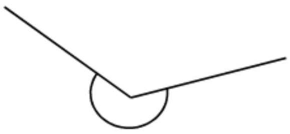
Acute angle
< 90°

Right angle
= 90°

Obtuse angle
> 90° and < 180°

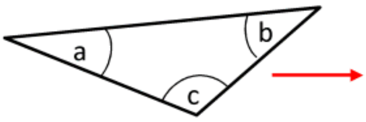


Straight line
= 180°

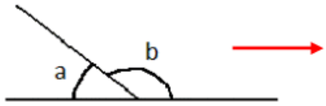


Reflex angle
> 180°

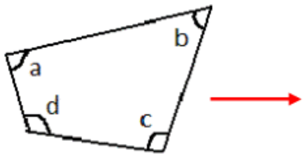
**Angle Rules**



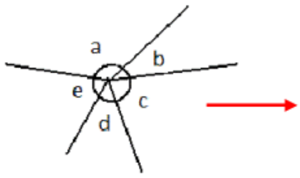

Angles in a triangle add up to 180°
So a + b + c = 180°




Angles on a straight line add up to 180°
So a + b = 180°




Angles in a quadrilateral add up to 360°.
So a + b + c + d = 360°



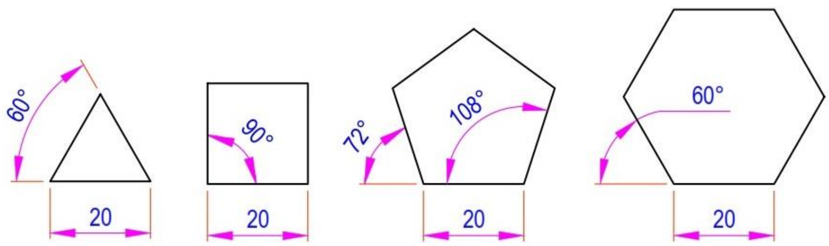

Angles around a point add up to 360°.
So a + b + c + d + e = 360°

<u>Angles in regular shapes</u>

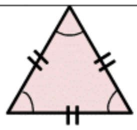
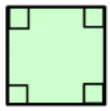
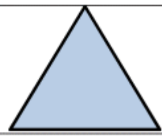
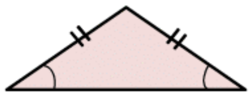
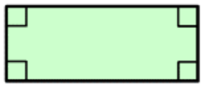
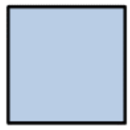
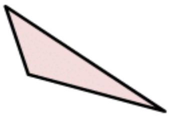
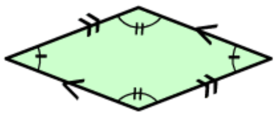
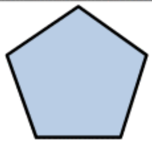
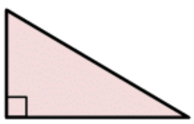
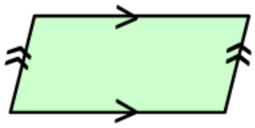
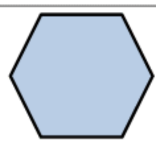
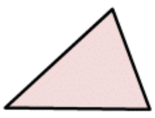
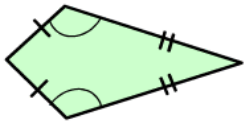
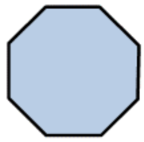
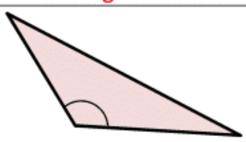
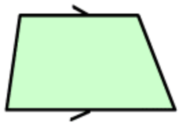
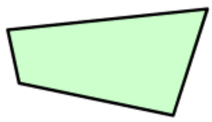
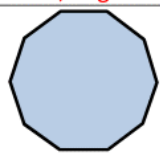
| Name of shape | Sides | Interior angles |
|---|---|---|
| equilateral triangle | 3 | 60° |
| square | 4 | 90° |
| regular pentagon | 5 | 108° |
| regular hexagon | 6 | 120° |
| regular heptagon | 7 | 128.6° |
| regular octagon | 8 | 135° |
| regular nonagon | 9 | 140° |
| regular decagon | 10 | 144° |

Interior angles of regular n-sided polygons add up to 180(n-2) °

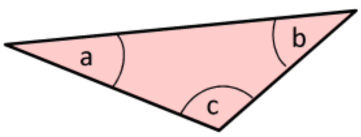
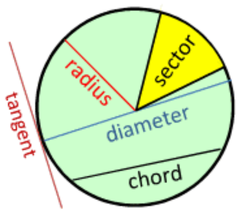
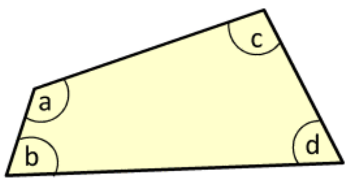
$$\text{Interior Angle for polygon} = \frac{(2n-4)\,90^0}{n} = 180 - \frac{360}{n}$$



## Various Geometric Shapes

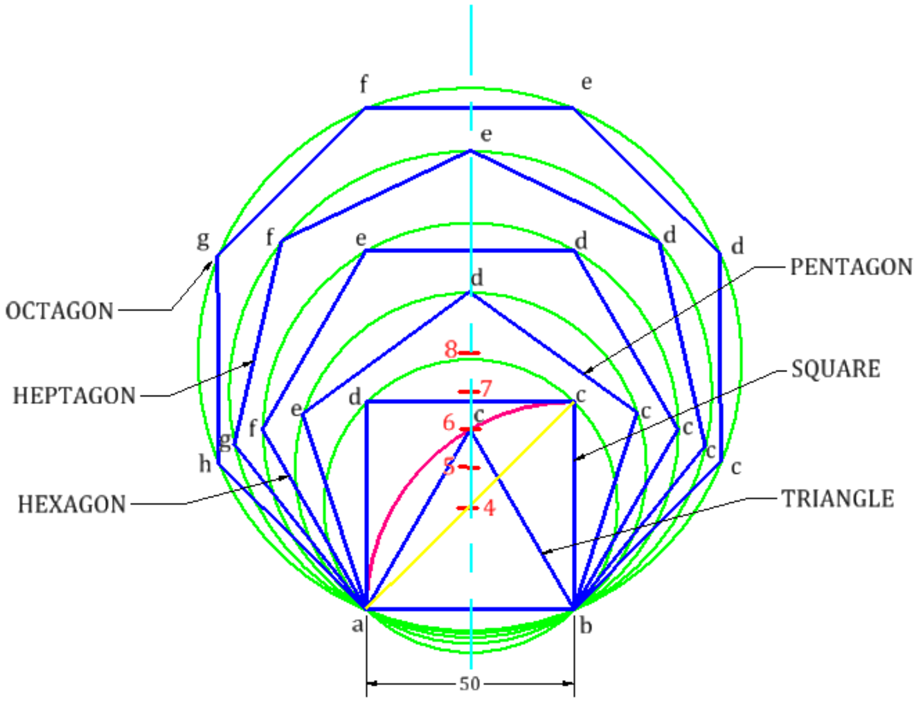
| TRIANGLES | QUADRILATERALS | REGULAR POLYGONS |
|---|---|---|
|  |  |  |
| **Equilateral triangle**<br>All sides equal; interior angles 60° | **Square**<br>All sides equal; all angles 90° | **Equilateral triangle**<br>3 sides; angle 60° |
|  |  |  |
| **Isosceles triangle**<br>2 sides equal; 2 congruent angles | **Rectangle**<br>Opposite sides equal, all angles 90° | **Square**<br>4 sides; angle 90° |
|  |  |  |
| **Scalene triangle**<br>No sides or angles equal | **Rhombus**<br>All sides equal; 2 pairs of parallel lines; opposite angles equal | **Regular Pentagon**<br>5 sides; angle 108° |
|  |  |  |
| **Right triangle**<br>1 right angle | **Parallelogram**<br>Opposite sides equal, 2 pairs of parallel lines | **Regular Hexagon**<br>6 sides; angle 120° |
|  |  |  |
| **Acute triangle**<br>All angles acute | **Kite**<br>Adjacent sides equal; 2 congruent angles | **Regular Octagon**<br>8 sides; angle 135° |
|  |   |  |
| **Obtuse triangle**<br>1 obtuse angle | **Trapezoid**<br>1 pair of parallel sides<br>**Trapezium**<br>No pairs of parallel sides | **Regular Decagon**<br>10 sides; angle 144° |

## Some important Geometric Terms

| TRIANGLE FORMULAS | CIRCLE FORMULAS | QUADRILATERAL FORMULAS |
|---|---|---|
|   |   |   |
| **Angles in a triangle** add up to 180°. So a + b + c = 180° | **Parts of a circle** | **Angles in a quadrilateral** add up to 360˚. So a + b + c + d = 360˚ |

**Universal Method of Polygon**

Universal method to draw polygons is very popular and very legendary technique to draw different shapes like triangle, square, pentagon, hexagon, heptagon, octagon etc.




Procedure:

Step-1 First draw a line AB of the dimension equal to the side of a polygon. i.e., 50 mm.

Step-2 Then draw a perpendicular bisector of the line AB and draw it of sufficient length.

Step-3 Draw a perpendicular line BC from B of the length equal to the line AB.

Step-4 Connect the two points A & C by a straight line. i.e., AC

Step-5 Draw an arc by the center B and radius equal to AB between the points A & C.

Step-6 Mark the point 4 at the intersection of line ‘AC with the perpendicular bisector.

Step-7 Mark the point 6 at the intersection of the arc AC with the perpendicular bisector.

Step-8 Find out the midpoint of between the points 4 & 6 mark it as a point 5.

Step-9 Mark points 7 & 8 at the distance equal to 4-5 or 5-6 in sequence.

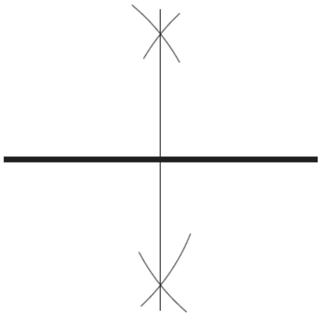
Step-10 Draw a triangle ABC by connecting the line AC & BC at point 6.

Step-11 Draw circles by taking the points 4,5,6,7,8 as center points and divide the respective circles with the compass measurement equal to the distance of the line AB. i.e., 50 mm.

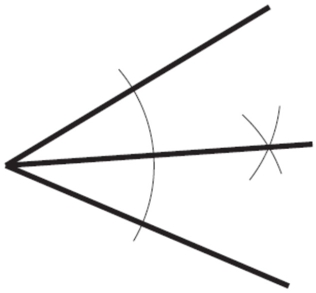
Step-12 Connect the divided points of respective circles in sequence with straight lines to get respective polygons. Like Square, Pentagon, Hexagon, Heptagon and Octagon.

## Practice Exercises

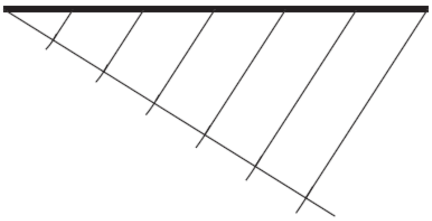
### Bisect a line



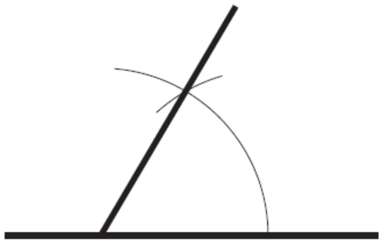
### Bisect an angle



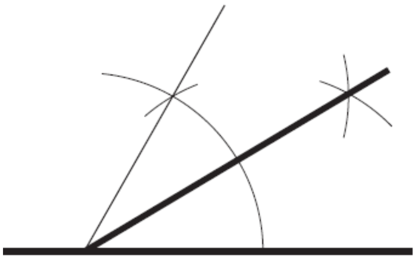
### Divide line into any equal parts



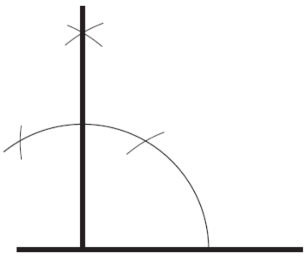
### Construct an angle of 60



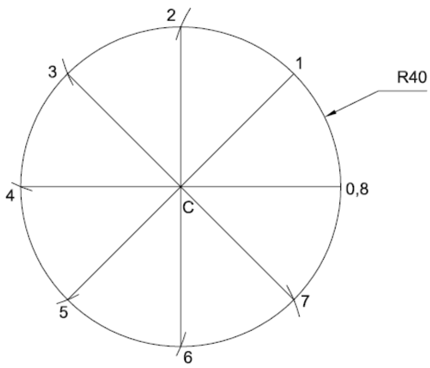
### Construct an angle of 30



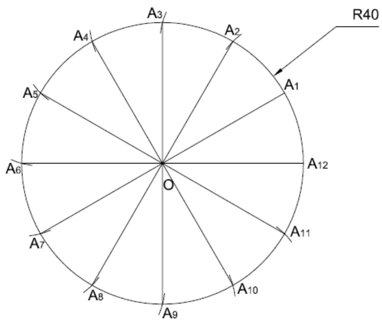
### Construct an angle of 90



### Divide circle in to 8 equal parts




### Divide circle into 12 equal parts

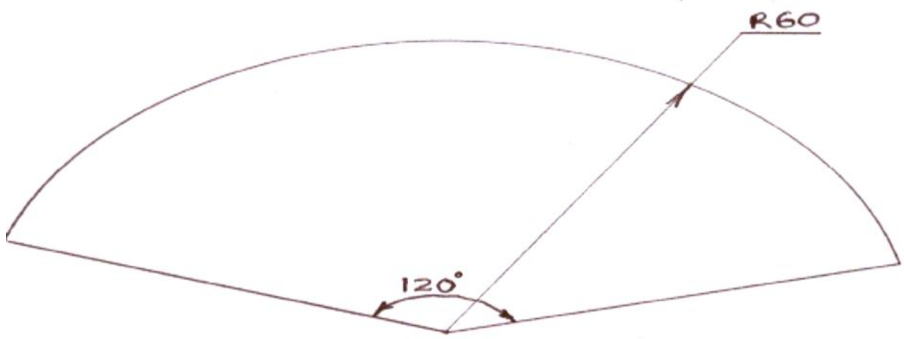


# 1. Introduction to Engineering Graphics

1. Give the dimension of **Title block** and list the information given in it.
2. Draw the figure to explain the **aligned and unidirectional** system of dimensioning. OR Explain the system of dimensioning in brief.
3. Explain the importance of the **dotted line and centre line**.
4. **Divide a line** PQ 100 mm long into six equal parts.
5. Without using protractor **draw a regular pentagon** of 40mm side.

**Scale**

6. Define **representative fraction**. What is difference between plain scale and diagonal scale?
7. If the distance of 300 km is represented as 15 cm on the map find representative fraction.
8. Draw Figure shown below in Half Scale.




**Plain Scale**

9. Construct a **plain scale** of R.F. 1:50 to show meters and decimeters and long enough up to 8 meter. Indicate 6.7 m distance on scale.
10. Construction the plain scale of R.F. 1:50 to show meters and decimeters and long enough to measure the length of 4 meters and 9 decimeters. Mark on the scale following distances (1) 2.5 meters (2) 4 meters and 2 decimeters.
11. Construct a **plain scale** with RF = 1/5 to show decimeters (dm) and centimeters. The scale should be long enough to measure 1 m. Show the length of 7.4 dm on it.
12. Construct a **plain scale** in which 1 cm represents 5 kms. It should be long enough to measure a distance of 95 kms indicate 76 kms in it.
13. Construct a **plain scale** to show metres when 1 centimetre represents 5 metres and long enough to measure up to 50 metres. Mark a distance of 32 metres on the scale.
14. On a map of a state, 1 cm represents 5 kms. Construct a **plain scale** long enough to measure a distance between two city 100 kms far from each other.

15. The distance between two places is 240 km and its equivalent distance on map is 12 cm. Draw **plain scale** & indicate 270 km and 120 km.
16. Construct a **plain scale** to show kilometers and hectometers when 25 mm is equal to 1 km and long enough to measure up to 6 km. Find RF and show a distance of 3km and 4 hectometer on the scale.
17. The length of the khandala tunnel on the Mumbai Pune express way is 330 meter on the road map. It is shown by 16.5 cm long line. Construct a **plain scale** to show meters and to measure up to 400 meter. Show the length of 290 meter long on the express way.
18. On map of Ahmedabad city 1 cm represents 1 Km. Construct a **plain scale** to measure the distance between Gujarat Technological University and Lal Darwaja which is 6 Km. Also indicate on scale, the distance between Geeta mandir and Kankariya lake which is 3 Km and 7 hectameters.

**Diagonal Scale**

19. Construct a diagonal scale of representative fraction = (1/36) showing yard, foot and inch. Scale should be long enough to measure 5 yard. Measure 3 yard, 2 foot, and 9 inch.
20. The distance between Ahmedabad and Bombay is 500 km. It is represented on a railway map by 10 cm. Construct a **diagonal scale** to measure kilometers. Show on scale the distance between Ahmedabad and Surat which is 237 km.
21. The distance between Rashtrapatibhavan and Fort is 5.00 km. It is represented on a Delhi city map by 10 cm. Construct a **diagonal scale** to measure a kilometer and its fraction up to two decimal. Show on the scale the distance between Rashtrapatibhavan and India Gate which is 1.73 km.

**Isometric Scale**

22. Draw an **isometric scale** long enough to measure 12 cm.
23. Construct the **isometric scale** to measure 100 mm.
24. A customer asked the shopkeeper to give an Aluminum sheet of 1m X 1m. Shopkeeper gave the sheet by measuring with **isometric scale**. How much percentage less sheet is given by shopkeeper to customer?

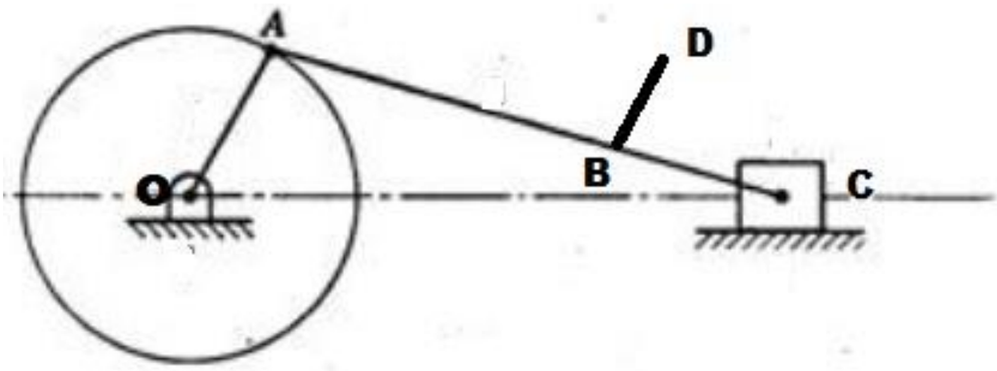
# 2. Loci of Points

## Problems on Locus of Points

1. Draw the locus of point *P,* moving in a plane, equidistant from the two fixed points *A* and *B.* Distance between points is *50mm.*
2. Draw the locus of a point P, moving in a plant, equidistant of 20mm from the fixed straight line AB.
3. Draw the locus of a point *P,* moving in a plane, equidistant of *10mm* from the fixed circle O *(Q, 20mm)* and outside.
4. Draw the locus of the point *P,* moving in a plane, equidistant from a fixed straight line *AB* and a fixed point *O.* The distance between point and line is *60mm.*
5. Draw the locus of a point *P,* moving in a plane, equidistant from a fixed point *B* and a fixed circle O *(A, 25mm).* AB is *65mm.*
6. Draw the locus of a point *P,* moving in a plane, equidistant from a fixed circle O *(A, 30mm)* and a fixed *MN.* Distance between line and centre of circle is 70 mm.
7. Draw the locus of a point *P.* moving in a plane, equidistant from two fixed *circle* (A, 30 mm) *and* (B, 15mm). *AB is* 70 mm.

## Problems on Slider Crank Mechanism

8. *OBA* is simple slider crank chain. *OB* is a crank of *30 mm* length. *BA* is a connecting rod of *90 mm* length. Slider *A* is sliding on a straight path passing through point *O.* Draw the locus of the mid-point of the connecting rod *AB* for one complete revolution of the crank *OB.*
9. Crank OA rotates about O (slide along OC., rod BD is fixed to connecting rod AC). Draw locus of point D shown in figure for one complete revolution of crank OA.



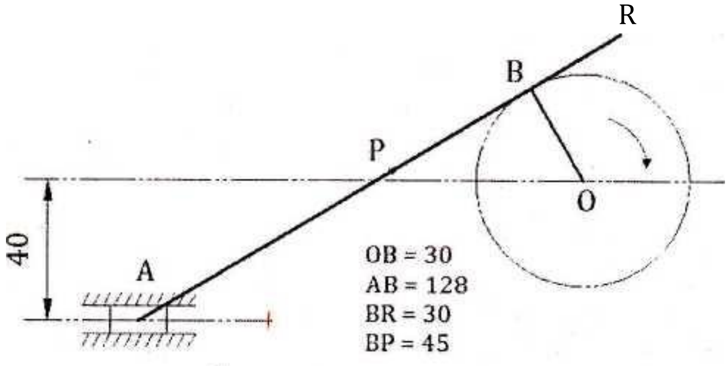

OA = 40 mm

AB = 75 mm

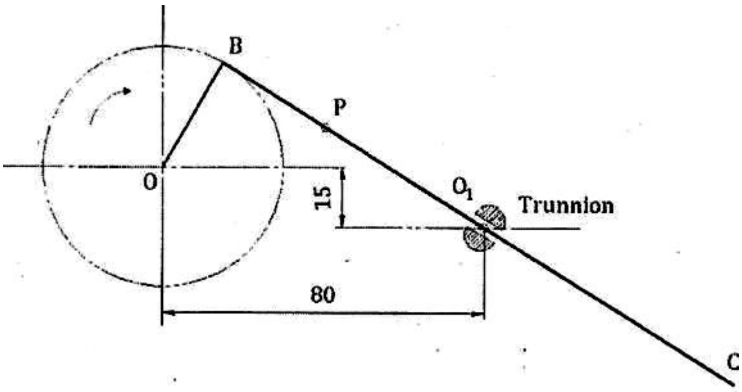
BC = 45 mm

BD = 15 mm

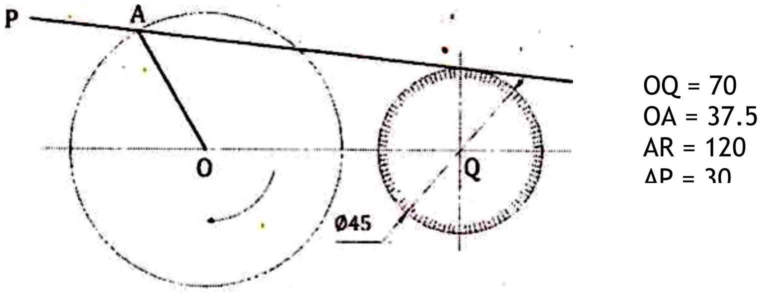
10. OBA *is an offset slider crank chain. Crank* OB *is* 30 mm *long and rotates in clockwise direction. Connecting rod* AB= 128mm *long. Offset is* 40 mm. *Draw the loci of two points* P *and* R *as shown in* Figure PB=45 mm *and* BR=30 mm.




11. Figure shows a mechanism in which OB is a crank of 30 mm length revolving in clockwise direction. BC is rod connected to the crank at the point B by turning pair and rod BC is constrained to pass through the guide at O, called trunnion. Draw the loci of point P and for one revolution of crank. The point P is 30 mm from B on the rod BC. Length of BC is 150 mm. Point O, is 80 mm on the right and 15 mm below the point O.



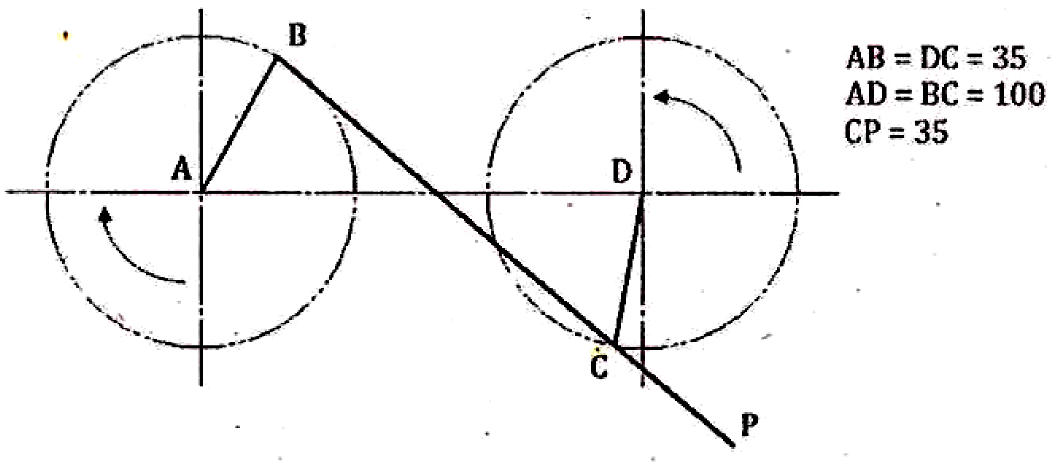

12. The crank OA shown in figure rotates about O and the connecting rod AB slides in the same plane on the curved surface of a shaft (with centre Q) of 45 mm diameter. Trace the locus of (1) the end B and (2) the point P beyond AB and 30 mm from A for one revolution of OA. OA=37.5 mm, AB = 120 mm and OQ= 70mm.



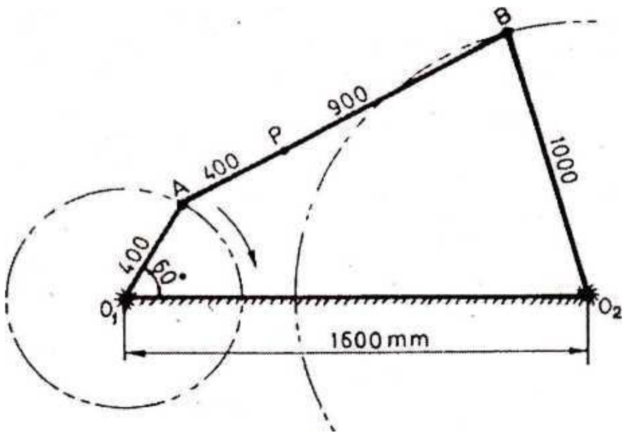
13. The crank $0_1A$ is 35mm long and rotates about the point $O_1$, in the clockwise direction. The link AB is connected to the crank by turning pair at the point A. The link AB glides/slides over a fixed cylinder for which the circle ($O_2$, 25). $O_1$,$O_2$ = 100 mm, AB= 140 mm, AC= 15 mm, BC= 155 mm. Draw the loci of the points B and C for one revolution of the crank.

