



METHODIST COLLEGE OF ENGINEERING AND TECHNOLOGY

(An Autonomous Institute)

Accredited by NBA & NAAC with A+ Grade

Approved by AICTE, New Delhi, Affiliated to Osmania University, Hyderabad
Abids, Hyderabad, Telangana – 500 001

LABORATORY MANUAL ENGINEERING GRAPHICS LABORATORY

BE I/II Semester 2024-2025

NAME: _____

ROLL NO: _____

BRANCH: _____ **SEM:** _____

Empower youth- Architects of Future World



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LABORATORY MANUAL

ENGINEERING GRAPHICS LABORATORY

BE I/II Semester 2024-25

NAME: _____

ROLL NO: _____

BRANCH: _____ SEM: _____

DEPARTMENT OF CIVIL ENGINEERING

Empower youth- Architects of Future World



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VISION

To produce ethical, socially conscious and innovative professionals who would contribute to sustainable technological development of the society.

MISSION

To impart quality engineering education with latest technological developments and interdisciplinary skills to make students succeed in professional practice.

To encourage research culture among faculty and students by establishing state of art laboratories and exposing them to modern industrial and organizational practices.

To inculcate humane qualities like environmental consciousness, leadership, social values, professional ethics and engage in independent and lifelong learning for sustainable contribution to the society.



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ENGINEERING GRAPHICS LABORATORY

LABORATORY MANUAL

B.E I/II SEMESTER

ACADEMIC YEAR: 2024-25

Prepared

By

Mrs. S. Deva Samyuktha,

(Assistant Professor)

Department of CIVIL ENGINEERING



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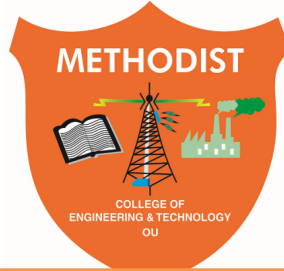


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Hall Ticket No.

Name of the Lab: _____

Subject code: _____

Department: _____

This is to certify that this is a record work done by
Ms/Mr _____ of _____ Department
_____ semester in the _____ Laboratory during
the Year 20 -20

No. of Experiments performed _____

Signature of Lab-in-charge

Submitted for the practical Examination held on _____

Internal Examiner

External Examiner



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PROGRAM OUTCOMES

Engineering Graduates will be able to:

- PO1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and civil engineering specialization to the solution of complex civil engineering problems.
- PO2. Problem analysis:** Identify, formulate, review research literature, and analyse complex civil engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- PO3. Design/development of solutions:** Design solutions for complex civil engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex civil engineering activities with an understanding of the limitations.
- PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional civil engineering practice.
- PO7. Environment and sustainability:** Understand the impact of the professional civil engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the civil engineering practice.
- PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- PO12. Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.



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PROGRAM SPECIFIC OUTCOMES

Civil Engineering Graduates will be able to:

- PSO 1.** Investigate properties of traditional and latest construction materials using standard testing methods.
- PSO 2.** Use AutoCAD