## Problem on Four-bar Mechanism

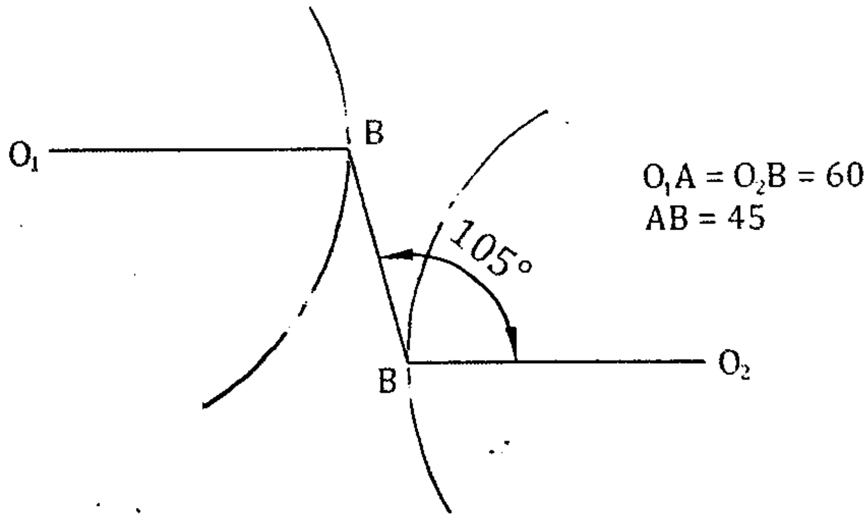
14. Crank AB rotates about A in clockwise direction and crank CD rotates about D in anticlockwise direction. Draw the locus of point P for one complete revolution of crank AB. AB=DC=35mm; AD=BC= 100mm; CP=35mm.
15. $0_1AB0_2$ is four bar crank chain with link $0_10_2$ as the fixed link. Driving link $0_1A$ is 30 mm long. Driven crank $O_2B$ is also 30 mm long. Connecting link AB is 90 mm long. Distance between $O_1$, and $0_2$ is 90 mm. Two cranks are in opposite direction. Draw the loci of point P and R for one complete revolution of the driving crank. The point P is the mid-point of the connecting link AB and the point R is 35 mm from A on BA extended.
16. In a four bar chain mechanism $0_1AB0_2$, the horizontal fixed link 0102 and the connecting link AB both are 120 mm long. $0_1A$ is a driving crank and is 40 mm long. 02B is driven crank and is also 40 mm long. Draw the loci of points P, M and Q where the point P is on extension of BA and 30 mm from A, the point M is the midpoint of connecting link AB and the point O is on the connecting link 30 mm from B. when Both the crank rotates in same direction, and Both the crank rotates in opposite direction.




17. In the four bar chain mechanism $0_1AB0_2$ shown in Figure, two cranks $0_1$ A and $0_2B$ are (driven) are 400 mm and 1000 mm long respectively and the connecting link AB is 1300 mm long. Fixed link 0102 is 1600 mm long. Draw the locus of point P, on AB and 400 mm from A, for one revolution of driving crank 0,A.




18. Figure shows four bar chain mechanism $O_1ABO_2$ with $O_1O_2$ as the fixed link. $O_1A$ and $O_2B$ is driver and driven cranks respectively and link AB is a connecting link. Draw the locus of mid-point M of link AB. $O_1A = O_2B = 60$ mm. Initial Position is shown in figure.



# 3. Engineering Curves

1. Explain the terms: (1) Conics (2) Eccentricity (3) Ellipse (4) Parabola (5) Hyperbola (6) Cycloid (7) Hypocycloid (8) Epicycloid (9) Involute (10) Spiral
2. Differentiate between Epitrochoid and Hypotrochoid.

**Ellipse**

3. Construct **an ellipse** when the distance of the **focus from the directrix** is equal to 60 mm and **eccentricity is 2/3.**
4. Draw **an ellipse** if the distance of **focus from the directrix** is 70 mm and the **eccentricity is 3 / 4**.
5. Construct **the ellipse** if the distance between the focus and the directrix is 50 mm. &**the eccentricity is 2/3**. Draw the tangent and the normal to the ellipse at given point.
6. Draw **an ellipse** having major axis 120 mm and minor axis 80 mm. Use **Arc of circle method**.
7. Construct **an ellipse** by **arcs of circle method**. The major and minor axes are 140 mm & 100 mm respectively. Also draw the tangent and normal to the ellipse at any suitable point.
8. Draw **an ellipse** by **an oblong method** given the major and minor axes as 120 mm and 90 mm respectively.
9. Construct an Ellipse by **rectangle method**, given the major and minor axes as 65 mm and 40 mm respectively.
10. A Fish **pond of elliptical shape** is to be inscribed **inside a rectangular plot** of size 100 m X 50 m. Draw the boundary line of fish pond (use suitable scale)
11. Construct **an ellipse** in a **parallelogram** 125 mm x 90 mm sides. Take included angles of parallelogram as 120° and 60°. Determine its major and minor axis.
12. Two points A and B are 100 mm apart. Third point C is 75 mm from A and 50 mm from B. Draw **an ellipse** passing through A, B &C.
13. The foci of **an ellipse** are 120 mm apart and the minor axis is 70 mm long. Draw the ellipse by **concentric circle method**.
14. The major axis and the minor axis **of Ellipse** are 125 mm and 75 mm. Construct **half ellipse by Oblong method** and **another half by Concentric circle method**.
15. The foci of **an ellipse** are 110 mm apart. The minor axis is 70 mm long. Determine the length of major axis and draw half ellipse **by rectangle method** and other half **by concentric circle method**.

**Parabola**

16. Construct a parabola with distance between **focus and directrix** is 40 mm.
17. Construct a **parabola,** when the distance of the **focus from the directrix** is 50 mm and draw tangent and normal to the curve.

18. Construct **the parabola** of the base 105 mm and the axis length 98 mm **using rectangle method**. Locate focus, vertex and directrix of the parabola. Also draw tangent and normal to the parabola.
19. Construct **a parabola** having base length 100 mm and axis height 60 mm by **tangent method**.
20. Construct **the parabola** if the base is 80 mm and the axis length is 50 mm.
21. A throw of ball from boundary of a cricket ground reaches the wicket keeper's gloves following the parabolic path. Maximum height achieved by the ball above the ground is 31 m. Assume the point of throw and point of catching position 1m above the ground. Radial distance of boundary from wicket keeper is 75 m. Construct the path of ball.

**Hyperbola**

22. Draw **a hyperbola** having **eccentricity 8:5**, the vertex V of which is at a distance of 25 mm from the directrix AB. Find at least 8 points to draw the curve. Find the distance of the focus F from the directrix. Also draw a normal and a tangent to the curve at a distance 52 mm from the focus.
23. A point P is 20 mm and 30 mm respectively from two straight lines which are at right angles to each other. Draw a **rectangular hyperbola** from P within 6 mm distance from each asymptote line.

**Cycloid**

24. **A wheel** of the diameter 50 mm **rolls over the straight line without slipping** for one rotation. Draw the path traced by the point P which is initially at the point of the contact between the wheel and the straight line. Name the path traced. Name the curve and also draw tangent and normal to the curve at suitable point on the curve.
25. A **rolling circle**, of 60 mm diameter **rolling along a straight line without slipping**. Take initial position of the tracing point at the bottom of the vertical centre line of the rolling circle. Name the curve and draw tangent and normal to the curve at a point 35 mm above the directing line.
26. **A wheel rolls** over **the horizontal straight line** path and covers **1980 mm distance** in one rotation. Draw the path traced by the point P which is initially at the point of contact between the wheel and the horizontal straight line. Name the path traced by the point P.
27. **A circle** of 50 mm diameter **rolls along the circumference of another circle** of 150 mm diameter from **outside.** Draw the path of a point P on the circumference of the rolling circle for one complete revolution and name the curve.
28. **A circle** of 50 mm diameter **rolls on another circle** of 175 mm diameter, **outside it.** Trace the locus of a point on the circumference of the rolling circle for one complete revolution. Name the curve.
29. Draw and name the curve traced by a point on the perimeter of 60 mm diameter **circle** if it **rolls by one revolution outside the circle** with 160 mm Diameter.

30. **A circle** of 60 mm diameter is **rolling on a circle** of 120 mm radius and **inside** it. Initially point P is at contact point of two circles. Draw the locus of point P. Draw tangent and normal at any point on the curve.
31. Show graphically that the **hypocycloid is a straight line**, when the **diameter of the rolling circle is half that of the directing circle**. Take radius of the rolling circle as 40 mm.

**Trochoid**

32. Draw the **inferior epitrochoid** generated by the moving point P which is 25 mm from the centre of the rolling circle. Take the rolling circle radius as 30 mm and the directing circle radius is 90 mm. The rolling circle rolls for one rotation without slippage. Draw tangent and normal to the curve at any point on the curve.

**Involute**

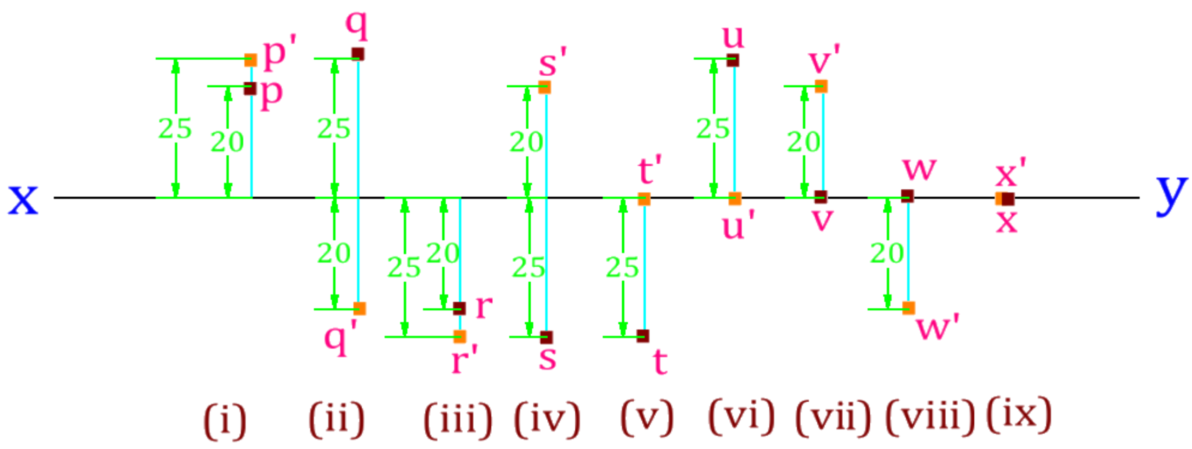
33. A string is kept tight while unwinding it **from a square prism** which is resting with its base on the H.P. Trace the path of the end point of the string, if 100 mm long string can be unwound in one turn. Name the path traced by the end point of the string.
34. Construct an **Involute** of a regular pentagon of 25 mm sides.
35. A string is unwound **from a pentagon** of 25 mm side. Draw the locus of end P for unwounding **the one turn of string**. String is kept tight during the operation of unwounding. Give the name of curve. Draw the tangent and normal to the curve at any point.
36. A string is unwound from a **hexagon** of 25 mm side. Draw the locus of end P for unwinding the one turn of string.
37. Construction the **involute of a hexagon** of side 20 mm. Draw the tangent and normal to the involute at any point.
38. Construct **the Involute of circle** of 30 mm diameter for one turn. Draw tangent and normal to the Involute at any point on it.
39. An elastic string is unwounded to a **length of 120 mm** from **a drum of diameter 30 mm**. Draw the locus of the free end of the string which is held tight during unwinding.
40. Draw **an involute of a circular arc** which subtends an angle of 90° at the centre of the circle of diameter 120 mm.
41. Draw an **involute of a line** of 10 mm for either minimum 3 turns or maximum 5 turns.

**Spiral**

42. Draw an **Archimedean spiral of 2/3 convolution**. When maximum and minimum radii being 60 mm and 20 mm respectively.
43. Construct an **Archimedean** spiral of **one and half convolutions** given the greatest and shortest radii as 84 mm and the 00 mm respectively. Draw the tangent and normal at point 60 mm away from the pole.
44. Draw **an Archimedean spiral of 1.5 convolutions,** the greatest and least radii being 125 mm and 35 mm respectively. Draw tangent and normal to the spiral at any point on the curve.
45. **A point P moves towards another point O**, 75 mm from it, and reaches it during **1¼ revolution** around it in clockwise direction. Its movement towards O is uniform with its movement around it. Draw the curve traced out by the point P and name it.

# 4. Projections of Points & Lines

1. Draw the projection of points, the position of as per data given below:
    - i. A point P 25 mm above HP and 20 mm behind VP
    - ii. A point Q 20 mm below HP and 25 mm behind VP
    - iii. A point R 25 mm below HP and 20 mm in front of VP
    - iv. A point S 20 mm above HP and 25 mm in front of VP
    - v. A point T on HP and 25 mm in front of VP
    - vi. A point U on HP and 25 mm behind VP
    - vii. A point V on VP and 20 mm above HP
    - viii. A point W on VP and 20 mm below HP
    - ix. A point X on HP as well as VP both.




**Position of an End Point & Inclination with HP & VP & TL**

2. A **line AB 75 mm long** is inclined at an angle of **45° to HP and 30° to VP.** One of its end **point A is in HP as well as VP.** Determine its apparent inclination with VP.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

3. A **line AB, 100 mm long,** is **inclined to HP by 45° and inclined to VP by 30°**. The line is in first quadrant with **point A 10 mm above HP and 20 mm in front of VP**. Draw the projection of line AB.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

4. A **line AB is 80 mm long**. It is inclined at **an angle of 45° to the Horizontal Plane and 30° to the Vertical Plane.** The end **A is 20 mm above Horizontal Plane and 40 mm in front of Vertical Plane.** Draw the projections of the line and also write Elevation Length and Plan length of the line.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

5. A **line AB, 60 mm long, is inclined to H.P. at 35° and also inclined to V.P. at 45°**. The end **A of the line is 20 mm above H.P. and 15 mm in front of V.P.** The **end B is in third quadrant**. Draw the projections of line AB.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

6. A **line PQ, 65 mm long**, **is inclined to HP by 30° and inclined to VP by 45°**. The end **P is 20 mm below HP and 25 mm behind VP** Point **Q is in fourth quadrant**. Draw its projections and find the position of the point Q.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

7. A straight **line AB** is **inclined to the HP by 55° and to the VP by 35°,** if true **length of line is 80 mm.** The **end A is 10 mm above HP and 25 mm in front of VP** find lengths of plan and elevation of the line and draw the projections.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

8. A **line PQ, 100 mm long** has its **end P 15 mm above the HP** Line makes **an angle of 30° with the HP and 45° with the VP** End **Q of the line is on VP** Draw the projections of the line considering it in first quadrant.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

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**Position of Mid-Point is given**

9. A **line AB, 140 mm long** is **inclined at 35° to HP and 45° to VP**. Its **midpoint C is in VP and 15 mm above HP.** The **end A is in the third quadrant and B in the first quadrant**. Draw the projections of the line.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

10. A straight **line AB 80 mm long** is **inclined at 30° to the HP and at 45° to the VP**. Its **midpoint C is in the VP and 18 mm above the HP**, while its end A is in the third quadrant, and the end B is in the first quadrant. Draw its projections.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

**Position of End Points & TL**

11. A **line AB 100 mm long** has its end **point A 15 mm above HP and 10 mm in front of VP** and end **point B 60 mm above HP and 70 mm in front of VP**. Determine true inclination of line AB with HP and VP

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

12. A **line AB, 75 mm long**, has its **end A 20mm below HP and 25 mm behind VP** The **end B is 50 mm below HP and 65 mm behind VP** Draw the projections of line AB and find its inclinations with HP and VP

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

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**Position of End Points & Distance between End Projectors**

13. The **projectors of the ends of a line AB are 75 mm apart**. The **end A is 20 mm above horizontal plane and 30 mm in front of the vertical plane**. The **end B is 45 mm below the HP and 45 mm behind the VP** Determine the true length of line AB, its inclinations with HP and VP and apparent angles also.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

14. The distance between **end projectors of a straight line PQ is 130 mm** point **P is 40 mm below HP and 25 mm in front of VP** Point **Q is 75 mm above HP and 30 mm behind VP** Draw the projection of a line and find out its true length and inclination with HP and VP

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

15. The distance between **end projectors of a straight line CD is 65 mm**. The point **C is 30 mm above HP and 25 mm behind VP** The point **D is 40 mm above HP and 20 mm in front VP** Draw the projections of straight line CD. Through which principal plane the straight line will pass and what will be the distance of the point of intersection of line from the other principal plane?

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

16. A **line AB** has its **end A is 15 mm above HP and 20 mm in front of VP.** The **end D is 60 mm above HP and 55 mm infront of V.P.** The distance between the **end projectors is 70 mm**. The line is **inclined to HP by 30°.** Draw the projections and find its inclination with VP and true length of line AB.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

17. A **line PQ has its end P 15 mm above HP and 10 mm in front of VP** The **end Q is 60 mm above HP** The distance between the **end projectors is 55 mm.** The line is **inclined to HP by 25 degree**. Draw the projections and find its inclination with VP and true length of line PQ.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

18. The **end projectors of a line PQ are 35 mm** apart. The **end P of the line is 10 mm above H.P. and 15 mm in front of V.P.** The **front view and top view** of the line measure **50 mm and 60 mm** respectively. Draw the projection of the line assuming **end Q is in first quadrant**. Also find the true length and true inclinations of the line with H.P. and V.P.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

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**Position of an End Point or Length of FV/TV or Inclination with HP/VP or inclination of FV/TV**

19. The **top view of 75 mm long line AB measures 65 mm**, while the **length of its Front view is 50 mm**. It's one **end A is in the HP and 12 mm in front of the VP** Draw the projections of line AB and its inclinations with the HP and the VP

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

20. A **line AB 65 mm long** appears to be **55 mm in plan and 45 mm in elevation**. Its end **A is 20 mm below HP and 40 mm behind VP** Draw projections of a line and find the true angle of inclinations of line with HP and VP

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

21. The **top view and the front view of the line EF, measures 65 mm and 53 mm** respectively. The line is **inclined to HP and VP by 30° and 45°**, respectively. The end **E is on the HP and 10 mm in front of VP**. **Other end F is in the 1st quadrant**. Draw the projections of the line EF and find its true length.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

22. A **line AB** is having its **end A 10 mm, above HP and 30 mm in front of VP** It is **inclined at 45° to HP and 30° to VP** The **end B is below HP and behind VP** Draw the projections of the line AB if the **plan length is 80 mm**. Also, find the true length of the line.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

23. A **line** is measuring **80 mm long** has one of its **end 60 mm above HP and 20 mm in front of VP** The **other end is 15 mm above HP and in front of VP** The **front view of the line is 60 mm** long. Draw the projection of line and find the true angle of inclination of line with HP and VP

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

24. A **line AB, 100 mm long**, is **inclined at 50° to Horizontal Plane**. The **end A is 10 mm above the Horizontal Plane and end is 65 mm in front of the Vertical Plane**. Draw projections of the line if its **Front View measures 90 mm** and find the inclination of the line with the Vertical Plane.

| | | | |
|---|---|---|---|
| T.L.= | $\theta =$ | L.F.V.= | $\alpha =$ |
| L.E.P. = | $\varphi =$ | L.T.V.= | $\beta =$ |

25. The **front view of a line AB, 90 mm long, measures 65 mm**. **Front view is inclined to XY line by 45°.** Point **A is 20 mm below HP and on VP Point B is in third quadrant**. Draw the projections and find Inclinations of line with HP and VP.

| | | | |
|---|---|---|---|
| T.L.= | θ = | L.F.V.= | α = |
| L.E.P. = | φ = | L.T.V.= | β = |

26. **Plan of a 75 mm long line CD measures 50 mm**. End **C is in HP and 50 mm in front of VP** End **D is 15 mm in front of VP and it is above HP.** Draw projections of CD and find angles with VP and HP.

| | | | |
|---|---|---|---|
| T.L.= | θ = | L.F.V.= | α = |
| L.E.P. = | φ = | L.T.V.= | β = |

27. A **line AB 90 mm** long is **inclined at 30° to the HP** Its end **A is 12 mm above the HP and 20 mm in front of VP** Its **front view measures 65 mm**. Draw the top view of AB and state its length. Determine the inclination of top view and line AB with VP.

| | | | |
|---|---|---|---|
| T.L.= | θ = | L.F.V.= | α = |
| L.E.P. = | φ = | L.T.V.= | β = |

28. A **line AB, 100 mm long**, is **inclined at $45^0$ to HP** The end **A is 10 mm above the HP and is 65 mm in front of the VP** Draw projections of the line if its **Front View measures 90 mm** and find the inclination of the line with the VP.

| | | | |
|---|---|---|---|
| T.L.= | θ = | L.F.V.= | α = |
| L.E.P. = | φ = | L.T.V.= | β = |

29. The **front view and top view of a line MN is inclined at an angle of 30° and 40°** respectively. The **front view of line MN measures 50 mm**. Point **M is 15 mm above HP and 10 mm in front of VP** Draw the projections of line MN and find the true length of line MN.

| | | | |
|---|---|---|---|
| T.L.= | θ = | L.F.V.= | α = |
| L.E.P. = | φ = | L.T.V.= | β = |

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**Miscellaneous**

30. A straight **line AB** has its end **A 10 mm above HP** and end **B 50 mm in front of the VP** Draw the projections of line AB, if it is **inclined to HP by 30° and to VP by 45°** and **it is 50 mm long**.

| | | | |
|---|---|---|---|
| T.L.= | θ = | L.F.V.= | α = |
| L.E.P. = | φ = | L.T.V.= | β = |

31. A **line PQ 70 mm** long has its **end P in VP** and **end Q in HP**. Line is **inclined to HP by 60°** and **VP by 30°**. Draw the projections.

| | | | |
|---|---|---|---|
| T.L.= | θ = | L.F.V.= | α = |
| L.E.P. = | φ = | L.T.V.= | β = |

32. A **line PQ 60 mm** long has its **end P on V.P** and **Q on HP** Line is **inclined to HP by 60°** and **VP by 30°** and it is 20 mm away from the profile plane. Draw the projections of the line.

| | | | |
|---|---|---|---|
| T.L.= | θ = | L.F.V.= | α = |
| L.E.P. = | φ = | L.T.V.= | β = |

33. A **line AB** measures **80 mm in top view and 70 mm in front view**. The **midpoint M of the line is 45 mm in front of VP and 35 mm above HP** The **end A is 10 mm in front of VP** Draw the projections of the line and find its true length and inclination with HP and VP.

| | | | |
|---|---|---|---|
| T.L.= | θ = | L.F.V.= | α = |
| L.E.P. = | φ = | L.T.V.= | β = |

34. The **line AB** has **end A in front of VP and 30 mm above H.P**, while **end B is in VP and 20 mm below HP** The **line is inclined at 30° to the VP** and the **apparent angle in elevation is 30°.** Draw the projections of the line AB. Find the true length, the elevation length and the plan length of the line. Measure the inclination of the line with the HP.

| | | | |
|---|---|---|---|
| T.L.= | θ = | L.F.V.= | α = |
| L.E.P. = | φ = | L.T.V.= | β = |

35. A **line AB** has a **point P on it such that AP: PB = 1: 2**. The **end A is in the first quadrant and it is 20 mm above HP** while the **end B is in the VP** The point **P is 35 mm from the HP** The **line is inclined at 30° to the HP** and the **elevation length of the line is 70 mm**. Draw the projections of the line AB and the point P. Find the true length, the plan length and the inclination of the line with VP.

| | | | |
|---|---|---|---|
| T.L.= | θ = | L.F.V.= | α = |
| L.E.P. = | φ = | L.T.V.= | β = |

# 5. Projections of Plane

1. **An isosceles triangular plane XYZ** having its base XY = 50 mm and altitude 60 mm is **resting on HP on its base** XY with its **surface making an angle of 45° to HP.** The **base XY which is in HP makes an angle of 60° to VP.** Draw projection of plane.
2. **An isosceles triangle plate ABC** having its base 50 mm and altitude 90 mm **resting on H.P. on its base.** The isosceles **triangle is inclined at an angle 50° to the H.P.** and the **altitude in the top view is inclined at the angle 70° to the V.P.** Draw the projections.
3. **A semi-circular thin plate** of 60 mm diameter **rests on H.P. on its diameter, which is inclined at 45° to V.P.** and the **surface is inclined at 30° to the H.P**. Draw the projections of the plate.
4. **A circular plane** of 60 mm diameter is **resting on H.P. on a point A of its circumference**. The plane **(surface) is inclined at 30° to the H.P**. The **diameter AB of the plane** makes an **angle of 45° with the V.P.** Draw the projections of the circular plane.
5. **A square lamina** of side 35 mm is **resting on HP on one of its sides** such that the **surface of the lamina is inclined at 40° to HP.** Draw its top view and front view when **the side on which it rests is parallel to VP.**
6. **A regular pentagonal plane** having the side 30 mm is **resting on H.P. on one of its corners**. The **surface of the plane is inclined to the H.P. at 45°**. Draw the projections of the plane when the **side opposite to the corner on which it rest on H.P. is inclined at 30° to V.P.**

   **OR**

   **A pentagon plate**, side 30 mm is **resting on H.P. on one of its corners** with **opposite edge to the corner making 30° with V.P**. The **plate (surface) is inclined to H.P. by 45°.** Draw its projections.
7. **ABCDE is a regular pentagonal plate** of 40 mm sides, has **its corner A on the H.P.** the **plate is inclined at 30° to the H.P.** such that the **side CD is parallel to both the reference planes**. Draw the projection of plate.
8. A **pentagon plate**, side 40 mm is resting on H.P. on one of its corners. The plate is inclined to **H.P. by 45°** and **perpendicular to VP**. Draw its projections.
9. A **hexagonal plate (30 mm)** is resting on one of its side on H.P. The side on which it rests makes an angle of **60° with V.P**. and the plate makes an angle of **45° with H.P**. Draw the projections of the plate.
10. **A Pentagonal plane** of side 50 mm is **kept on the HP on one of its side** in such a way that its **surface makes an angle of 45° with HP.** Draw the projection of plane when **side which is in HP is inclined at 60° with VP** in such a way that **nearest corner point is at a distance of 20 mm from VP**.

11. **A square plate PQRS** of side 35 mm is **resting on corner P on V.P.** with **diagonal PR making 30° with V.P.** and **diagonal QS inclined to H.P. by 60° and parallel to V.**P. Draw the projections of the square plate.
12. **A Pentagonal plate** having 30 mm side is **resting on V.P on one of its corner** plate **(surface) makes $45^0$ with V.P.** The **side opposite to the corner on which it rest makes $30^0$ with H.P**. Draw its projection.
13. **A thin 30°-60° set square** has its **longest edge is 80 mm in the VP and inclined at 45° to the HP**. Its **surface makes an angle of 60° with the VP.** Draw its projections.
14. **A regular pentagon** of 30 mm side has **one side parallel to the V.P. and making an angle of 40° with the H.P.** the plane **surface of the pentagon make 35° the V.P.** Draw its projections.
15. **A regular pentagonal plate** is **resting in V.P. on one of its sides** with **surface making an angle 45° with V.P**. The **side on which it rests on V.P. makes 60° with H.P.** Draw the projections of pentagonal plate having the side 30 mm.
16. **A regular hexagonal plate** of 30 mm sides is **resting on one of its edges on V.P**. such that the **surface is inclined at 45° to V.P.** and the **edge on which it is resting is inclined at 30° to H.P.** Draw the projections of the hexagonal surface.

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17. **A square plate** of side 60 mm is held on **a corner on H.P** Plate is inclined to the H.P. such that the **plan of it is rhombuses** with a diagonal of 30 mm. determine the angle it makes with H.P. The other diagonal is **inclined at 45° V.P.** Draw the projection of plate.
18. **A square plate** of side 40 mm is rest on one of its **corner on H.P**. with diagonal horizontal and **inclined at 50° to V.P**. The Plate is **seen as a rhombus in plan** with one of its diagonals measuring 30 mm. Draw the projections.
19. **A thin rectangular plate** of 60 x 30 mm has its shorter side **in the V.P.** and inclined at 30º to the H.P. Project its top view, if its **front view is a square** of 30 mm long sides.
20. **ABCD is a rhombus** of diagonals AC =100 mm and BD=70 mm. Its **corner A is in the H.P.** and the plane is inclined to the H.P. such that its **plan appears to be a square** and the plan of the diagonal AC makes an **angle of 20° to the V.P.** Draw the projections of the plane and find its inclination with the H. P.
21. **A circular plate** of negligible thickness having 70 mm diameter is resting on HP on a point of the circumference. Plate is kept **perpendicular to VP** and inclined to the HP such that the **plan of it is an ellipse** of minor axis 40 mm. Draw the projections.
22. A **circular plane** having the diameter 75 mm is resting with point A of its periphery on HP. The surface of the **plane is inclined to HP** such that the **plan of the plane becomes an ellipse** with

minor axis is 30 mm. Draw the projections of the plane when plan of the **diameter through point A is inclined at 30° to VP** and the **centre of the plane is 50 mm from VP**. Find the inclination of the plane with HP.

23. **A circular plate** of negligible thickness and 46 mm diameter **appears as an ellipse in the top view**, having its major axis 46 mm long and minor axis 28 mm long. Draw its front view when the major axis of ellipse makes an **angle of 60º to V.P**.
24. **An elliptical plane** with major axis 70 mm and minor axis 50 mm is inclined to H.P. such that the **top view of the plane is a circle**. Draw the projections of the plane when the major axis is inclined at **30º to the V.P**. Find the inclination of the plane with the H.P. Use the concentric circle method to draw the top view of the plane in the initial stage.
25. **An Elliptical plane** of major axis 70 mm and minor axis 50 mm is **resting on H.P** on one end point of major axis. It **appears as circle in the top view**. Minor axis makes **$45^0$ with V.P**. Draw its projection.
26. **The top plan** of a pair of **equal legs AB and AC of compass appears as an isosceles triangle** having base 50 mm and vertex angle at 45° .Actual lengths of compass legs AB and AC are 120 mm. Assume **points B and C on H.P.** and line connecting B and C is **perpendicular to V.P**. Draw the projections and find (I) the actual angle between two legs (ii) the height of point above HP and (iii) angle of plane, containing compass, makes with H.P.

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27. **A rhombus** is having its diagonals 100 mm and 50 mm long. Draw the projections of the rhombus when the **longer diagonal is inclined at 30° to the Horizontal Plane** and **30° to Vertical Plane.**
28. A **Square plate**, side 40 mm, is resting on H.P with one side of plate inclined to **V.P. by 30°**. Draw the projections.
29. **An isosceles triangular plate ABC** has its base 45 mm and altitude 60 mm. It is so placed that the **front view is seen as an equilateral triangle** of 45 mm side and (i) base is inclined at 45º to HP, (ii) side is inclined at 45º to HP. Draw its plan when its **corner A is on HP.**

# 6. Projections of Solids, Sections of Solids and Development of Surfaces

## Projections of Solids

1. Give complete classification of solids.
2. Explain (1) Polyhedra (2) Solid of Revolution.

**Axis/Base Edge are inclined to HP/VP**

3. A pentagonal prism rests on one of its edges of the base on H.P. with its axis inclined at 45° to the H.P. The top view of the axis is inclined at 30° to the V.P. Draw the projections of the prism, assuming the edge of the base to be 30 mm and the axis 70 mm long.
4. A pentagonal pyramid is having its base ABCDE and the apex O. The length of the axis is 80 mm and the edge of base is 30 mm. The pyramid is resting on the H.P. with the edge CD on it. Draw the projections when the axis of the pyramid is inclined at 30° to the H.P. and the plan of the axis of the pyramid makes 45° with the V.P.
5. Draw the projection of cylinder, base 30 mm diameter and axis 40 mm long, rests with a point of its base circle on H.P. such that the axis is making an angle of 30° with H.P. and its top view perpendicular to V.P.
6. Draw the projection of a cone, base 44 mm diameter and axis 50 mm long, when it is resting on the H.P. on a point of its base circle with the axis making an angle of 45° with H.P. and 30° with V.P.
7. A cone diameter of base 60 mm and height 90 mm is resting on H.P. on the point of periphery of the base. Axis of the cone makes 60 degree with the H.P. and 30 degree with the V. P. Draw the projections of the cone, when the apex is nearer to observer.
8. A square pyramid, side of the base 40 mm and axis 60 mm long, has one of its base edges in the H.P. and axis inclined at 30° to the HP. Draw its projections when a) the top view of the axis makes an angle 45° with the V.P. and b) the axis makes an angle of 45° with the V.P.
9. A square prism, having base 30 mm side and axis 50 mm long, has its axis inclined at 45° to the H.P. and has an edge of its base on the H.P. and inclined at 30° to the V.P. Draw the projection.
10. A Hexagonal prism is resting on one of its side of base (30 mm), such that axis(60 mm) is inclined at 45° to H.P. and the side on which it is resting is inclined at 30° to V.P. Draw the projections.
11. A Square pyramid, side of base 50 mm and axis length 60 mm is kept on HP on one of its base edges in such a way that its axis makes an angle of 45° with HP. If the base edge which is on HP makes an angle of 45° with VP, draw the projections when apex is 30 mm away from VP.
12. A cylinder of base diameter 50 mm and axis 70 mm rest in the VP, has its axis inclination 30° VP and front view of axis is inclined at 30° to the ground line XY. Draw the projection of the cylinder.

13. The frustum of a cone of 30 mm base diameter, 50 mm top diameter and 50 mm height is resting on V.P. on a point of its base circumference such that the axis is inclined at 50° to V.P. and parallel to H.P. Draw the projections of the solid.

**Triangular surface is inclined to HP/VP**

14. A pentagonal pyramid has height 60 mm and the side of a base 30 mm. The pyramid rests on one of its sides of the base on the H.P. such that the triangular face containing that side is perpendicular to the H.P. and makes an angle of 45 degree with the V.P. Draw its projections.
15. A hexagonal pyramid, side of the base 25 mm long and height 70 mm resting on HP on its side, has one of its triangular faces perpendicular to the HP and inclined at 60° to VP. Draw its projections.
16. A tetrahedron of 50 mm edge is resting on H.P on one of its edge. Face passing through that edge is perpendicular to H.P and parallels to V.P. Draw its projections.
17. A pentagonal pyramid of 35 mm base edge and 70 mm height is resting on the Horizontal Plane with one of its triangular surfaces perpendicular to the Horizontal Plane and parallel and nearer to Vertical Plane. Draw its projections.

**Slant edge is inclined to HP/VP**

18. A hexagonal pyramid, base 25 mm side and axis 55 mm long, has one of its slant edges on the H.P. A plane containing that edge and the axis is perpendicular to the H.P. and inclined at 45° to the V.P. Draw its projections when the apex is nearer to V.P. than the base.
19. ABCD is tetrahedron of 60 mm long edge. The edge AB is in the H.P. The edge CD is inclined at an angle of 30° to the H.P. and 45° to the V.P. Draw the projections of the tetrahedron.
20. A pentagonal prism is resting on one of the corner of its base on the H.P. The longer edge containing that corner is inclined at 45° to the H.P. The axis of the prism makes an angle of 30° to the V.P. Draw the projections of the solid.

**Miscellaneous**

21. A cube with a 30 mm side resting on one of its corners on the HP. Draw the projections when the base is inclined at 45° to HP and axis parallel to VP.
22. A frustum of a cone, having base diameter 60 mm, top base diameter 25 mm and axis 45 mm, is resting on one of its generators on H.P. The axes of the frustum makes and angle of 30° with V.P. Draw the projections of the solid.

23. A circular cone is of 60 mm base diameter and 80 mm long generator. It is resting on the H.P. with one of the points of its base on it and the apex 55 mm above it. Draw the projection of the cone when the plan of the axis is inclined at 45° to the V.P. Measure the inclination of the cone with the H.P.
24. A square pyramid, side of base 50 mm and height 64 mm, is freely suspended from one of the corners of the base. Draw its projection when vertical plane containing the axis makes an angle of 45o to VP.

## Sections of Solids

**Cut by Auxiliary Inclined Plane**

25. A square pyramid, base 40 mm side and axis 65 mm long, has its base on the H.P. And all the edges of the base equally inclined to the V.P. It is cut by a section plane perpendicular to the V.P. inclined at 45° to the H.P. and bisecting the axis. Draw its sectional top view, sectional side view ant true shape of the section.
26. A pentagonal prism of side length of base 30 mm and height 60 mm is resting on HP with one edge of base perpendicular to VP. It is cut by an Auxiliary Inclined Plane included at 40° to HP and bisecting the axis. Draw sectional top view, sectional side view and true shape of the section.
27. A hexagonal Prism, side of base 30 mm and height 60 mm, is standing upright with base on H.P. one side of the base and axis are parallel to V.P. It is cut by section plane making an angle of 60° to H.P. and crossing the axis 10 mm from the top. Draw top view, sectional front view, sectional left hand side view and true shape of section.
28. A pentagonal pyramid, side of base 40 mm and height 80 mm, is resting on its base with one of the edges of the base away from V.P. is parallel to V.P. It is cut by an AIP bisecting the axis, the distance of the section plane from the apex being 20 mm. Draw the elevation and sectional plan of pyramid and draw the true shape of the section. Also find the inclination of the section plane with the H.P.
29. A cone having the diameter of base 80 mm and the height 90 mm is resting with its base on the H.P. It is cut by A.I.P. inclined at 45° to the H.P. The cutting plane passes through the mid-point of the axis of the cone. Draw the elevation, the sectional plan and the true shape of the section.
30. A cone, base 75 mm diameter and axis 80 mm long is resting on its base on the H.P. It is cut by a section plane perpendicular to the V.P., inclined at 45° to the H.P. and cutting the axis at a 35 mm from the apex. Draw front view, sectional top view and true shape of the section.

**Cut by Auxiliary Inclined Plane (Base cut)**

31. A solid made of half cone, diameter of base 60 mm, and half hexagonal pyramid, side of base 30 mm, is having 60 mm height. It is resting on HP on its base with middle edge of base perpendicular to VP. It is cut by an AIP inclined at 30° to HP, passing through a point on axis 12 mm above the base. Draw elevation, plan and true shape of the section.
32. A cone, base 40 mm diameter and axis 60 mm long, rests on its base on the HP. It is cut by a section plane perpendicular to the VP and parallel to one of its generators and passing through a point on the axis at a distance of 25 mm from the apex. Draw the front view, sectional top view, sectional side view and the true shape of the section. Give the name of that True shape.

**Cut by Auxiliary Vertical Plane**

33. A hexagonal pyramid of the base side 30 mm and axis length 70 mm is resting on H.P. with its base on it and one of the sides of the base parallel to V.P. The axis of the pyramid is 40 mm away from the V.P. The pyramid is cut by the A.V.P. inclined at 30°. The cutting plane is 15 mm away from the axis and nearer to the observer. Draw the top view, sectional front view and the true shape of the section.
34. A cone with base circle diameter 60 mm and axis length 75 mm is kept on its base on the ground. It is cut by a sectional plane perpendicular to HP and inclined at 60° to VP at a distance of 8 mm away from the top view of axis. Draw sectional elevation and true shape of the section.
35. A frustum of hexagonal pyramid, side of base 30 mm and height 60 mm, is cutting from a pyramid of height 80 mm, is standing upright with base on H.P. and axis parallel to V.P. It is cut by section plane making an angle of 50° to V.P. and remaining 20 mm away from the axis. Draw top view, sectional front view, sectional left hand side view and true shape of section.

**Combined projection and section cut by AIP**

36. A cone diameter of base 50 mm and height 80 mm is resting on the H.P. on one of its generators with axis parallel to the V.P. It is cut by horizontal section plane passing through a point on the axis 55 mm away from the apex. Draw the elevation and sectional plan of cone.
37. A cone, having diameter of base 50 mm and axis 65 mm long, is lying on the ground on one of its generator with the axis parallel to V.P. It is cut by a horizontal section plane 12 mm above the H.P. Draw its sectional top view.
38. A triangular prism, with a base side of 50 mm and an axis length of 70 mm, is resting on a rectangular face on the HP, the axis being parallel to the VP. An AIP inclined at 45° to the HP cuts the prism. The cutting plane intersects the axis at a distance of 30 mm from one end of the prism. Draw Front View, Sectional Top view and sectional side view of the prism.

39. A hexagonal pyramid of side of base 40 mm and height of axis 110 mm is resting on one of its inclined vertical surface on H.P. such that its axis remains parallel to the V.P. It is cut by a cutting plane which is inclined at an angle 45° with H.P. and bisecting the axis of the pyramid. Draw front view, sectional top view.

**Combined projection and section cut by AVP**

40. A cylinder, diameter of base 75 mm and axis 84 mm is resting on one of its generator on the H.P. with its axis remaining parallel to V.P. It is cut by an A.V.P. inclined to the V.P. by 45° and passing through the midpoint of the axis of the cylinder. Draw sectional elevation, sectional end view and plan showing the cutting plane.
41. A hexagonal pyramid is resting on one of its triangular face on H.P. with axis remaining parallel to V.P. It is cut A.V.P. making 30° with V.P. passing through a point on the axis 33 mm from the apex. Draw plan, sectional elevation and the true shape of section. Take side of base 30 mm and height 75 mm.
42. A pentagonal pyramid, base 30 mm side and axis 60 mm long, is lying on one of its triangular faces on the H.P. with axis parallel to the V.P. A vertical section plane bisects the top view of the axis and makes an angle of 30° with V.P. Draw the sectional front view.
43. A pentagonal prism of 30 mm sides and 60 mm height is resting on one of its corners of its base on H.P. such that the axis is inclined at 45° to H.P. Draw the projection of the prism. Now, the prism is cut by a sectional plane inclined at 60° to V.P. and bisecting the axis. Draw the sectional front view of the prism.

**Reverse Problem (True Shape is given)**

44. A cone, base diameter 60 mm and axis length 60 mm is kept on H.P. on its base. It is cut by a plane in such a way that the true shape of the section is an isosceles triangle of base 40 mm. Draw front view and sectional top view.
45. A tetrahedron of 50 mm long edges is lying on HP on one of its faces with one of its edges perpendicular to VP so that the true shape of its section is an isosceles triangle of base 40 mm and altitude 28 mm. Find the inclination of the section plane with HP. Draw the front view, sectional top view and the true shape of the section.
46. A tetrahedron of 70 mm long edges is lying on Horizontal Plane on one of its faces with an edge of that face perpendicular to the Vertical Plane. It is cut by a section plane perpendicular to both the reference plane in such a way that the true shape of section is an isosceles triangle of 45 mm height. Draw elevation, plan and side view when smaller cut piece of the object is assumed to be removed.

47. A cube of 50 mm long edges has its vertical faces equally inclined to VP. It is cut by a section plane perpendicular to VP so that the true shape of the section is a regular hexagon. Determine the inclination of the cutting plane with the HP and draw the sectional top view and true shape of the section.

## Development of Surfaces

48. A pentagonal prism of base side 30 mm and axis length 60 mm is resting on H.P. on its base with a side of base is parallel to V.P. It is cut by a plane inclined at 35° to H.P. and perpendicular to V.P. and meets the axis at a distance 35 mm from the base. Draw the development of the lower portion of prism.
49. Fig.1 shows the F.V. of a square prism with side of 30 mm kept on H.P. on its base with all sides of base inclined to V.P. The prism is cut by two cutting planes C1-P1 and C2-P2. Draw the development of surface of the square prism.
50. Draw the development of surfaces of portion-P of the cut hexagonal prism shown in Fig.2.

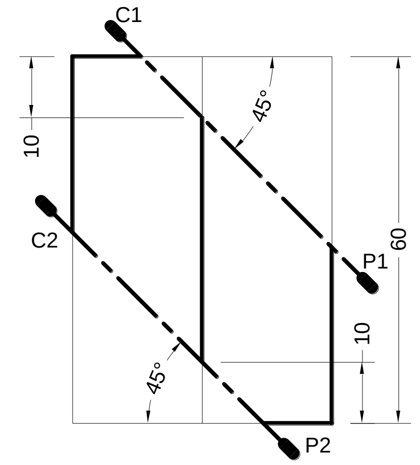



*Fig.1*

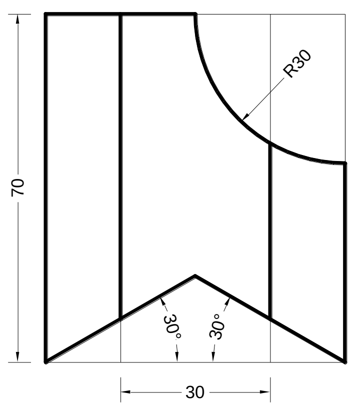



*Fig.2*

51. Draw the development of the lateral surfaces of the hexagonal prism as shown in figure3.
52. Part P of a pentagonal prism is shown in Fig.4. Draw its development of surfaces

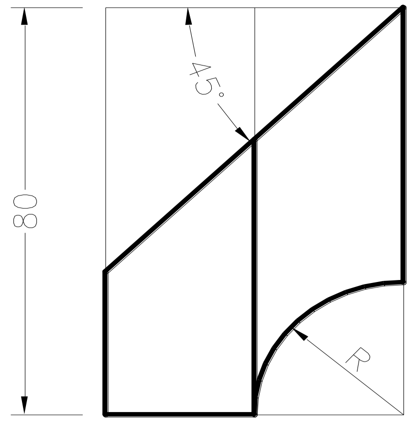



*Fig.3*

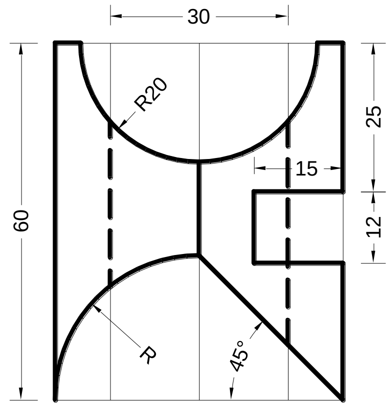



*Fig.4*

53. Draw the development of lateral surface of a cylinder of base diameter 40 mm and height 60 mm kept on H.P. on its base and cut by an AIP inclined 60° to H.P. and bisecting the axis of the cylinder
54. Draw the development of lateral surface of the cylinder shown in Fig.5.

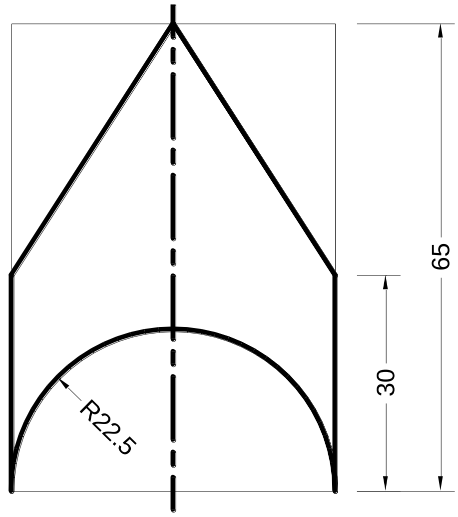


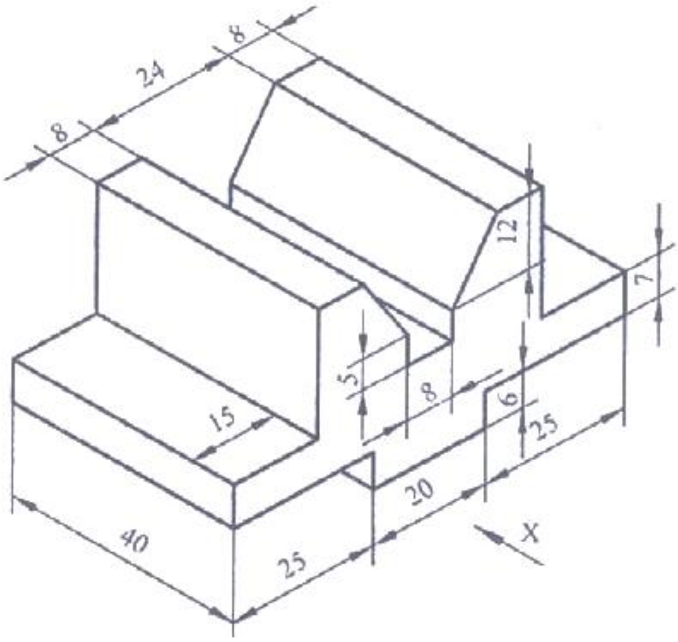

*Fig.5*

55. A cylinder of 50mm diameter and axis length 70 mm is resting on H.P. on its base. It has a pentagonal hole of 30 mm side the axis of which is perpendicular to V.P. and parallel to H.P. The hole axis is 6 mm to the right of the cylinder and35 mm above the base of cylinder. If the hole has one face parallel to the profile plane and to the left side of the axis of the cylinder. Draw the development of lateral surface of the cylinder with the pentagonal hole.
56. A regular pentagon pyramid is resting on H.P with its one of the edge perpendicular to the V.P. It is cut by A.I.P making 60° with H.P and cut the axis at a distance of 25 mm from apex. Length of edge of pyramid is 30 mm and height is 55 mm. Draw the development of the cut pyramid.
57. A hexagonal pyramid, side of base 33 mm and height 66 mm, is resting on H.P. on its base with two side of base perpendicular to V.P. It is cut by A.I.P., inclined to H.P by 45°, passing through a point 25 mm from apex on the axis. Draw the development of the cut pyramid..
58. A square pyramid, side of base 50mm and height 50 mm, is resting on H.P. On its base with all sides of base equally inclined to V.P. A rectangular slot, 40 mm wide and 15 mm high, is made in the centre at the bottom of the pyramid. Draw the development of the lateral surfaces of the pyramid. Show also the effect of the slot in the plan.
59. A cone of base diameter 50 mm and axis length 70 mm rests with its base on H.P.A section plane perpendicular to V.P. and inclined at 35° to H.P. bisects the axis of the cone. Draw the development of the truncated cone.
60. A cone, radius of base 40 mm and slant height 120 mm, is resting on H.P. on its base. It is cut by two cutting planes, passing through extreme left and right corner of elevation, and making an angle of 45° with H.P. Draw the development of the sectional cone.

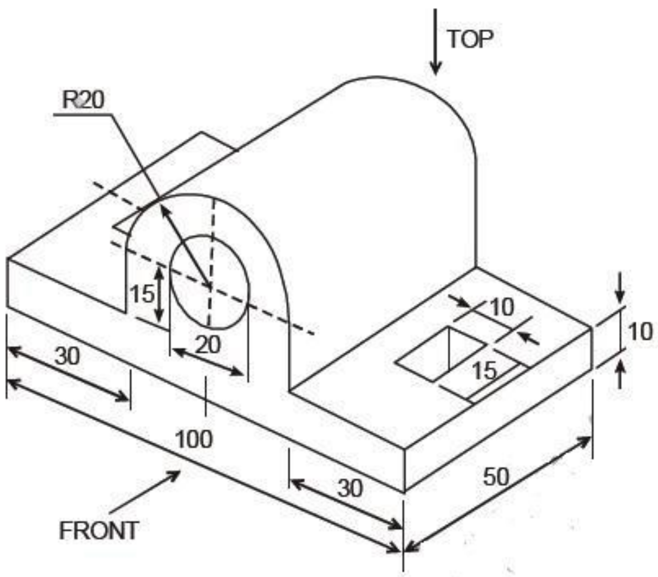
61. A cone, radius of base 30 mm and axis height 80 mm is resting on H.P. on its base. A circular hole of diameter 30 mm is drilled through the prism such that axis of hole is perpendicular to V.P. and parallel to H.P. and passing through 50 mm from apex and intersect on cone axis. Draw the development of lateral surfaces of the cone.

# 7. Orthographic Projections

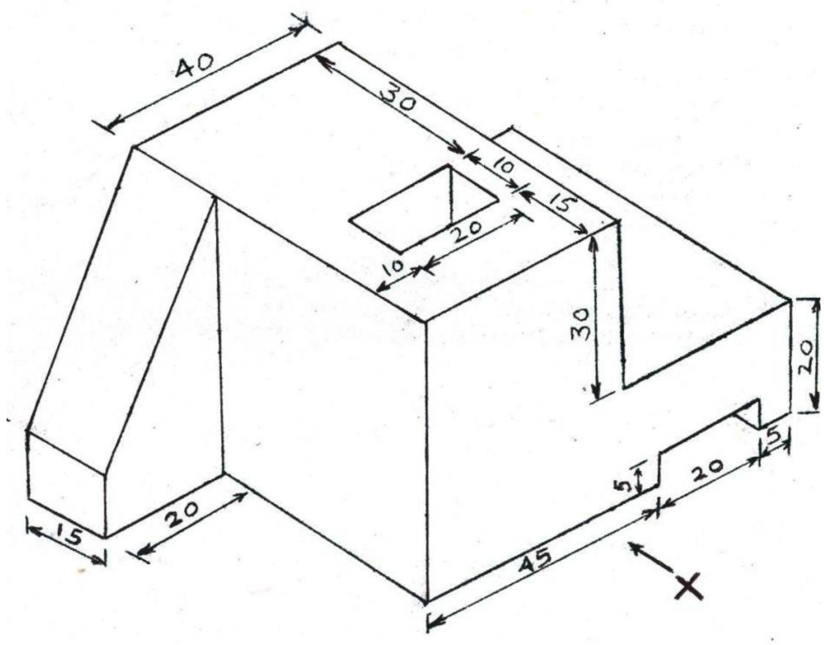
1. Explain the difference between 1st angle and 3rd angle orthographic projection.
2. Explain the reason why for first angle method of orthographic projection the sequence is observer – objet – plane and third angle is observer – plane – object.
3. In orthographic projection why second and fourth angle projection method are not used?
4. Draw the symbols for first angle and third angle projection method
5. Draw orthographic view (i) Elevation (ii) Top view (iii) Left Hand Side View of the following figure, Use 1st angle projection system



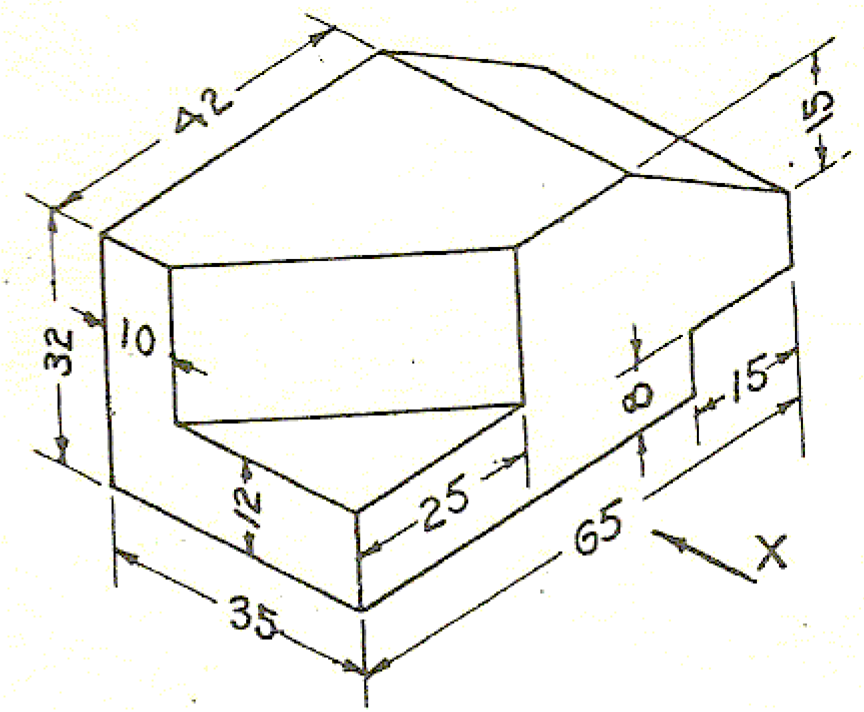

6. Using the Third angle projection method, draw the following view for the FIGURE-1. Give the dimensions using the Aligned dimensioning method. (i) Front view (ii) Top view (iii) Full Sectional Right Hand Side End View.



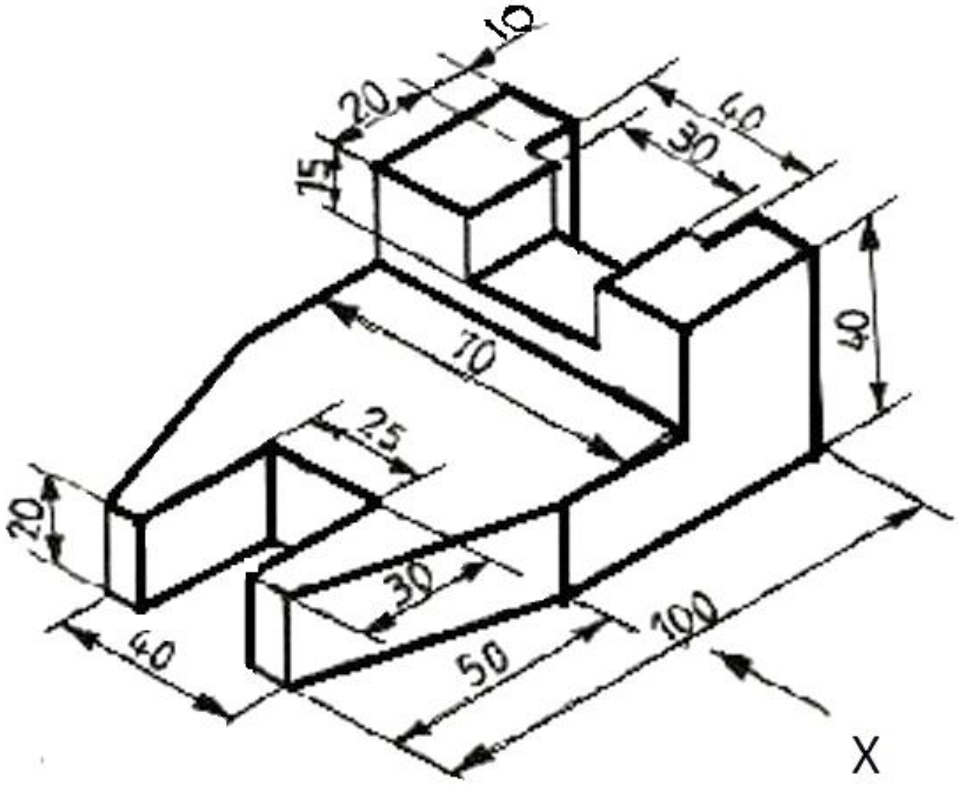
7. Refer the object shown in figure. Draw the following orthographic views using the first angle projection method. Use the Aligned System of dimensioning. (i) Front View from the direction X (ii) Top View (iii) Left Hand Side View.



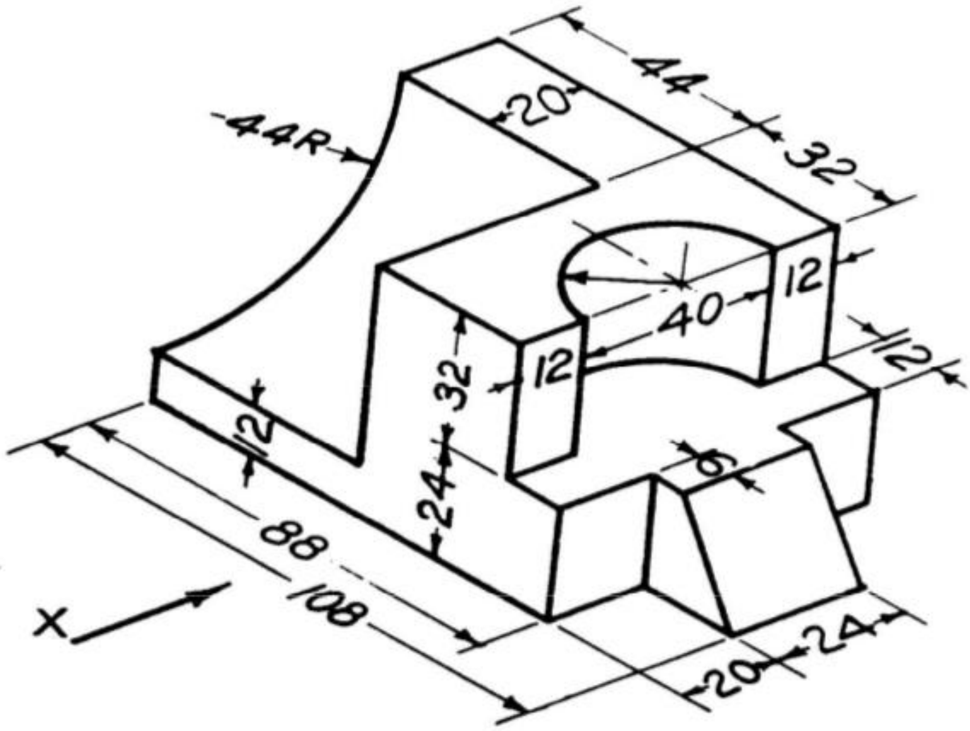

8. Draw front view and top view of the object shown in figure according to third angle projection method.



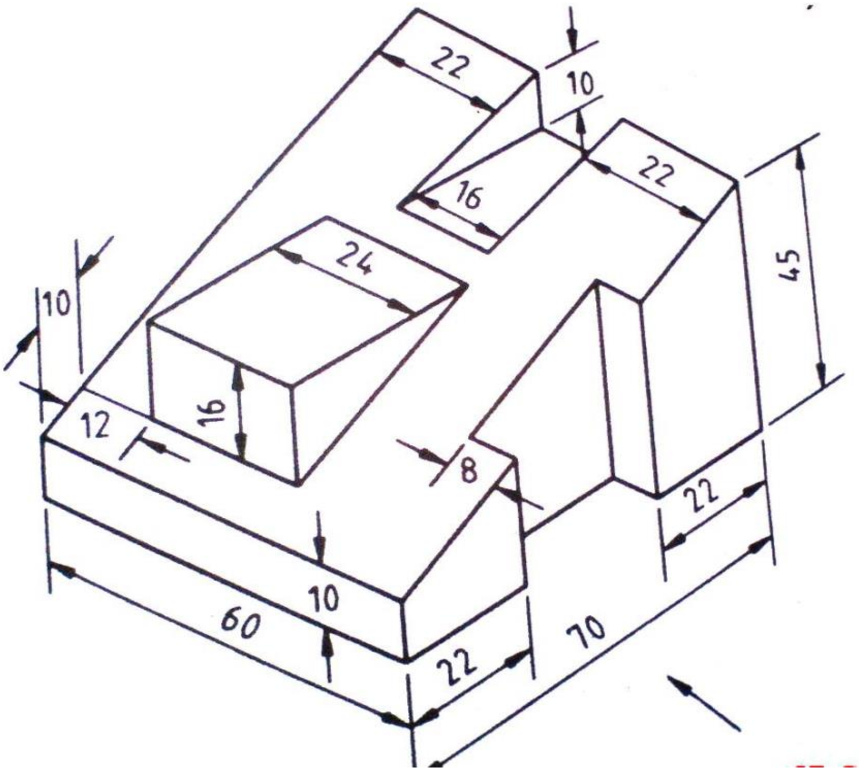
9. Figure shows the pictorial view of the object. Draw the sectional front view, top view and left hand side view using first angle method of projection.



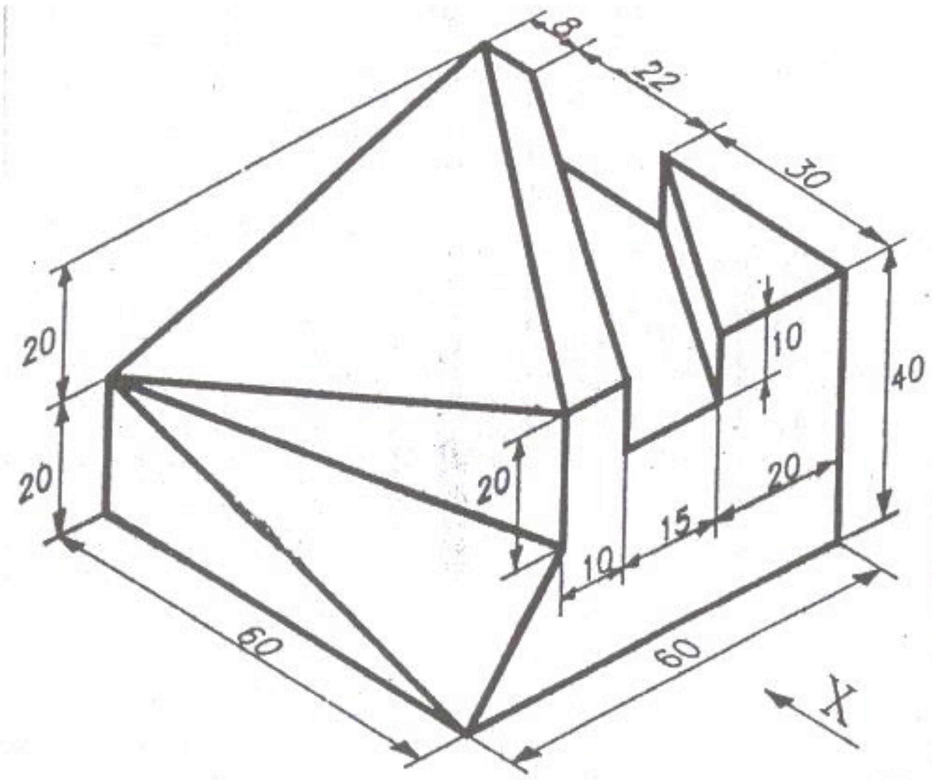

10. The following figure shows pictorial view of an object. Draw to the full scale the following views, using first angle projection method. Insert all dimensions. (1). Front view looking in the direction of arrow X (2). Top view, (3). Right hand side view



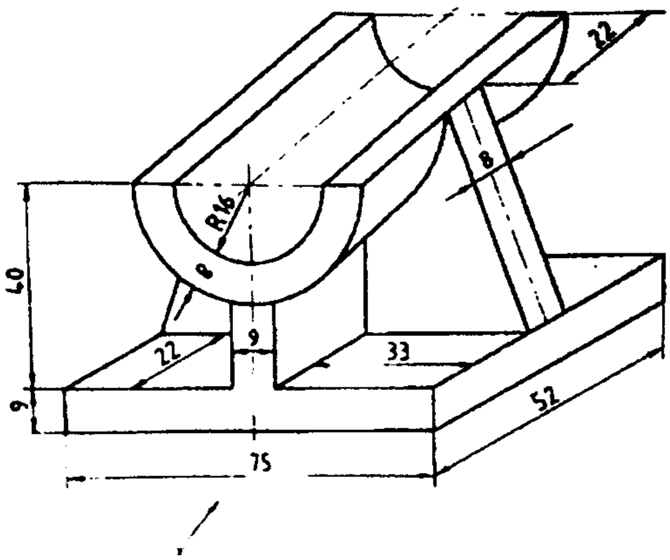
11. Draw the front view, top view and left hand side view of the object given in figure. Use first angle projection method.



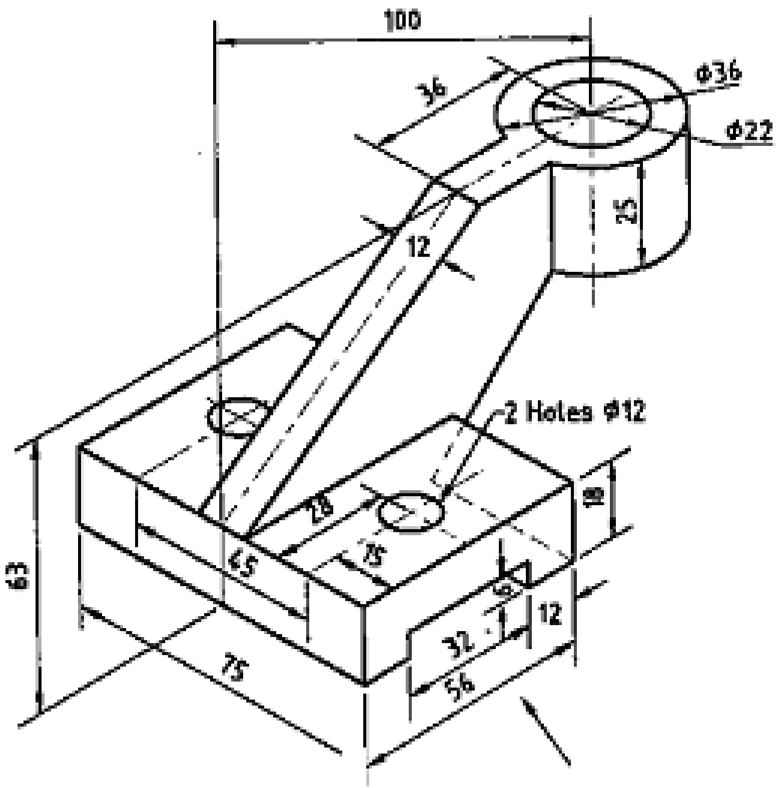

12. Draw Elevation and Left Hand Side View and top view of figure according to First Angle projection method.



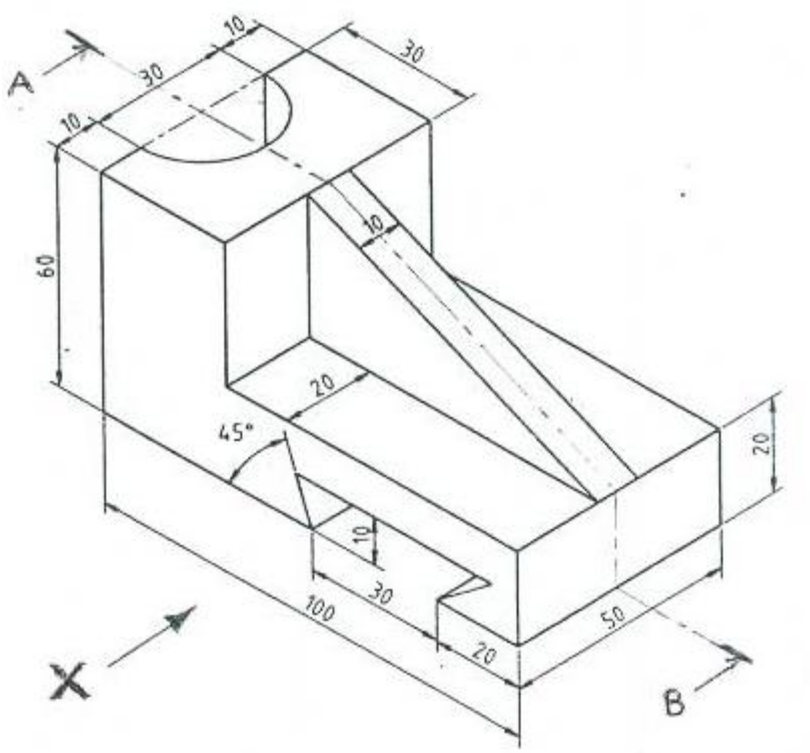
13. Following figure shows the pictorial view of the object .Draw the Front view, Top view and any hand side view using first angle method of projection.



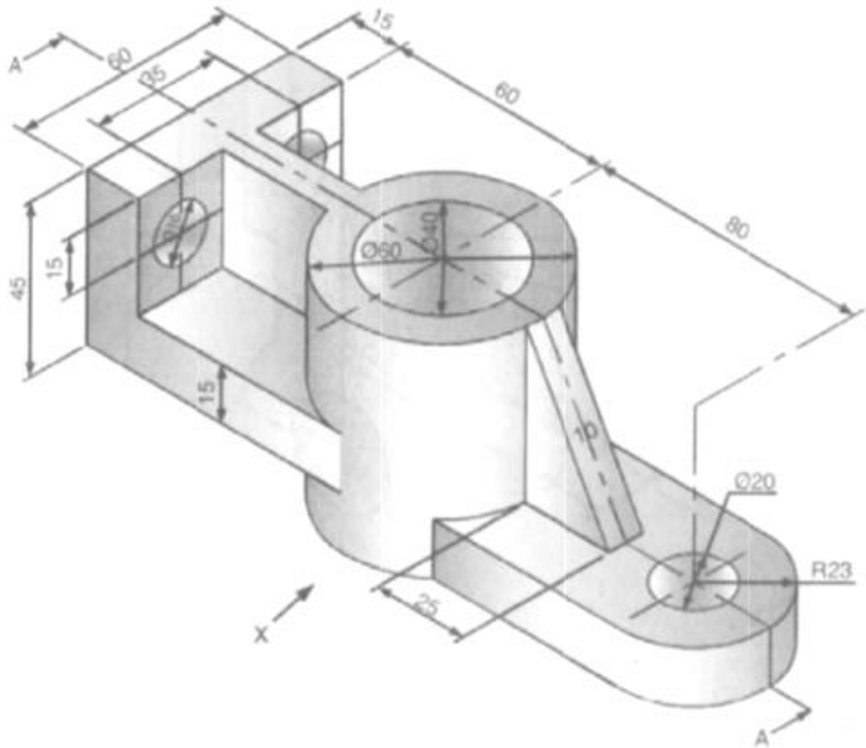

14. Following figure shows the pictorial view of the object .Draw the Front view, Top view and left hand side view using first angle method of projection.



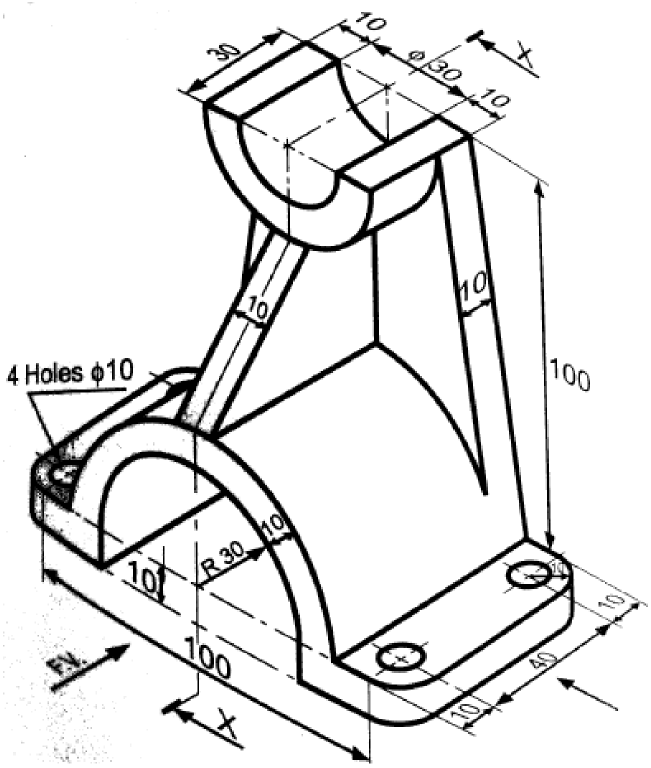
15. Refer the object shown in figure. Draw the following views using the first angle projection method. Use the unidirectional system of the dimensioning. (i) Sectional Front View (ii) Top View (iii) Right Hand Side View



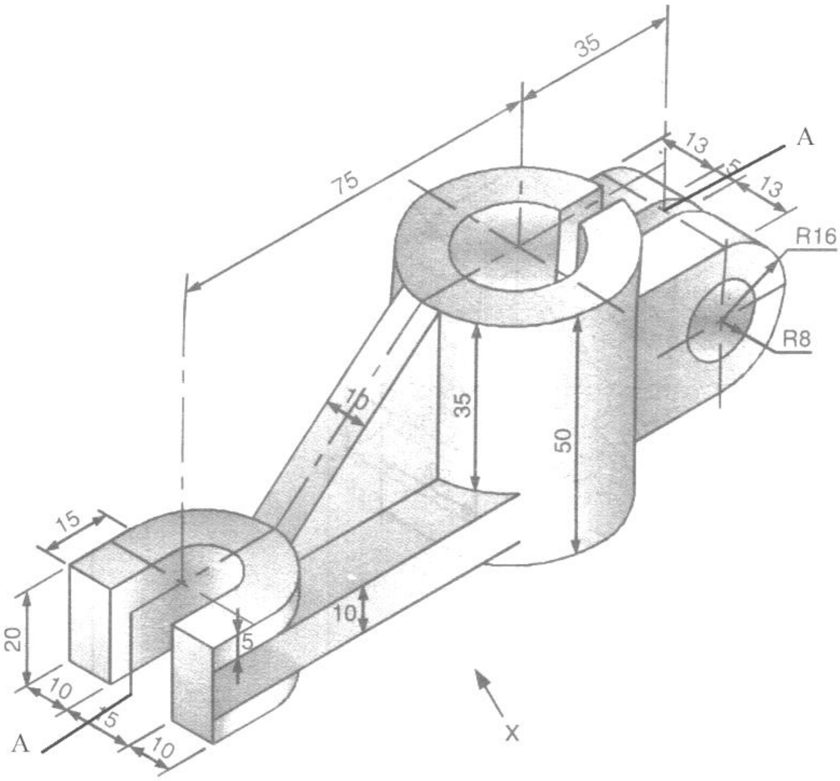

16. Figure shows the pictorial view of an object. Draw the following views: (i) Sectional front view from A-A, (ii) R.H.S. view and (iii) Top view using 1 st angle Projection Method.



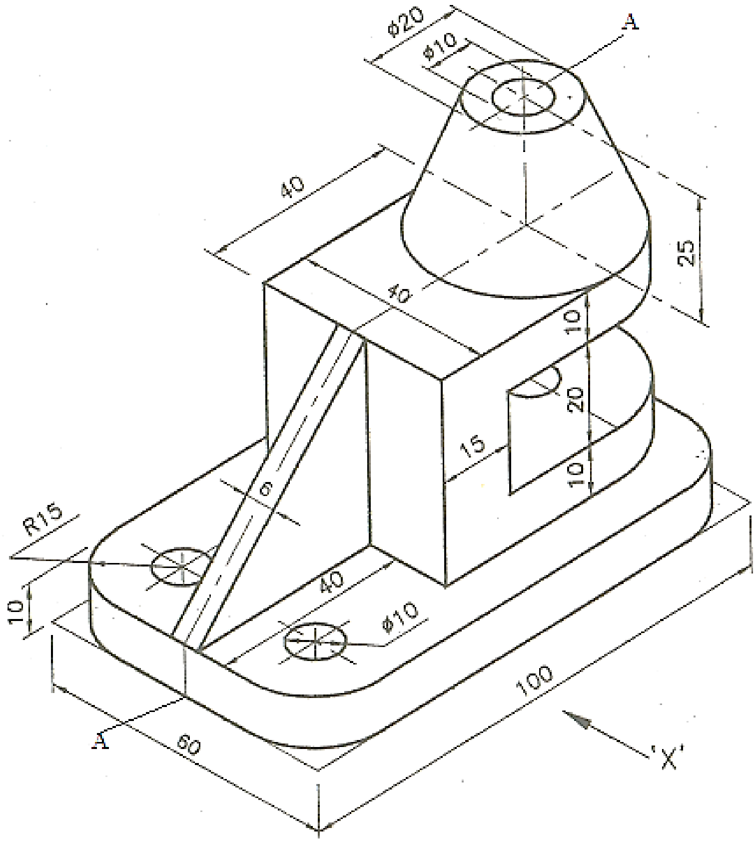
17. Pictorial view of an object is given in figure. Draw (i) Front View and (ii) Full Sectional Right Hand Side View. Insert necessary dimensions using aligned system of dimensioning. Take section along X-X.



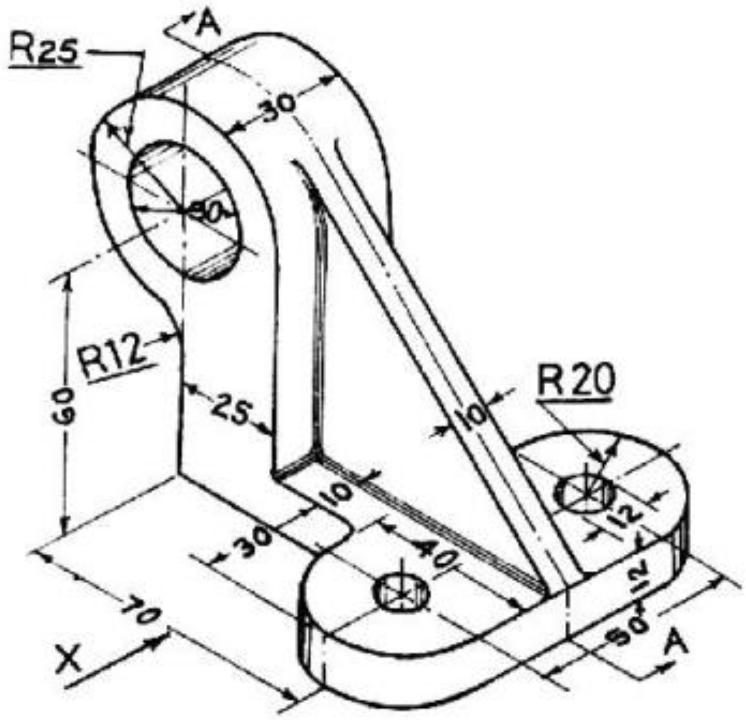

18. Figure shows the pictorial view of an object. Draw the following views. (I). Sectional front view. (ii). Right hand side view (iii). Top view. Use first angle projection method.



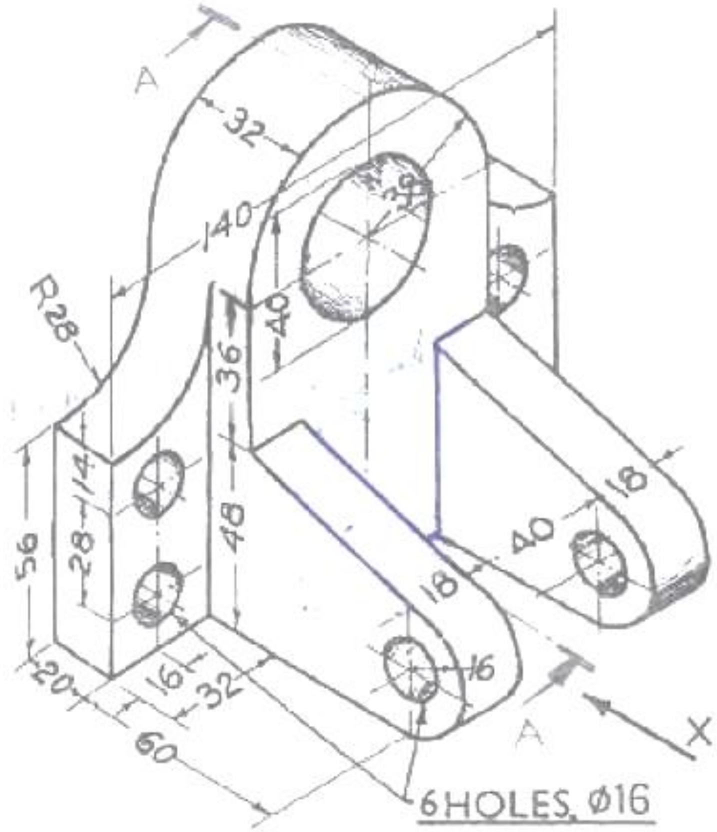
19. Isometric view of an object is given in Figure 1. Use first angle projection. Draw the sectional front view along with A-A and left hand view of the object.



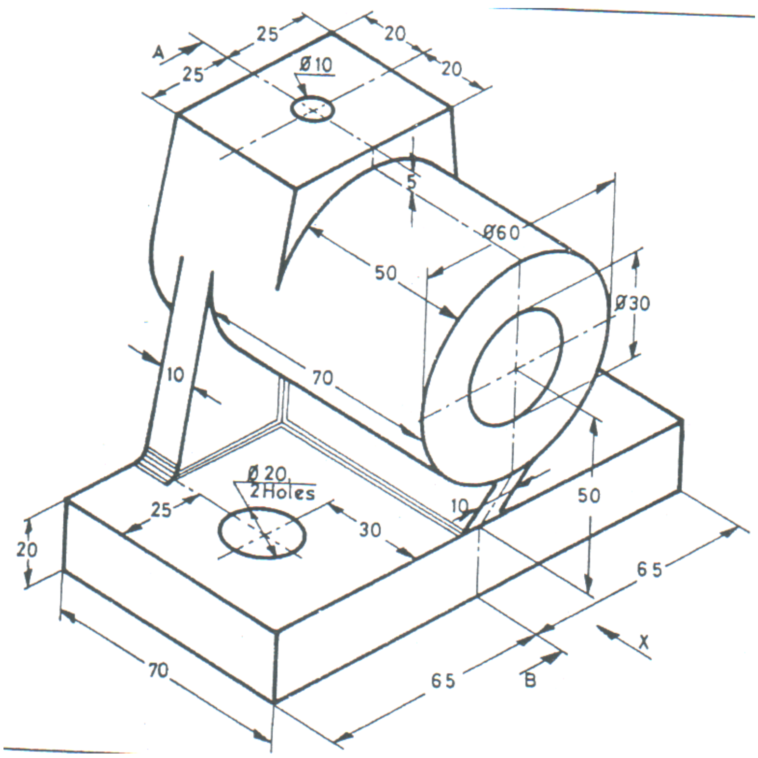

20. Figure shows pictorial view of an object. Draw following views (a) Sectional Elevation from – X (b) Plan and ( c ) Right hand side view



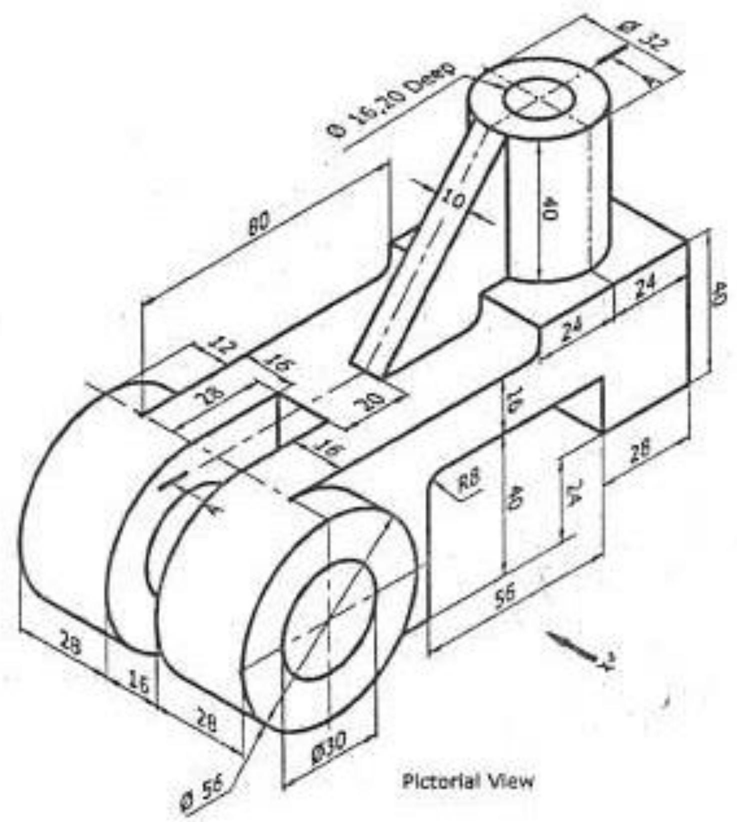
21. Figure shows the three dimensional pictorial view of an object. Draw using first angle projection method, front view, top view and sectional side view.




22. Draw the following views for the Figure. Give the dimensions using Aligned dimensioning method. (i)Front view (ii)Top view (iii)Sectional left hand side view

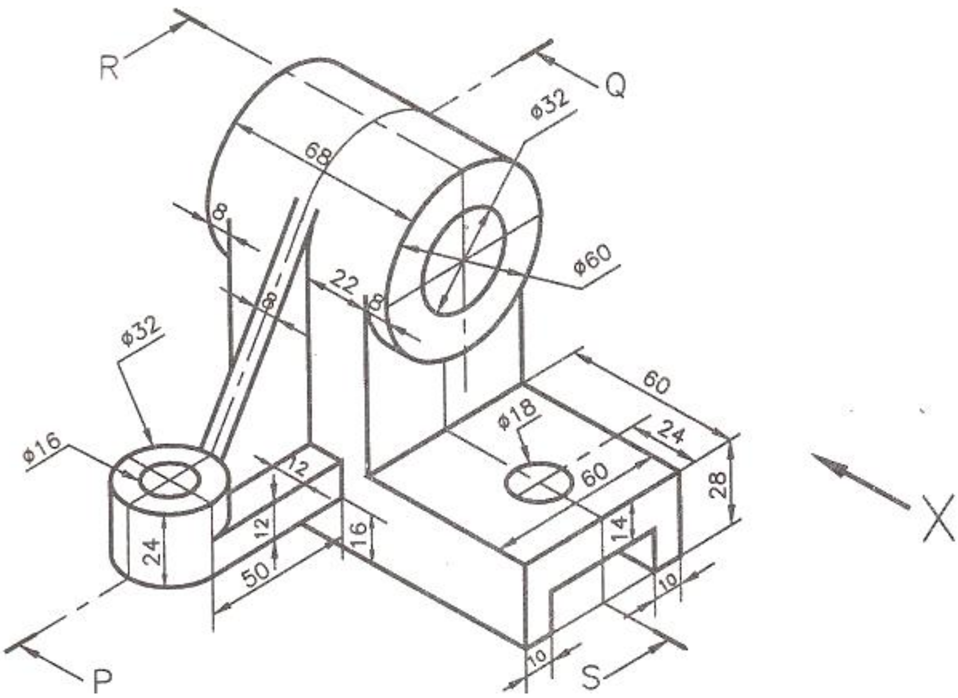


23. Figure shows the Pictorial view of an object. Draw the following views using first angle projection method (a) Sectional Front elevation looking from direction X, take section along A-A (b) Top view (c) Side view from left. Show all dimensions.

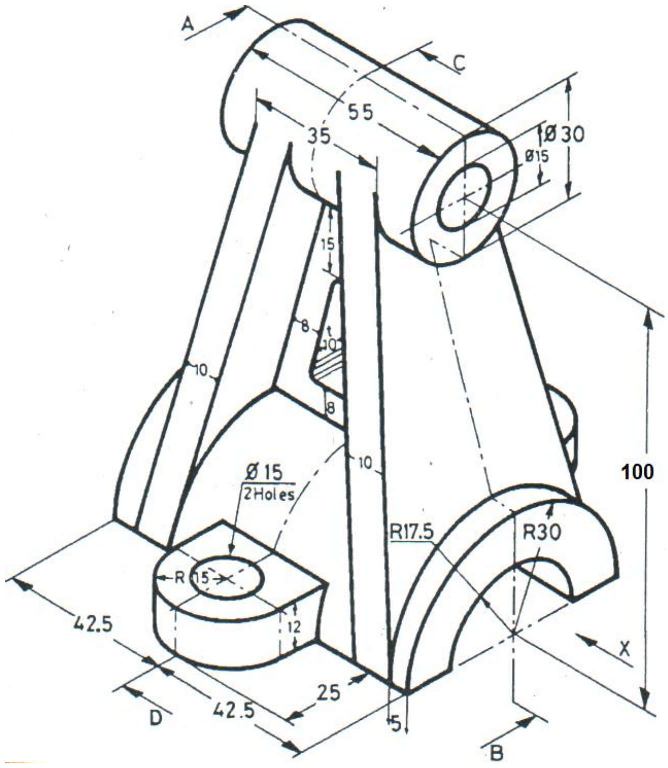



Pictorial View

24. Figure shows an object. Draw sectional front view along section P-Q looking in the direction of arrow X, top view and sectional left hand side view along section R-S using first angle projection method.

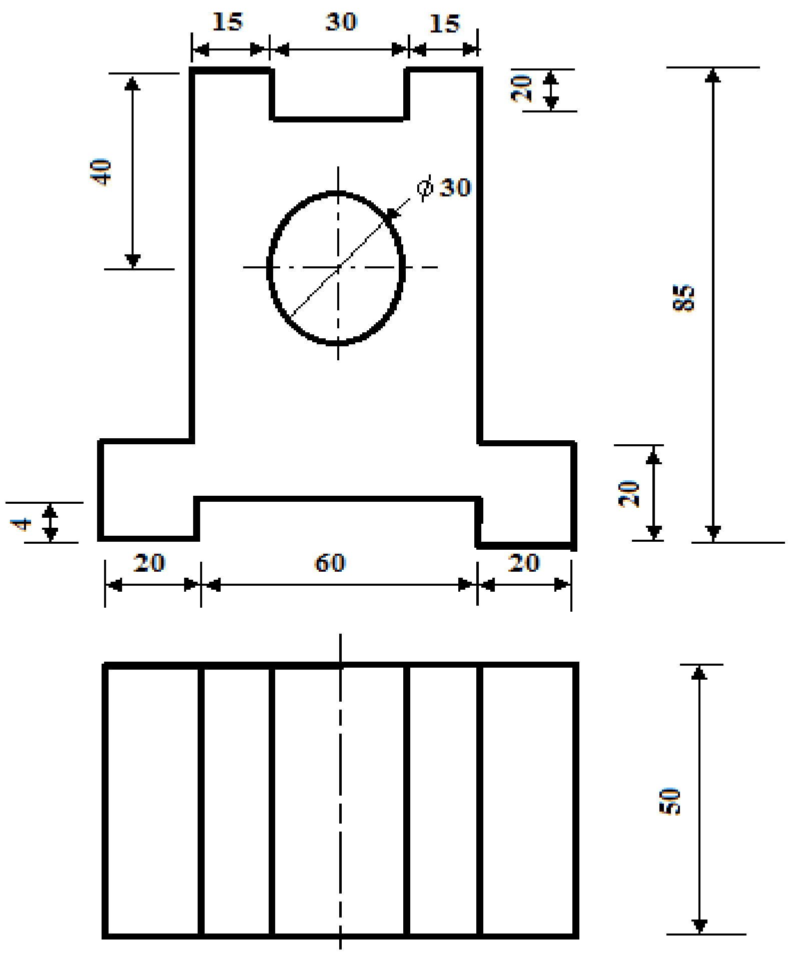


25. Using the first angle projection method, draw the following view for the figure Give the dimensions using the Aligned dimensioning method. (i) Sectional front view by taking section along C-D (ii) Sectional left hand side view by taking section along A-B (iii) Top view

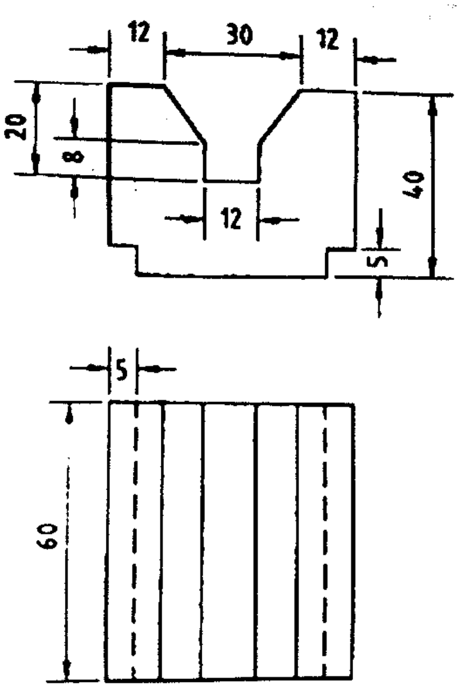


# 8. Isometric Projections and Isometric View or Drawing

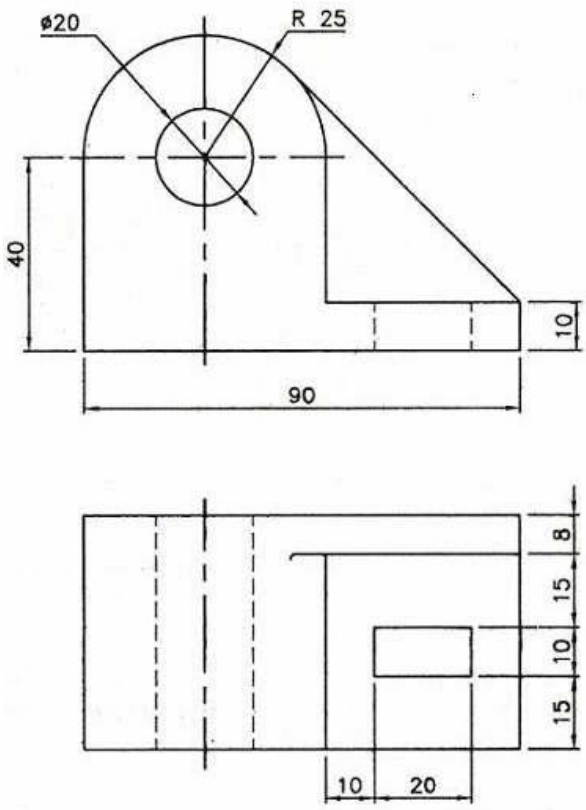
1. Construct an Isometric scale.
2. Differentiate between Isometric View and Isometric Projections.
3. The top view of an object is a square of 60 mm side while the front view is a circle of radius 30 mm. Draw the isometric projection of the object.
4. Draw the isometric drawing of the frustum of a square pyramid when the length of the bottom edge is 60 mm, the length of the top edge is 40 mm and the height of the frustum is 70 mm.
5. Draw the isometric projection and isometric drawing of a sphere of diameter 50 mm placed on a cylinder of base 60 mm diameter and height 30 mm.
6. Explain method of drawing cylinder in isometric draw.
7. Draw Isometric View of Square Prism with side of base 40 mm and length of axis 70 mm.
8. Draw the isometric view of the following orthographic views shown in Figure.



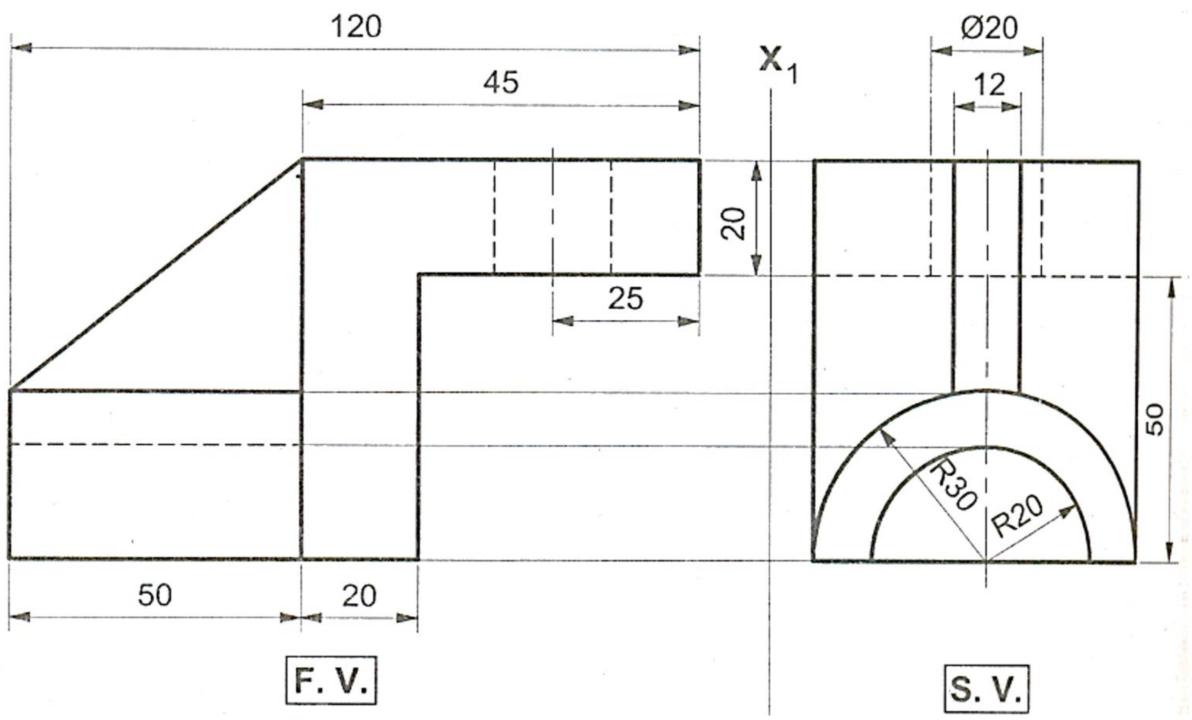
9. Draw the isometric view for the below figure.



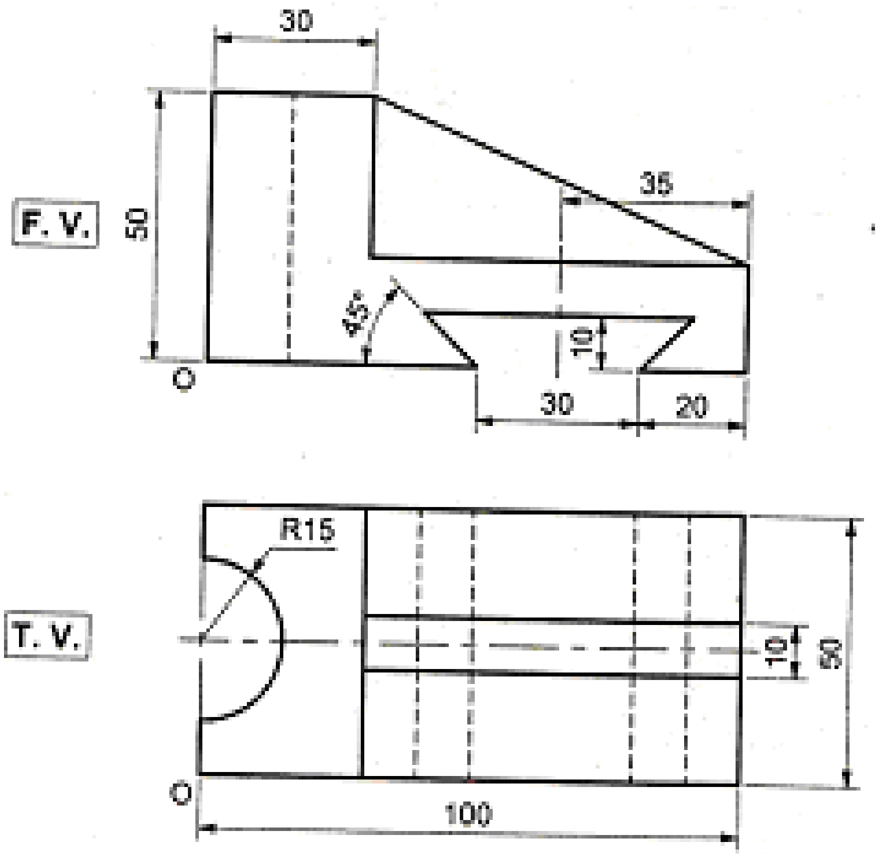

10. Figures shows elevation and plan of a bracket draw isometric projection of the bracket.



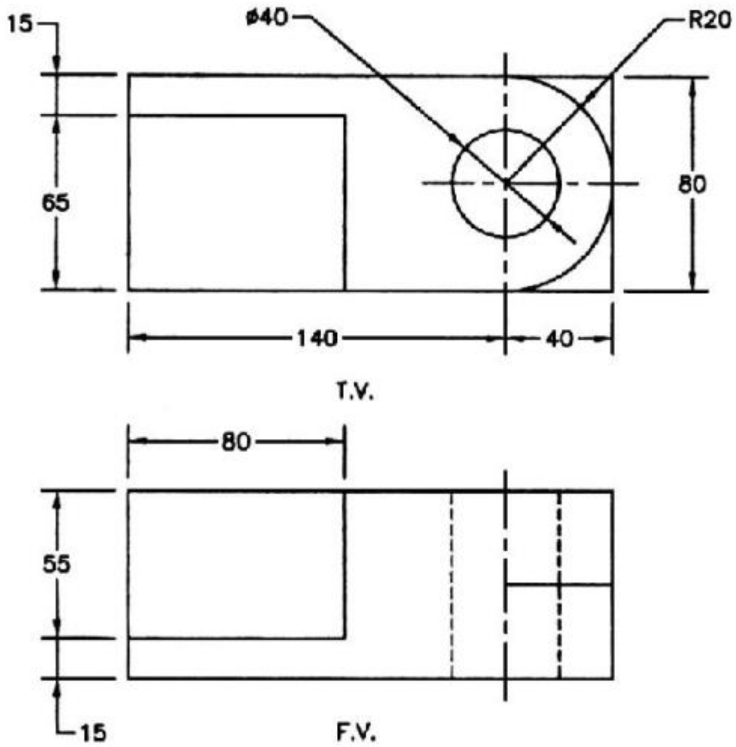
11. Figure shows the F.V. and LHSV of an object. Draw the Isometric view.



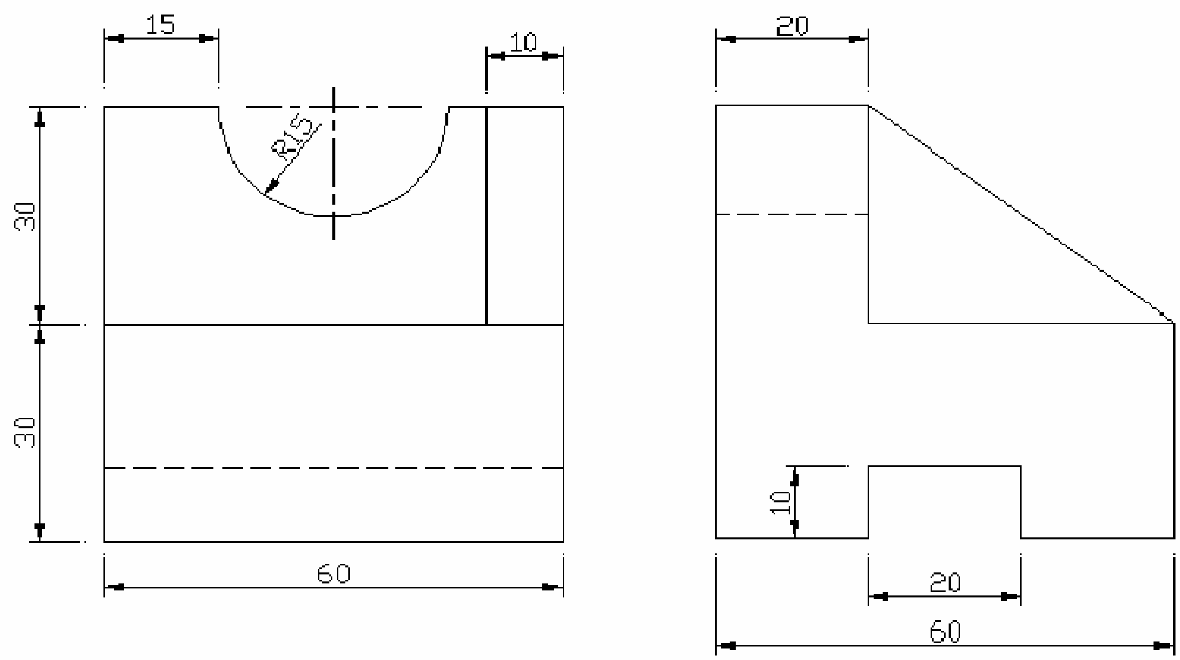

12. Draw the isometric view from the following orthographic views.



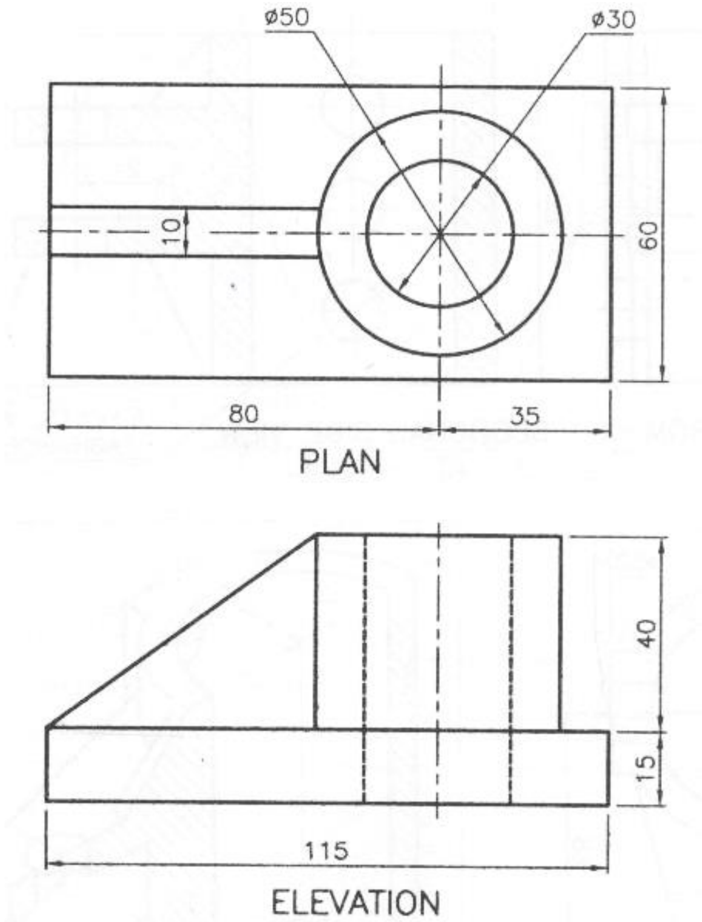
13. Figure shows two views of an object. Draw isometric projection.



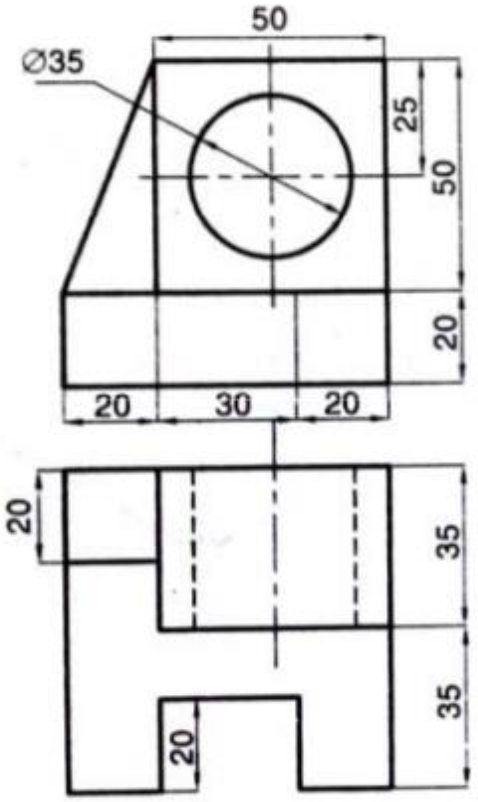

14. Draw the isometric view of the object, the orthographic views of which are shown in the figure below.



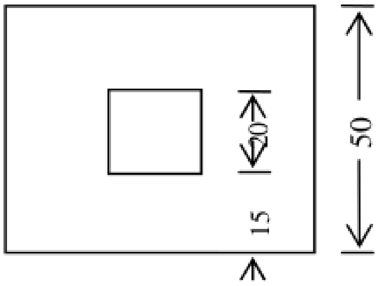

15. Figure shows two views of an object. Draw the Isometric Projection.



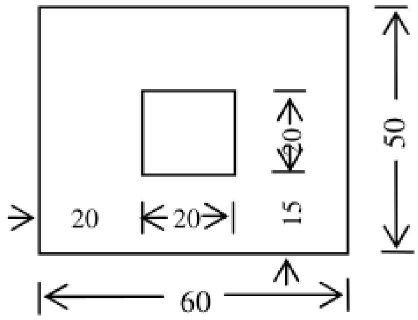

16. Draw the isometric view from the orthographic projections shown in figure 2.



17. Figure shows front view and top view of an object. Draw isometric view.

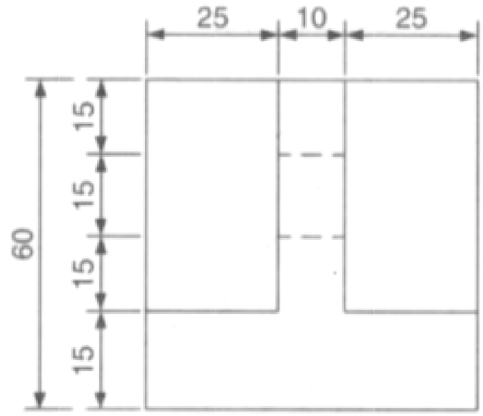



Front View

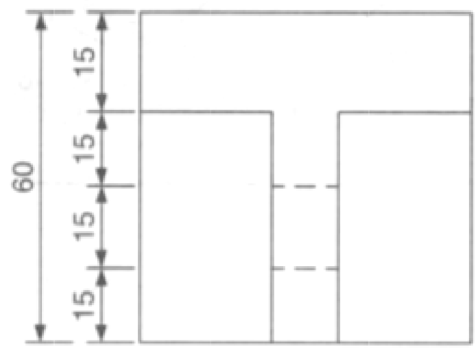



Top View

18. Figure shows the front view and top view of the object. Draw the Isometric Projection.

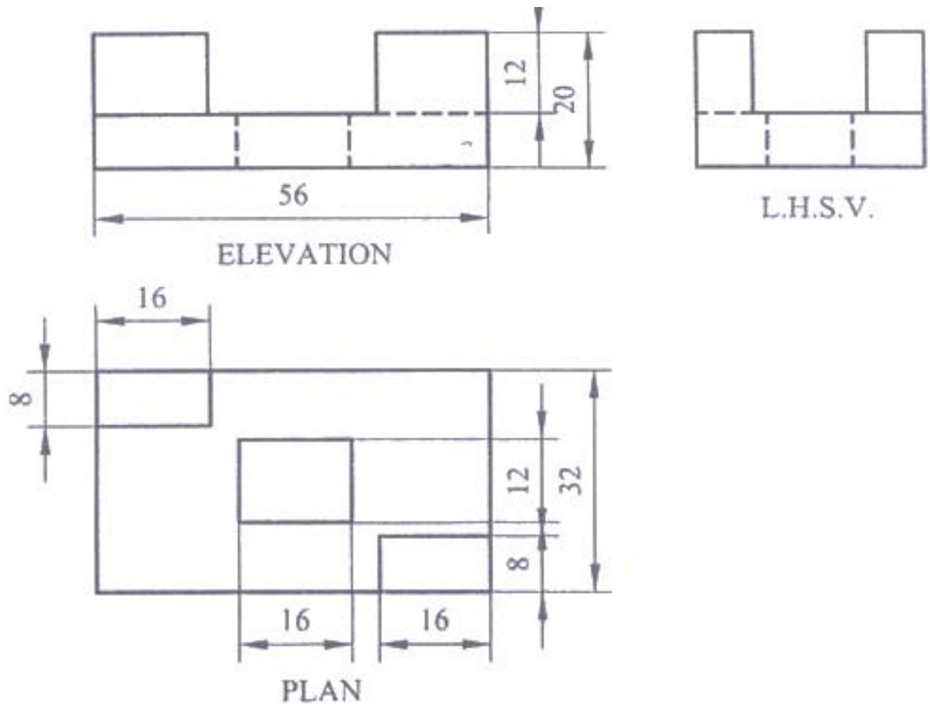



Front View

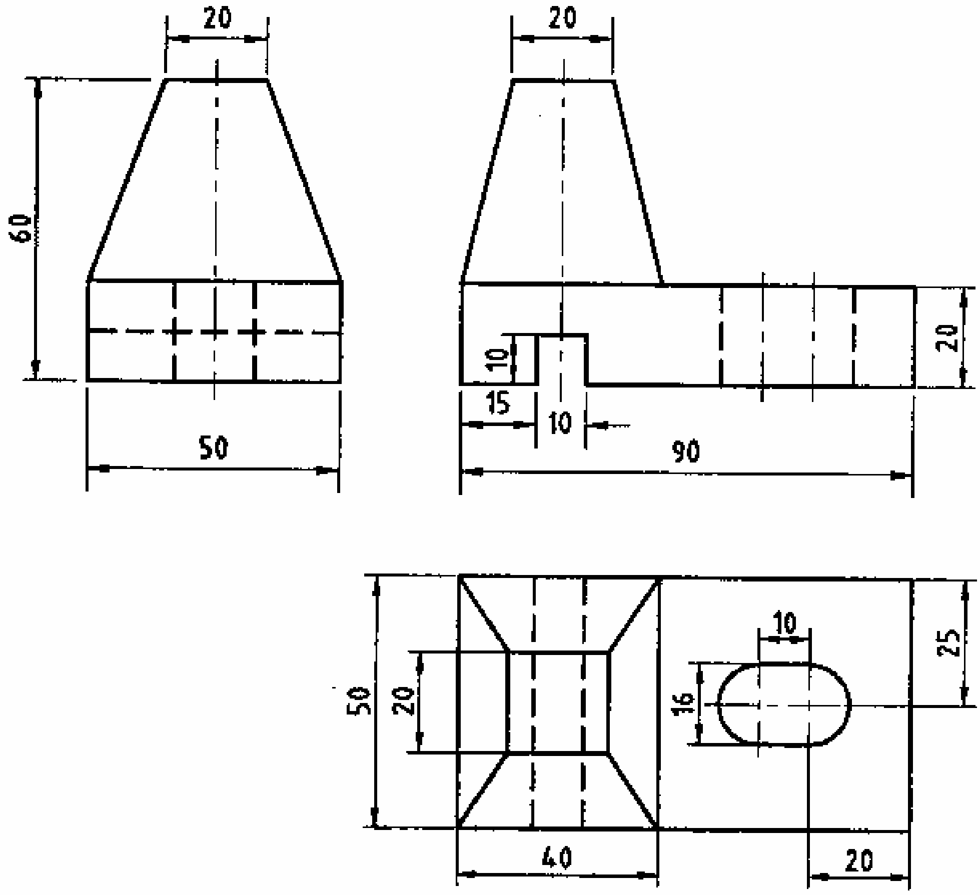



Top View

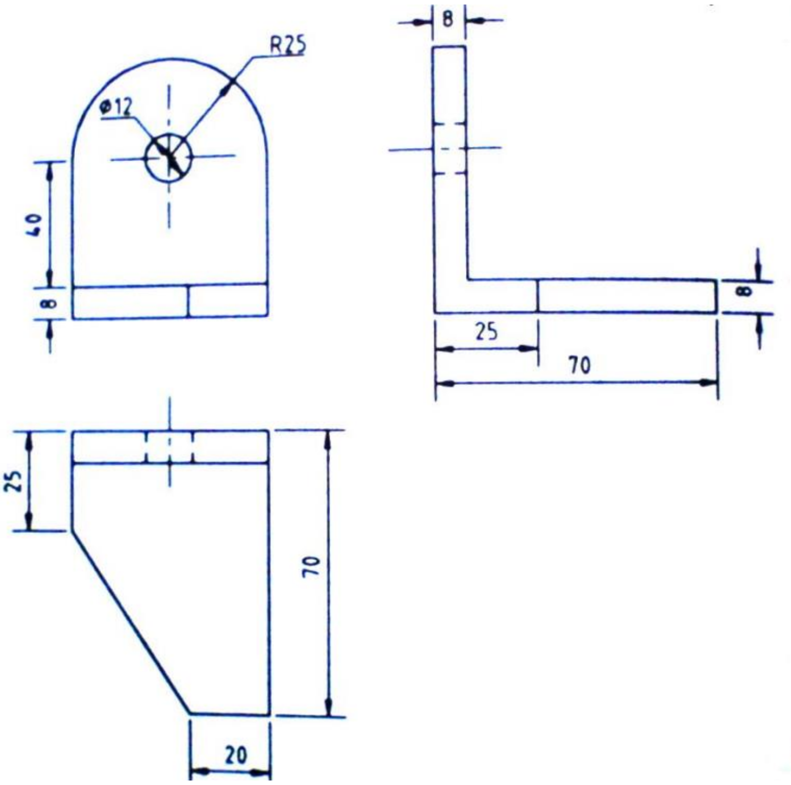
19. Draw the Isometric view of the following figure.



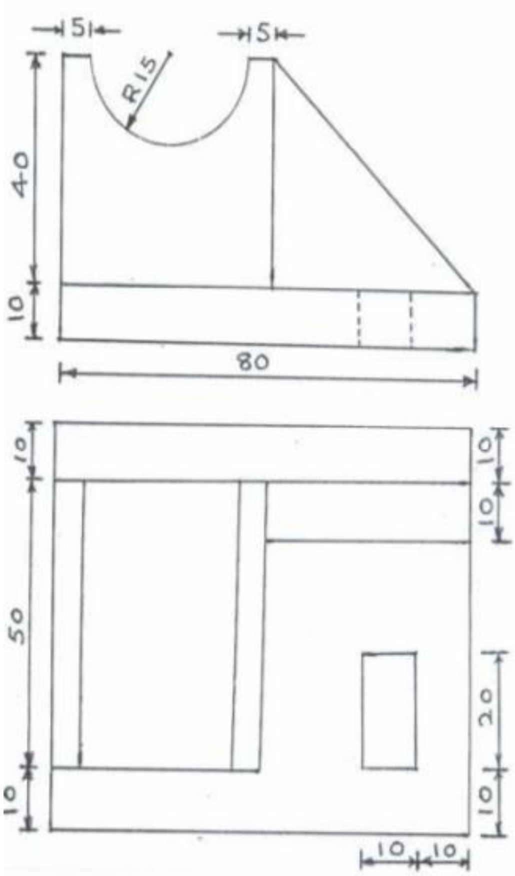

20. Draw Isometric view for the object shown in Figure.



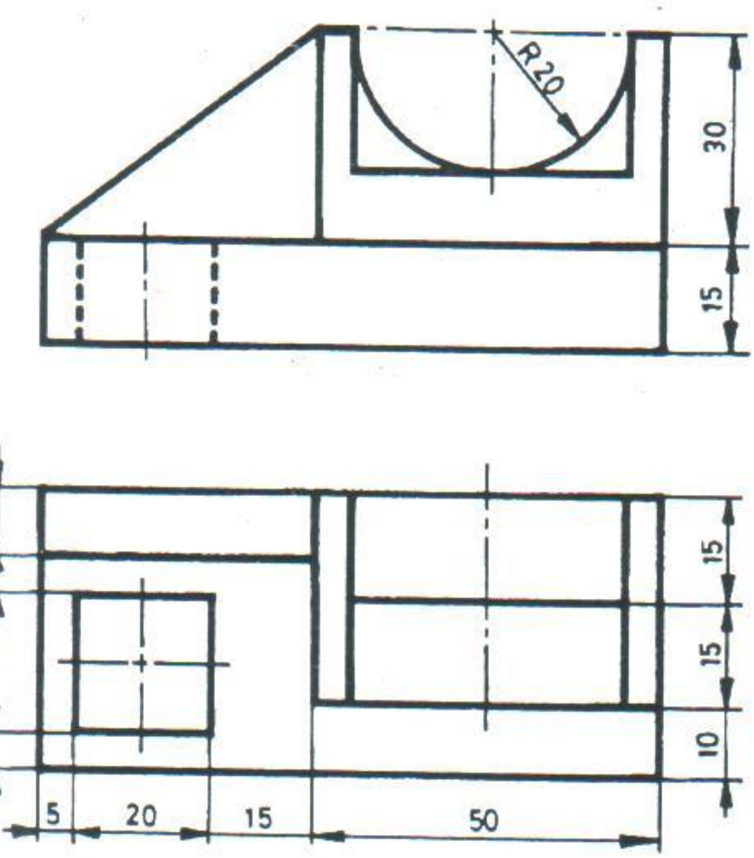
21. Draw the isometric view for the orthographic projection given below in figure.



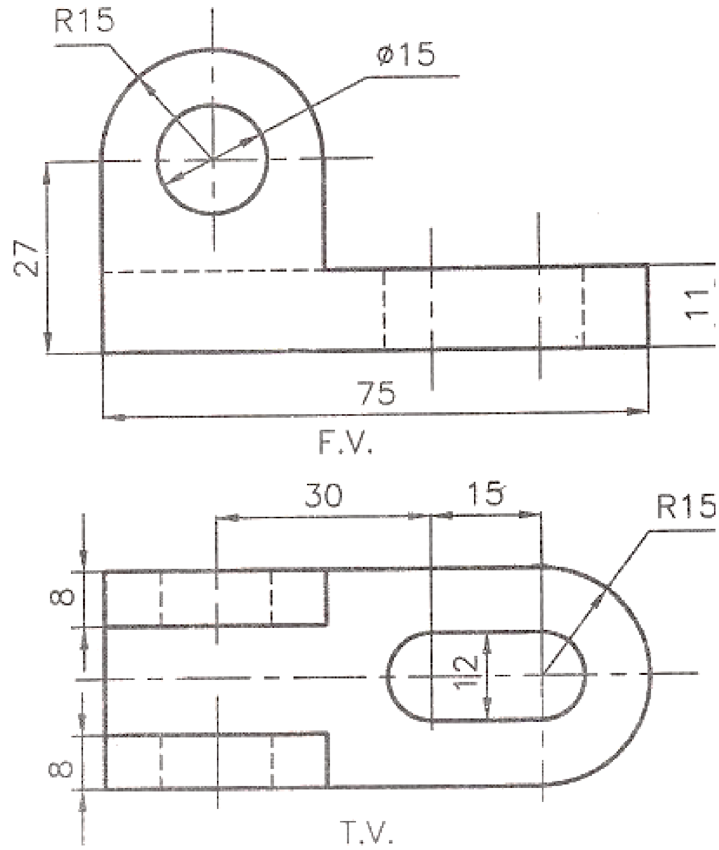

22. The orthographic views of an object using the first angle projection method are shown in the. Draw the isometric projection.



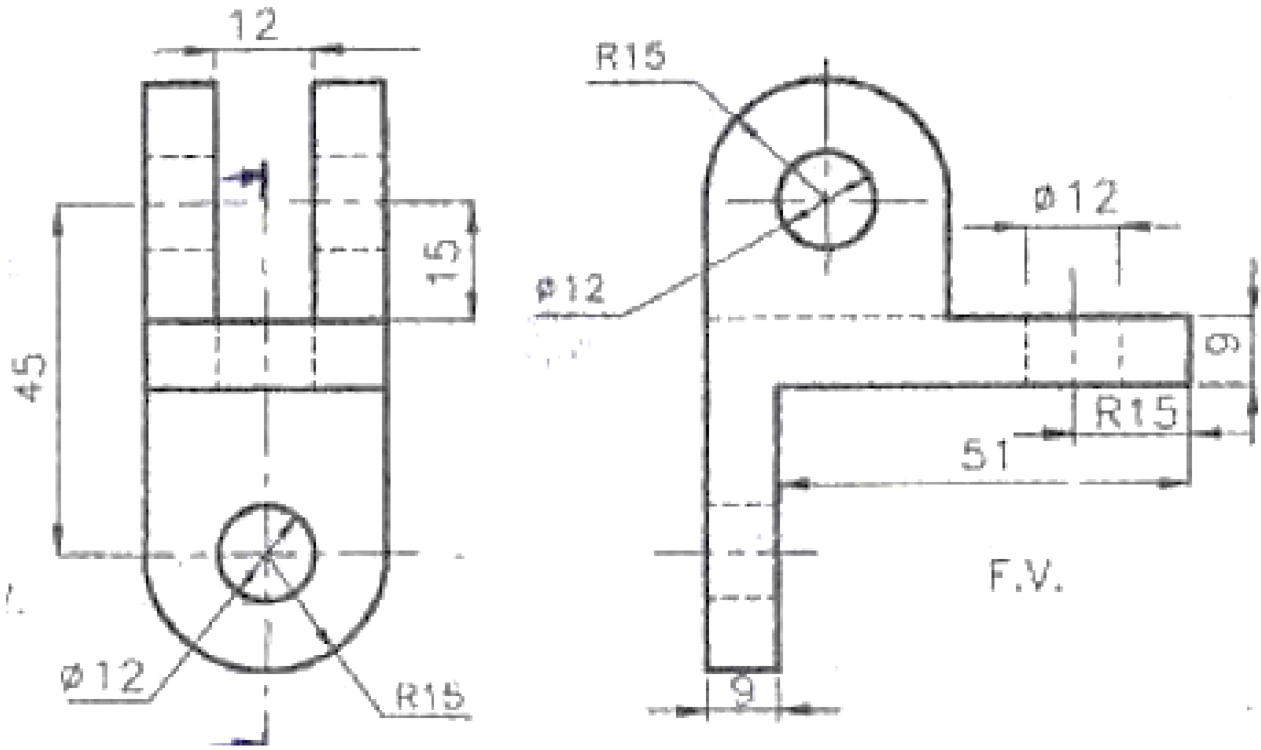
23. Draw the isometric view for the figure.



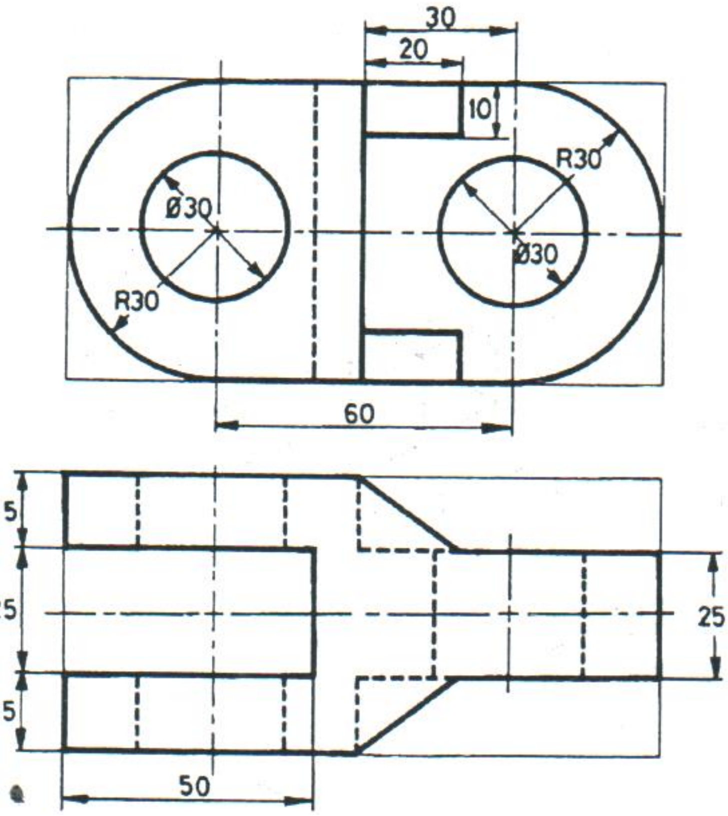

24. Figure shows the front view and top view of an object. Draw the isometric view.



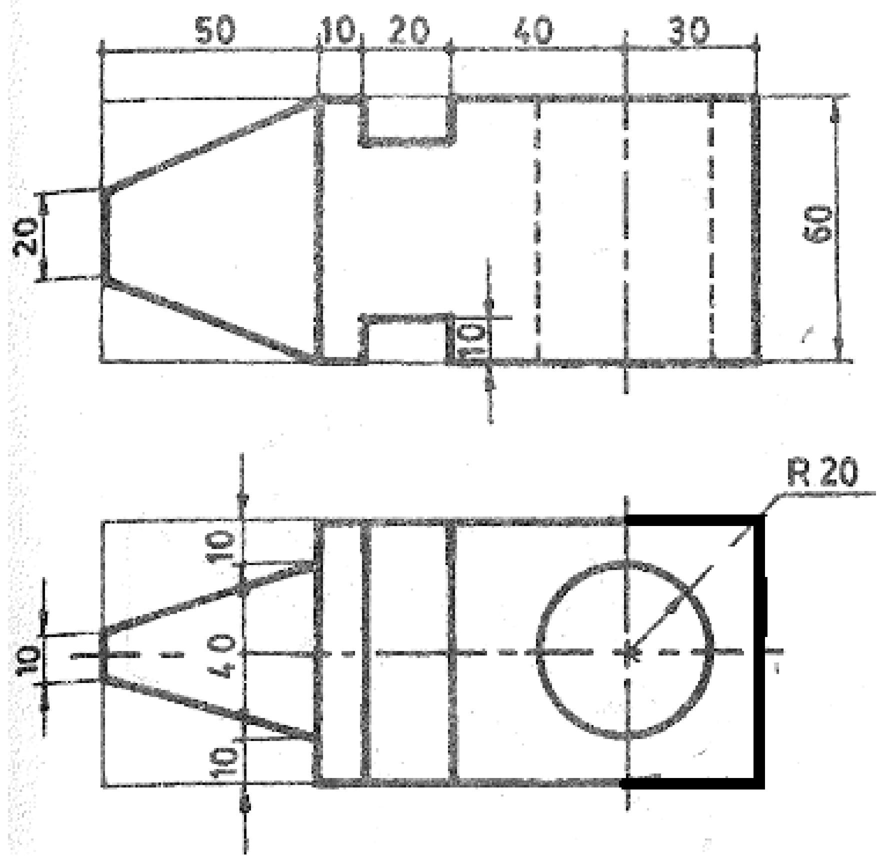
25. Figure shows side view and front view of an object. Draw isometric view.




26. Draw the isometric view for the figure.



27. Draw Isometric View of the Following Object.



# 9. Computer Aided Drawing

**Introduction to AutoCAD**

AutoCAD commands and their applications to solve drafting and design problems. Every AutoCAD command and customizing technique is thoroughly explained with examples and illustrations. This makes it easy for the uses to understand their function and application. You will be able to use AutoCAD commands to make a drawing, create text, create and insert symbols, dimension a drawing, create 3D objects and solid models, write script files, different line types and hatch patterns.

**AutoCAD Screen Components**

AutoCAD screen are drawing area, command window, menu bar, several toolbars, model and layout tabs, and status bar. A title bar that has AutoCAD symbol and the current drawing name is displayed on top of the screen.

The working environment and the types of interface elements that you must become familiar with if you are to become proficient in the software. Before you begin creating drawings, you should familiarize yourself with the interface. After completing this lesson, you will be able to start the application, activate the appropriate workspace, and identify key parts of the interface. The following image identifies key interface elements:

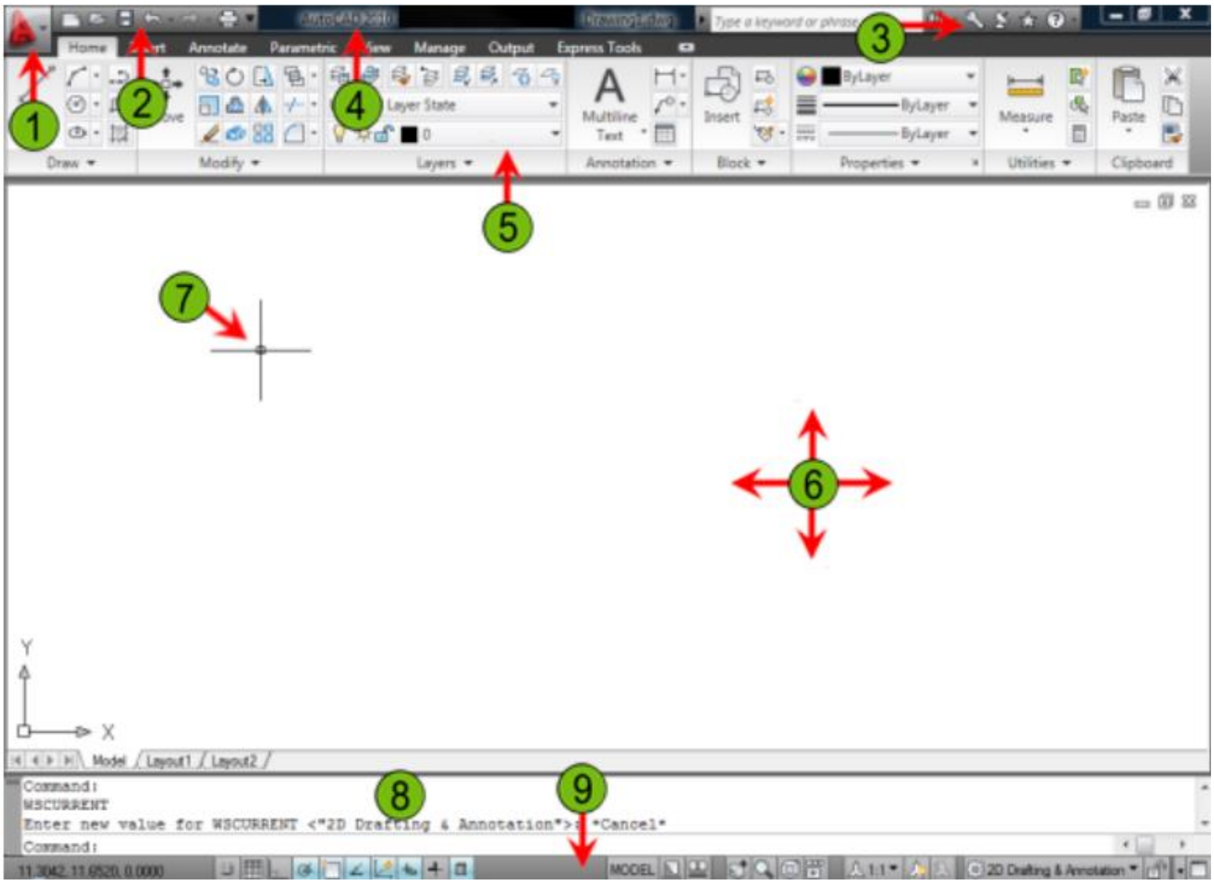



Figure 9.1 AutoCAD Screen or Workspace

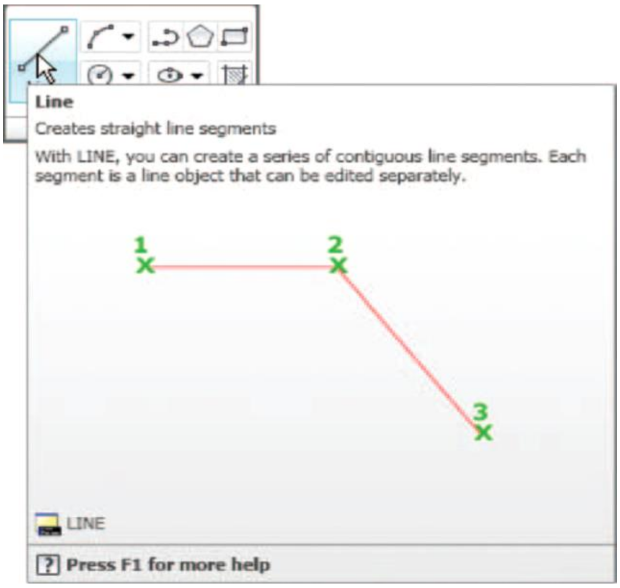
| | |
|---|---|
| 1.Application Menu Drawing Area<br>2.Quick Access Toolbar<br>3. Info Center<br>4. Title Bar<br>5. Ribbon | 6.Drawing Area<br>7.Crosshairs<br>8.Command Window<br>9. Status bar |

**Invoking Commands in AutoCAD**

On starting AutoCAD, when you are in the drawing area, you need to invoke AutoCAD commands to perform any operation. For example, to draw a line, first you need to invoke the Line command and the define the start point and the endpoint of the line. AutoCAD has provided the following methods to invoke commands. **KEYBOARD, MENU, TOOLBAR, SHORTCUT MENU, TOOL PALETTES, RIBBON**

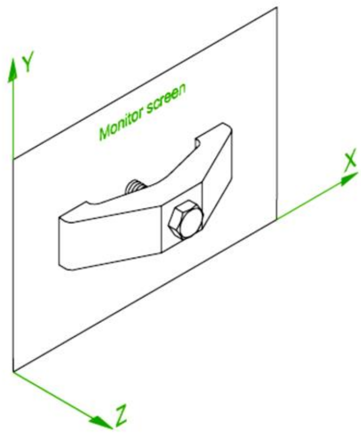
**Command Line in AutoCAD**

The most fundamental object in a drawing is line. A line can be drawn between any two points by using the Line command. You can also invoke the Line command by entering Line or L (L is the command alias of the Line) at the command prompt.

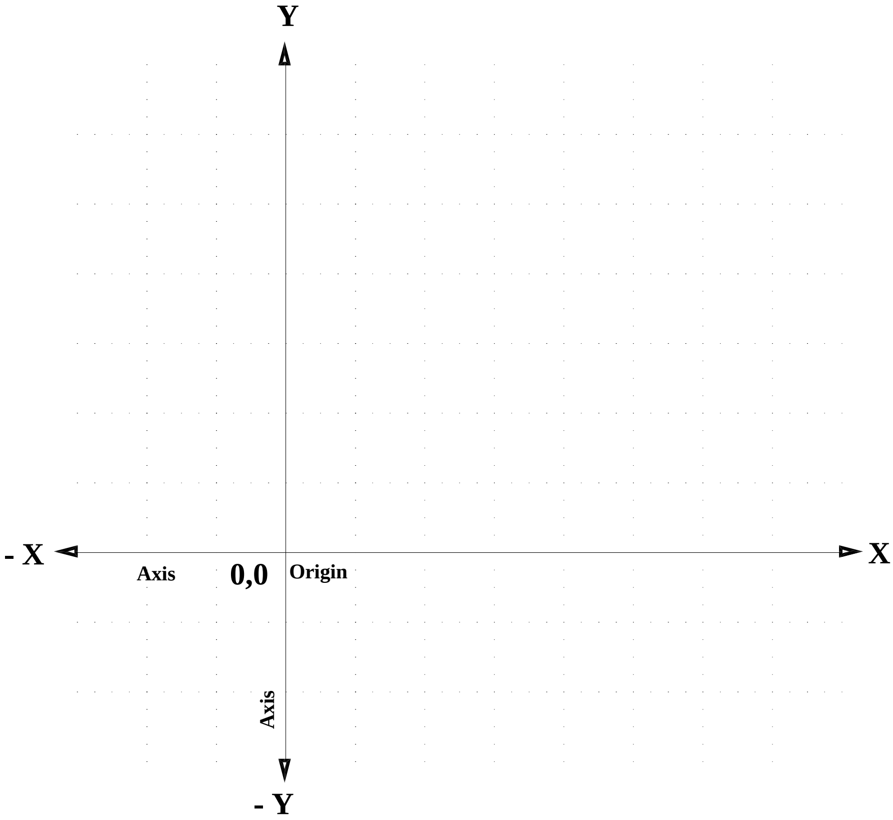



**Coordinate Systems:**

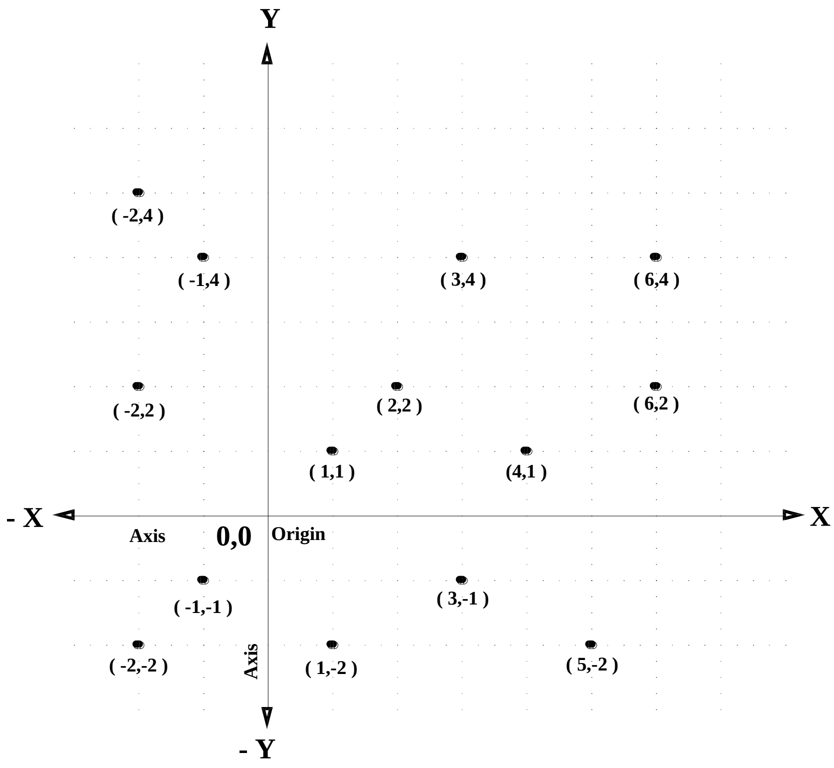
To specify a point in a plane, take two mutually perpendicular lines as references. The horizontal line is called the X axis, and the vertical line is called the Y axis. The point of intersection of these two axes is called the origin. The X and Y axes divide the XY plane into four parts, generally known as quadrants. The X coordinate is positive ( + ) if measured to the right of the origin, and negative ( - ) if measured to the left of the origin.




A 3D model drawing showing the X, Y and Z coordinate directions




**Co-Ordinate System**




**Cartesian Co-Ordinate System**

1). ABSOLUTE COORDINATES

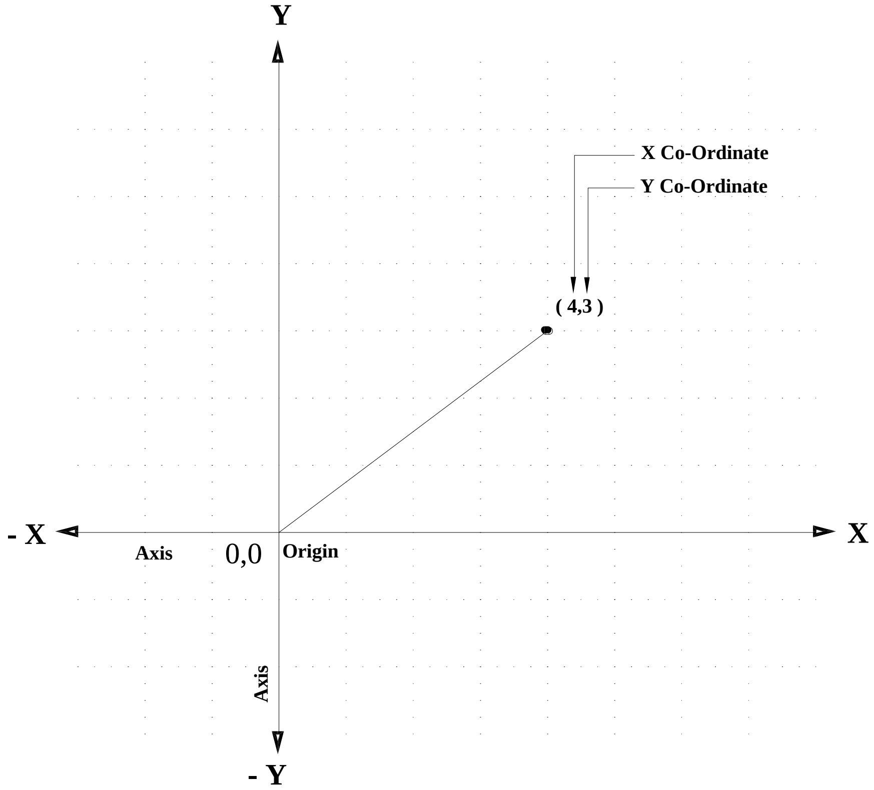
2). RELATIVE COORDINATES

A. RELATIVE RECTANGULAR COORDINATE

B. RELATIVE POLAR COORDINATE

3). DIRECT DISTANCE ENTRY

**1. Absolute Coordinate System:**
In the absolute coordinate system, the points are located with respect to the origin (0, 0). For example, a point with X = 4 and Y = 3 is measured 4 units horizontally ( displacement along the X axis ) and 3 units vertically ( displacement along the Y axis ) from the origin, as shown in figure.

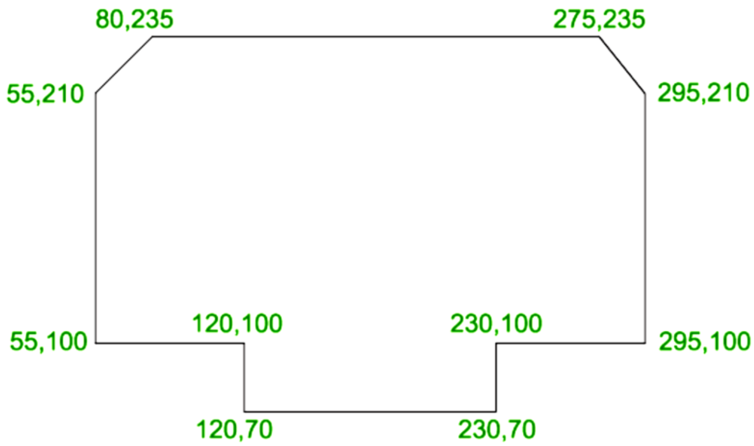



**Absolute Co-Ordinate System**

Left-click on the Line tool icon and enter figures as follows at each prompt of the command line sequence:

```
Command: _line Specify first point: enter 80,235
Right-click
Specify next point or [Undo]: enter 275,235
Right-click
Specify next point or [Undo]: enter 295,210
Right-click
Specify next point or [Close/Undo]: enter
295,100 right-click
Specify next point or [Close/Undo]: enter
```

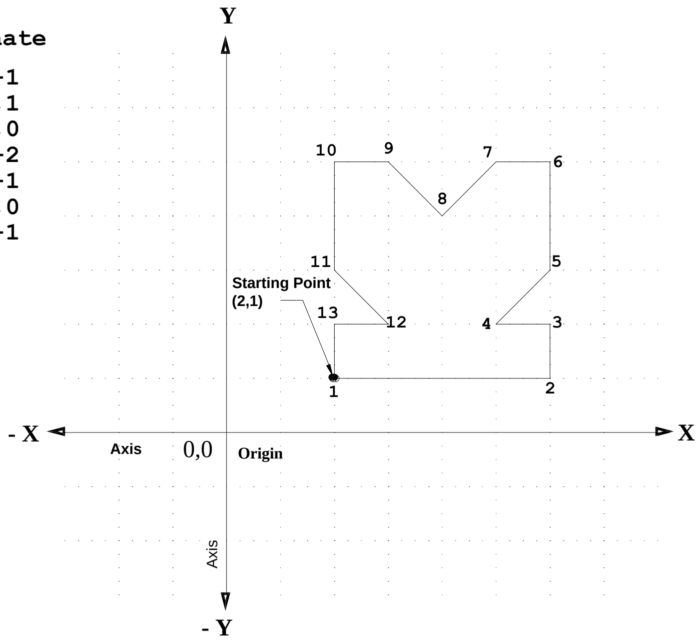
```
230,100 right-click
Specify next point or [Close/Undo]: enter
230,70 right-click
Specify next point or [Close/Undo]: enter
120,70 right-click
Specify next point or [Close/Undo]: enter
120,100 right-click
Specify next point or [Close/Undo]: enter
55,100 right-click
Specify next point or [Close/Undo]: enter
55,210 right-click
Specify next point or [Close/Undo]: enter c
(Close) right-click
Command:
```




**2. Relative Coordinate System:**

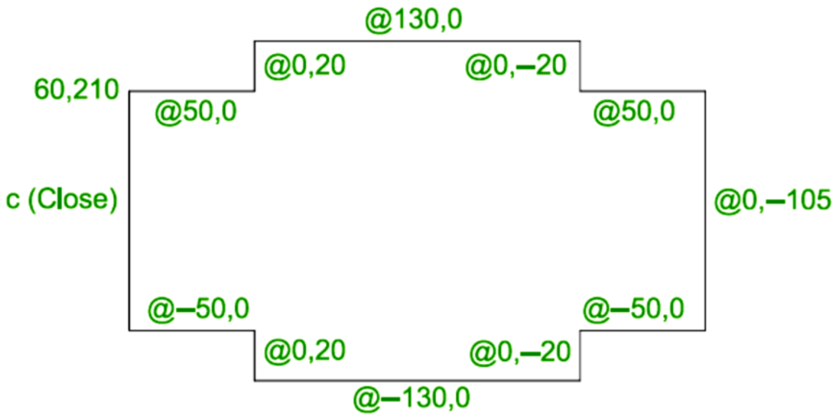
In the relative rectangular coordinate system, the displacements along the X and Y axes measured with reference to the previous point rather than to the origin. The relative coordinate system is designated by the symbol @ and it should precede any relative entry. The following prompt sequence illustrates the use of the relative rectangular coordinate system.

| Point | Cordinate | Point | Cordinate |
|---|---|---|---|
| 1. | 2,1 | 6. | @-1,-1 |
| 2. | @ 4,0 | 7. | @-1,1 |
| 3. | @ 0,1 | 8. | @-1,0 |
| 4. | @-1,0 | 9. | @0,-2 |
| 5. | @1,1 | 10. | @1,-1 |
| 6. | @0,2 | 11. | @-1,0 |
| 7. | @-1,0 | 12. | @0,-1 |




**Relaticve Co-Ordinate System**

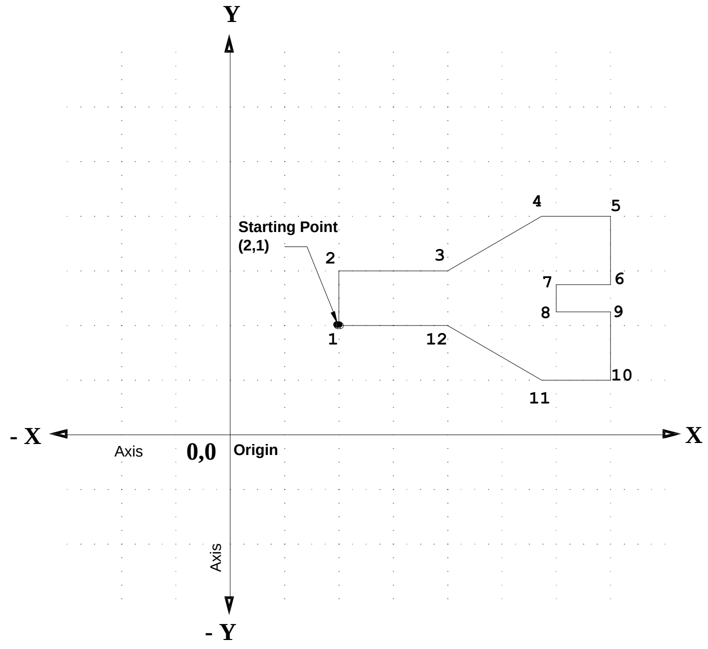
```
Command: _line Specify first point: enter 60,210
Right-click
Specify next point or [Undo]: enter @50,0
Right-click
Specify next point or [Undo]: enter @0,20
Right-click
Specify next point or [Close/Undo]: enter @130,0
Right-click
Specify next point or [Close/Undo]: enter
@0, _20 right-click
Specify next point or [Close/Undo]: enter @50,0
Right-click
Specify next point or [Close/Undo]: enter
@0, _105 right-click
Specify next point or [Close/Undo]: enter
@ _50,0 right-click
Specify next point or [Close/Undo]: enter
@0, _20 right-click
Specify next point or [Close/Undo]: enter
@ _130,0 right-click
Specify next point or [Close/Undo]: enter @0,20
Right-click
Specify next point or [Close/Undo]: enter
@ _50,0 right-click
Specify next point or [Close/Undo]: enter c
(Close) right-click
Command:
```

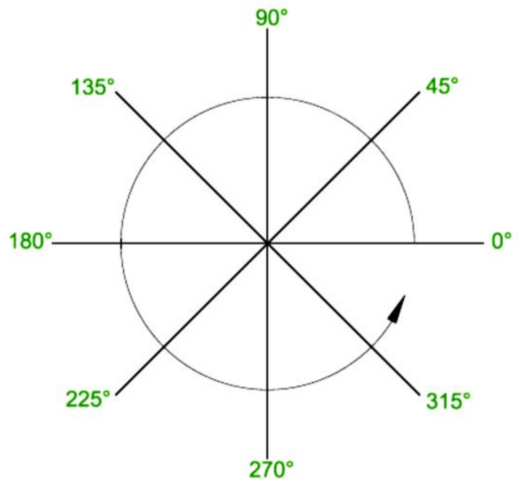



**2.2 Relative Polar Coordinate System:**

In relative polar coordinate mode is activated and the second input box shows the angle value, preceded by the < symbol. Therefore, you do not need to input the @ SYMBOL. You can simply enter the distance value and then press the TAB key to shift to the second input box for specifying the angle value.

| Point | Coordinate | Point | Coordinate |
|---|---|---|---|
| 1. | 2,2 | 8. | @0.5<270 |
| 2. | @1<90 | 9. | @1<0 |
| 3. | @2<0 | 10. | @1.25<270 |
| 4. | @2<30 | 11. | @1.2<180 |
| 5. | @1.2<0 | 12. | @20<150 |
| 6. | @1.25<270 | 13. | @2<180 |
| 7. | @1<180 | | |



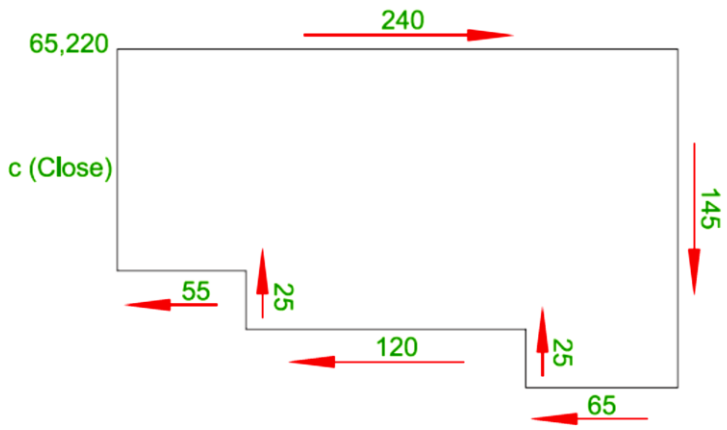




Polar Co-Ordinate System

**3. Direct Distance Entry:**

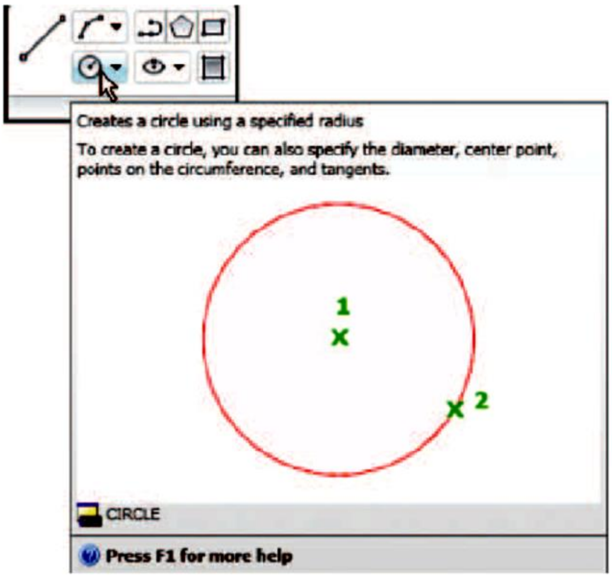
You can draw a line by specifying the length of the line and its direction using the Direct Distance Entry. The direction is by the position of the cursor, and the length of the line is entered from the keyboard. If the Ortho mode is on, you can draw lines along the X or Y axis by specifying the length of the line and positioning the cursor along the ortho.

```
Command: _line Specify first point: enter 65,220
Right-click
Specify next point: drag to right enter 240
Right-click
Specify next point: drag down enter 145
Right-click
Specify next point or [Undo]: drag left enter
65 right-click
Specify next point or [Undo]: drag
upwards
Enter 25 right-click
Specify next point or
[Close/Undo]: drag left
Enter 120 right-click
Specify next point or
[Close/Undo]: drag upwards
Enter 25 right-click
Specify next point or
[Close/Undo]: drag left
Enter 55 right-click
Specify next point or
[Close/Undo]: c (Close)
Right-click
Command:
```

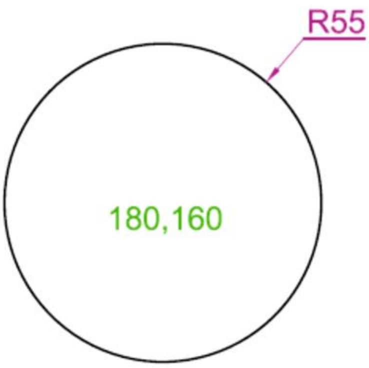


**Command Circle in AutoCAD**

To draw a circle, you can use the Circle command. You can invoke the Circle command from Draw panel of the Ribbon, as shown in figure.



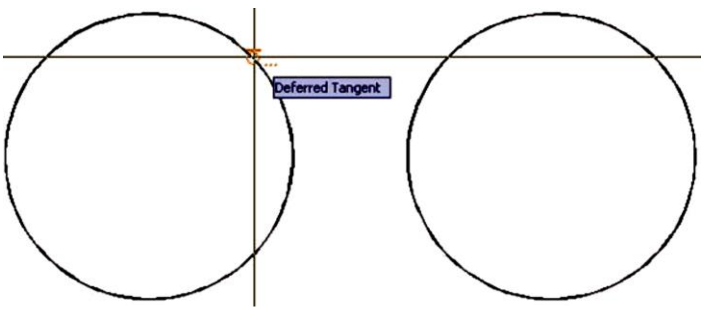

## First example – **Circle** tool



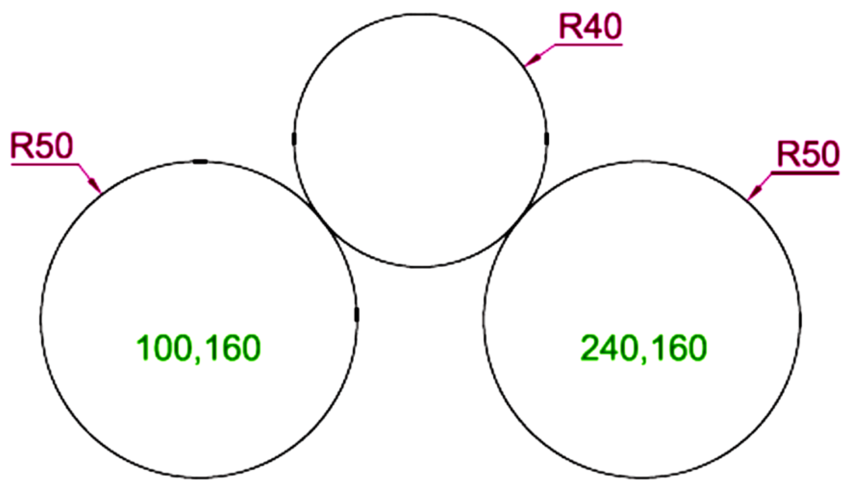

Enter a coordinate and a radius against the prompts appearing in the command window as shown in Figure followed by right-clicks. The circle appears on screen.

## Second example – **Circle** tool

Left-click on the Circle tool icon and construct two circles as shown in the drawing ( in the positions and radii shown in Figure Click the Circle tool again and against the first prompt enter t(the abbreviation for the prompt tan tan radius ), followed by a right-click .




Second example – Circle tool – the two circles of radius 50




Second example – Circle tool. The radius-40 circle tangential to the radius-50 circles

**Notes**

1. When a point on either circle is picked, a tip appears Deferred Tangent. This tip will only appear when the Object Snap button is set on with a click on its button in the status bar, or the F3 key of the Keyboard is pressed.
2. Circles can be drawn through 3 points or through 2 points entered at the command line in response to prompts brought to the command line by using 3P and 2P in answer to the circle command line prompts.

## Exercises

1. Using the Line tool construct the rectangle shown in Fig.9.2
2. Construct the outline shown in Fig. 9.3 using the Line tool. The coordinate points of each corner of the rectangle will need to be calculated from the lengths of the lines between the corners.


Fig.9.2

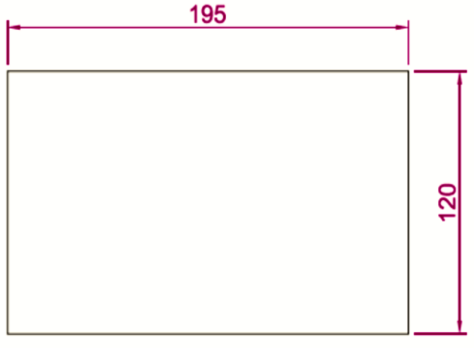



Fig 9.3

3. using the Line tool, construct the outline shown in Fig.9.4.
4. Using Tan Tan Rad Circle Draw as shown in figure 9.5.

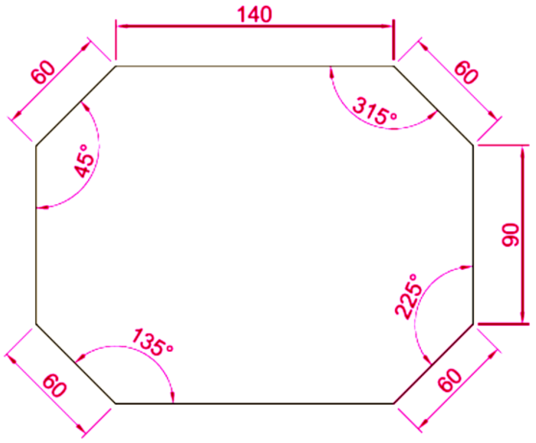



Fig.9.4

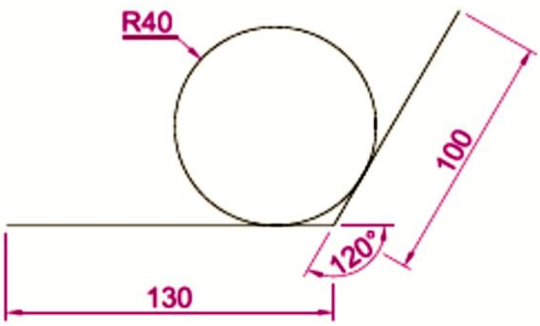
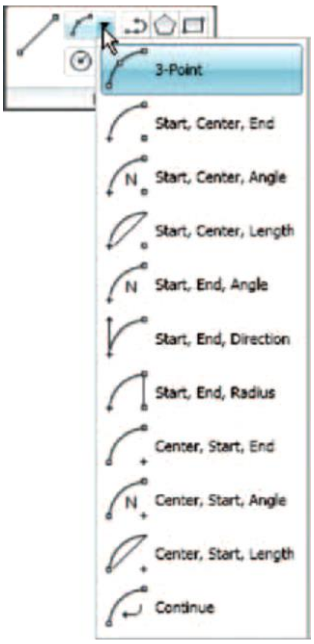
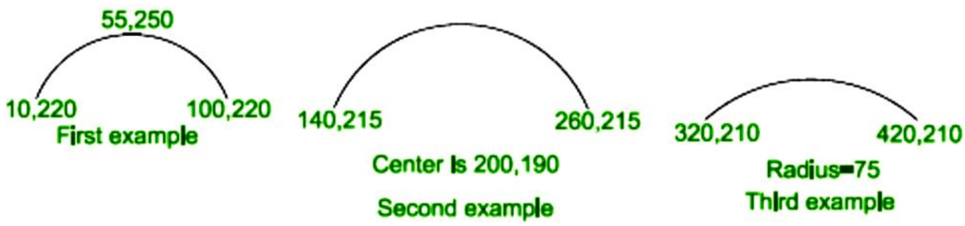


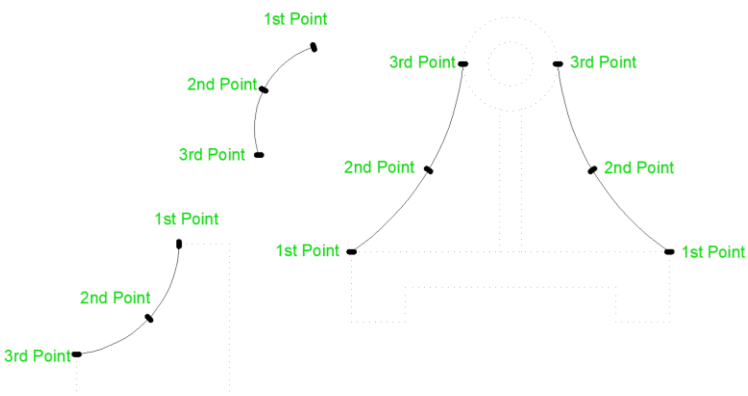

Fig.9.5

**Command Arc in AutoCAD :**

An **ARC** is defined as a part of a circle. In AutoCAD, it can be drawn using the **ARC** command. AutoCAD provides eleven different options to draw an arc. To view these options, click on the down arrow on the **3-point** button on the **Draw** panel of the Home tab in the Ribbon, a fly out will be displayed.



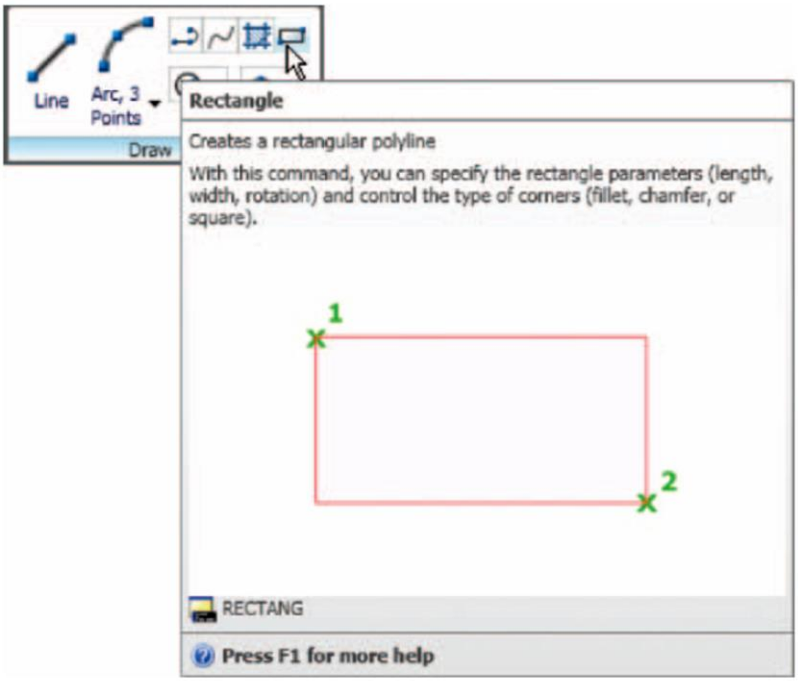




**3 Point Arc**

**Command Rectangle in AutoCAD :**

A rectangle can be drawn by choosing the **Rectangle** button from the **Draw** panel of the Ribbon. In AutoCAD, you can draw rectangles by specify two opposite corners of the rectangle, by specifying the area and the rectangle. All these methods of drawing rectangles are discussed next.




## Exercises

1. Using the **Line and Arc** tools, construct the outline given in Fig. 9.6.

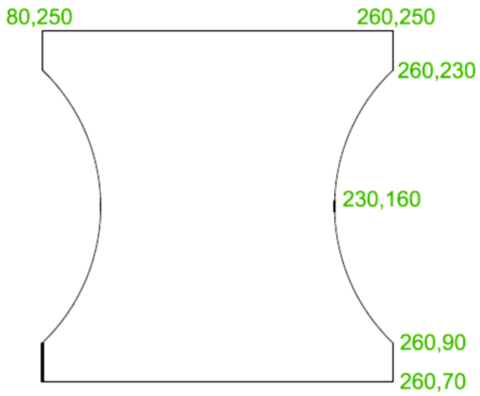
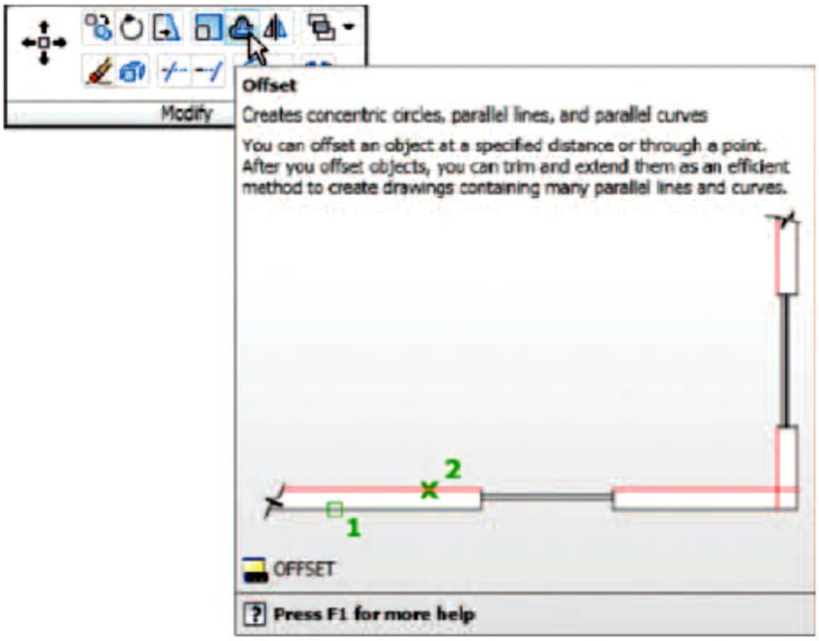



Fig.9.6

**Command Offset in AutoCAD :**

To draw parallel lines, polylines, concentric circles, arcs, curves, and so on, you can use the **Offset** command. This command creates another object that is similar to the selected one. Remember that you are allowed to select only one entity at a time to be offset. When offsetting an object, you want to offset the selected object. Depending on the side to offset, you can create smaller or larger circles, ellipse, and arcs. If the offset side is toward the inner side of the perimeter, the arc, ellipse, or circle will be smaller than the original.




## Exercise

1. Repeat Following Drawing by using Offset Command as shown in figure 9.7.

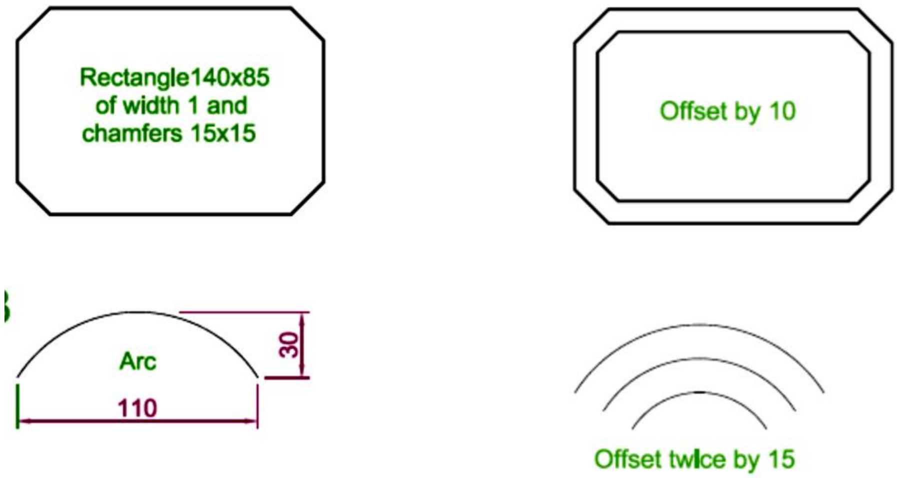
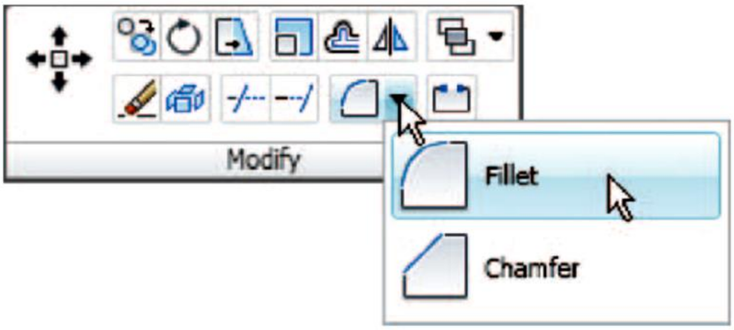
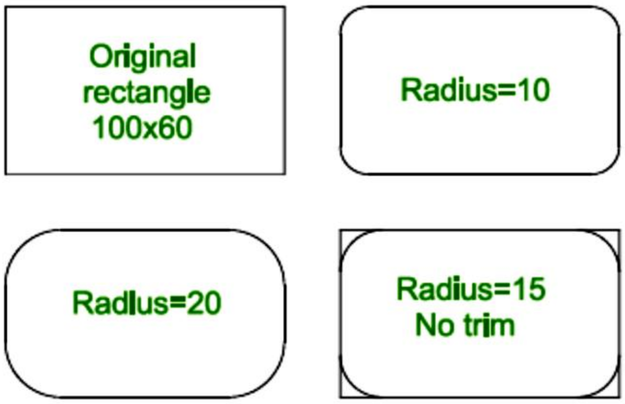



Figure 9.7

**Command Fillet in AutoCAD :**

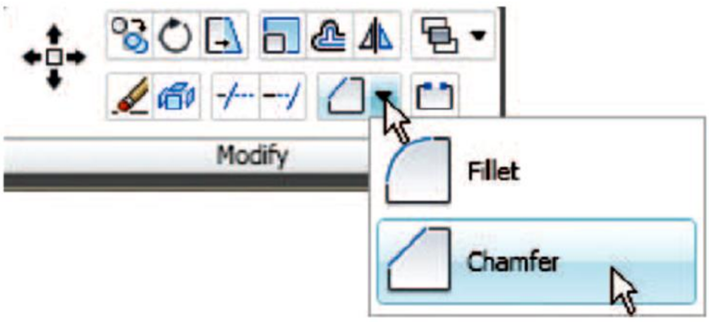
The edges in the design are generally filleted to reduce the area of stress concentration. The **Fillet** command helps you form round corners between any two entities by allowing you to that connects the two objects. A fillet can also be created between two intersecting or parallel line as wll as nonintersecting and nonparallel lines, arcs, polylines, xlines, rays, splines, circles, and true ellipse. The fillet arc created will be tangent to both the selected entities.



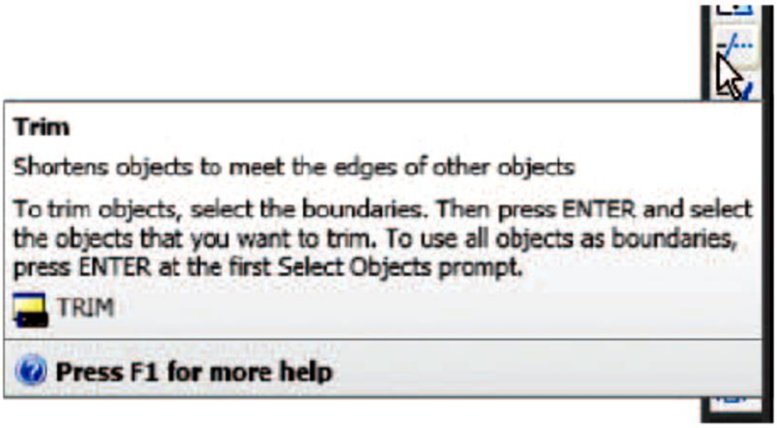

**Command Chamfer in AutoCAD :**

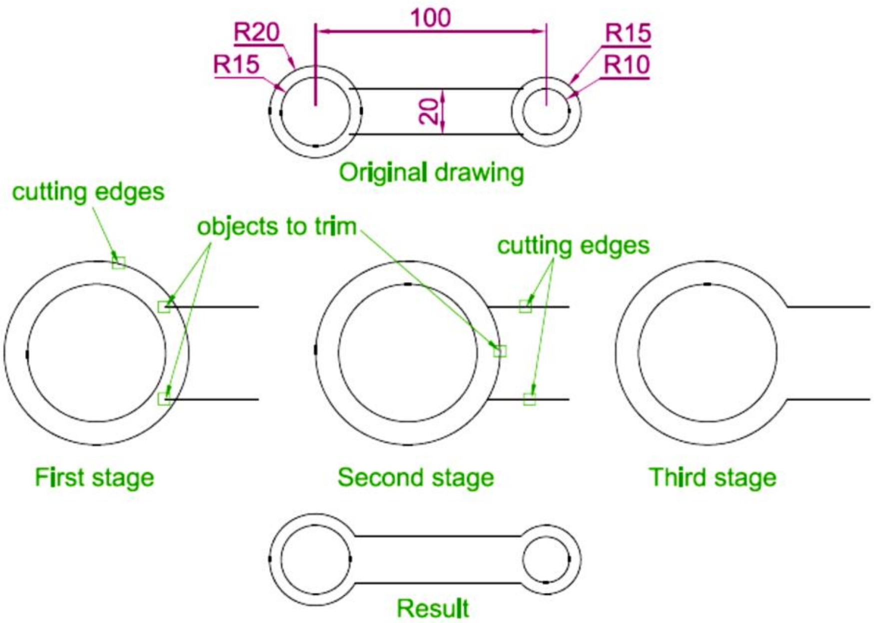
Chamfering the sharp corners is another method of reducing the areas of stress concentration in the design. Chamfering is defined as the process, in which the sharp edges or corners are beveled. In simple words, it is defined as the taper provided on a surface. A beveled line connects two separate object to create a chamfer. The size of a chamfer depends on its distance from the corner.




**Command Trim in AutoCAD :**

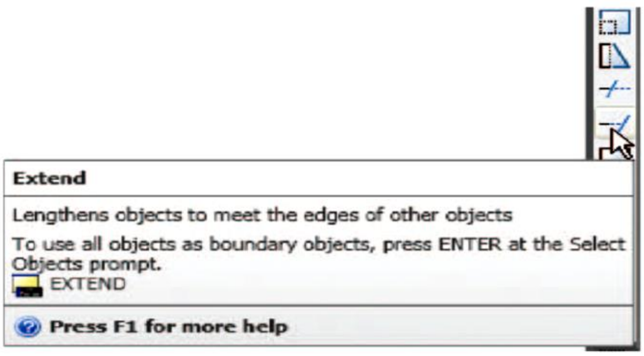
When creating a design, there are a number of places where you have to remove the unwanted and extending edges. Breaking individual object takes time if you are working on a complex design with many object. In such cases, you can use the **Trim** command. This command trims the objects that extend beyond a required point of intersection.

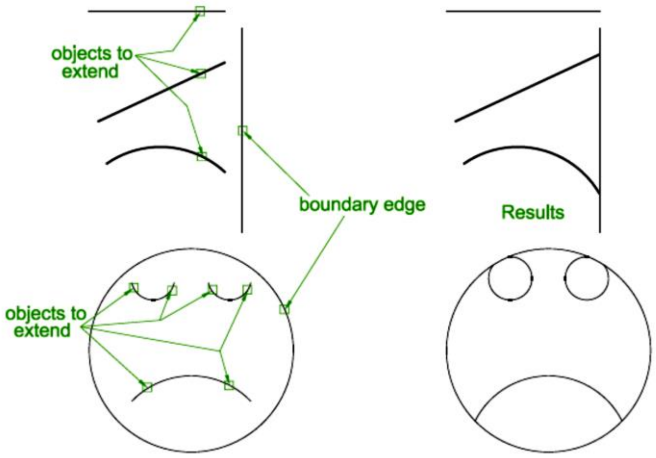



**Command Extend in AutoCAD :**

The **Extend** command may be considered the opposite of the **Trim** command. In the **Trim** command you trim objects, In the **Extend** command you can extend lines, polylines, rays, and arcs to meet other object.






## Exersice

1. Construct the drawing given in Fig. 9.8. All parts are plines of width _ 0.7 with corners filleted R10. The long strips have been constructed using **Circle, Polyline, Trim** and **Polyline Edit.**

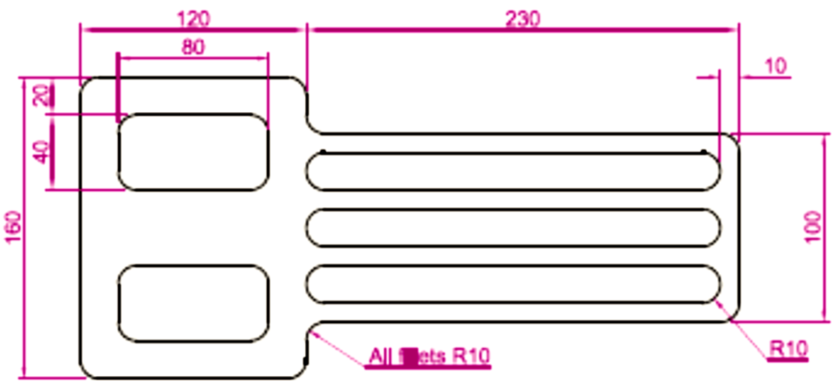
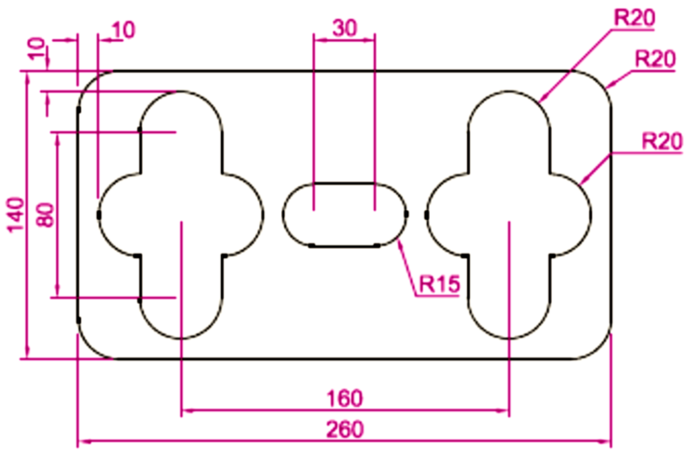



Figure 9.8

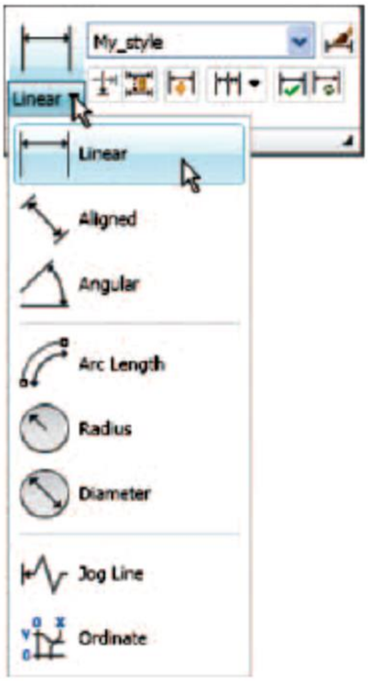
2. Using the tools Polyline , Circle , Trim , Polyline Edit , Mirror and Fillet construct the drawing Given in Figure 9.9



**Dimensioning in AutoCAD :**

The object that can be dimensioned in AutoCAD range from straight lines to arcs. The dimensioning commands provided by AutoCAD can be classified into four categories.

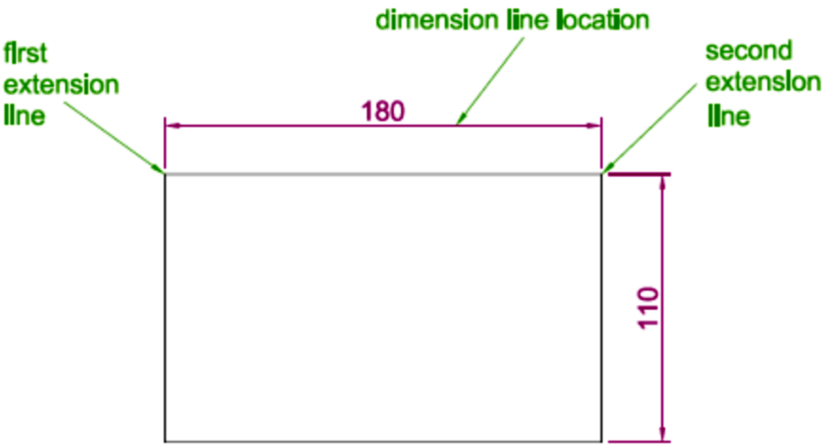
1. Dimension Drawing Commands
2. Dimension Style Commands
3. Dimension Editing Commands
4. Dimension Utility Commands




While dimensioning an object, AutoCAD automatically calculates the length of the object or the distance between two specified points. Also, setting such as the gap between the dimension text and the dimension lin, the space between two consecutive dimension line, arrow size, and text size are maintained and used when the dimension are being generated for a particular drawing. The generation of arrows, lines (dimension lines. Extension lines), and other objects that from a dimension is automatically performed by AutoCAD to save the user’s time. This also results in uniform drawings. However, you can override the default measurements computed by AutoCAD and change the setting of various standard values. The modification of dimensioning standard can be achieved through the dimension variables.

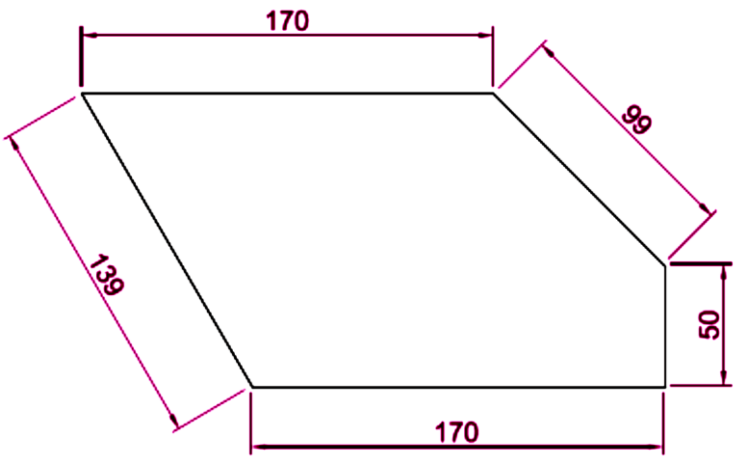
**Linear Dimension in AutoCAD**

Linear dimensioning applies to those dimensioning that measure the shortest distance between two points. You can directly select the object to dimension or select two points. The points can be any two points in the space, endpoints of an arc or line, or any set of points that can be identified.



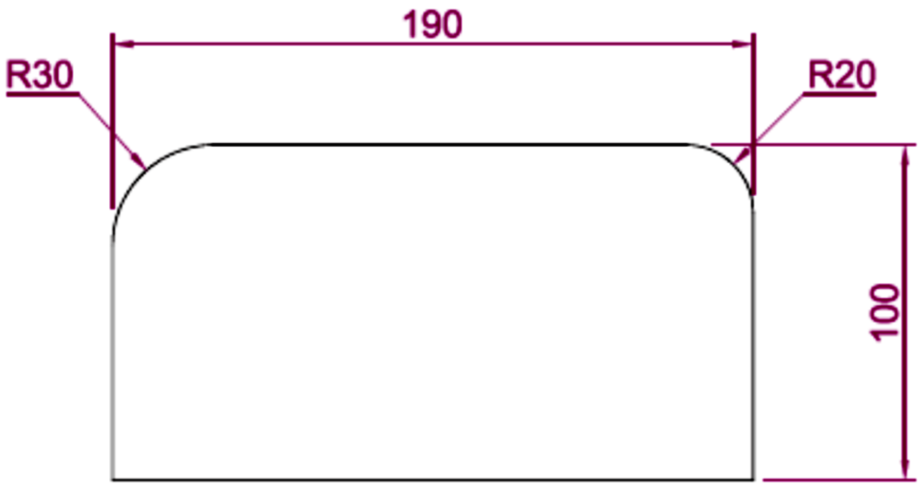
**Aligned Dimension in AutoCAD**

Generally, the drawing consists of various object that are neither parallel to the X Axis nor to the Y axis. Dimensioning of such objects can be done using aligned dimensioning. In horizontal or vertical dimensioning, you can only measure the shortest distance from the first extension whereas, with the help of aligned dimensioning, you can measure the true aligned distance between the two points. The working of the **Aligned** dimension command is similar to thatof the other linear dimensioning commands.



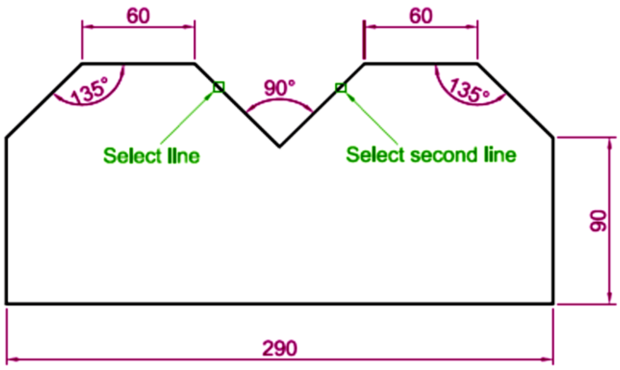

**Radius Dimension in AutoCAD**

The radius dimensioning used to dimension a circle or an arc. Radius and diameter dimensioning are similar, the only diffrance is that instend of the diameter line, a radius line is drawn (half of the diameter line), which is measured from the center to any point on the circumference.



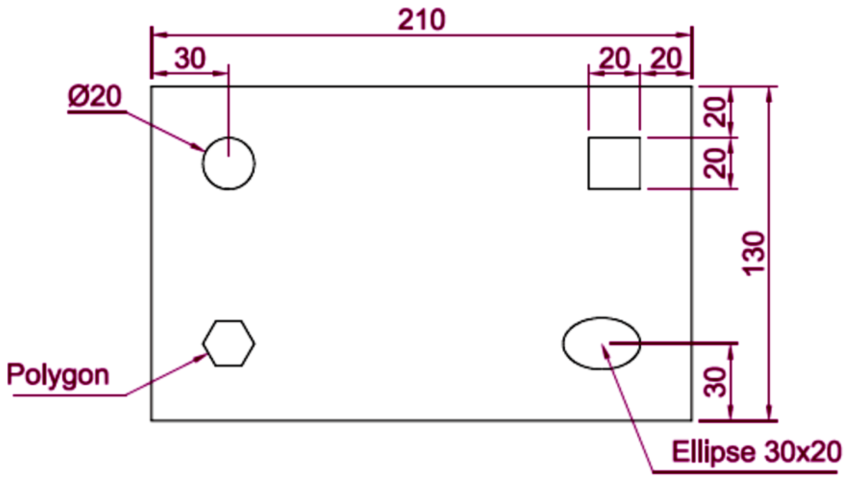

**Angular Dimension in AutoCAD**

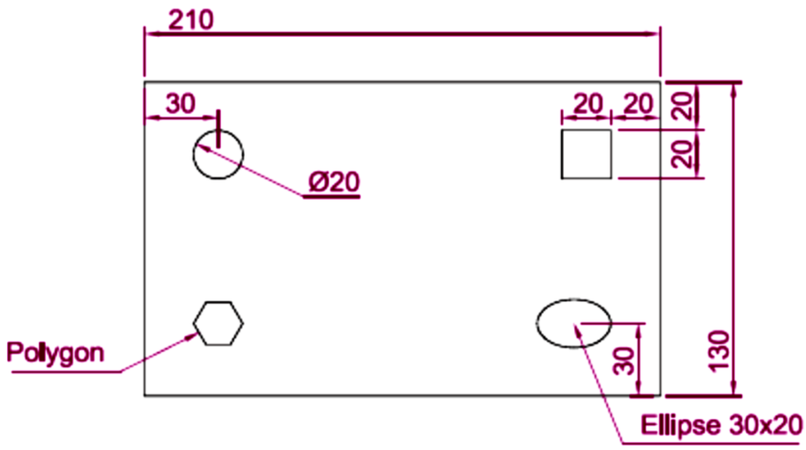
The angular dimensioning is used when you want to dimension an angle. This command generates a dimension arc (dimension line in the shape of an arc with arrowheads at both ends) to indicate the angle between two nonparallel lines.




**Modifying Dimension in AutoCAD**

You can edit a dimension by stretching it. However to stretch a dimension. Appropriate definition points must be included in the section crossing or window. As the middle point of the dimension text is a definition point for all types of dimension, you can easily stretch and move the dimension text to any location you want.



**Dimension Style and tolerance in AutoCAD**

By writing (DIMSTY) in command prompt The Dimension modification window will be popping up in which user can modify drawing dimension style, Dimension type, Dimension Arrow Size, Dimension text Height , Dimension decimal, Dimension Units and additionally Provide tolerance.

One of the most important parts of the design process is giving the dimensions and tolerances, since every part is manufactured from the dimensions given in the drawing. Tolerancing is equally important, especially in the assembled parts. Tolerance ad fits determine how the parts will fit. In addition to dimensioning and tolerancing, the function and the relationship that exists between the mating parts is important if the part is to perform the way it was designed.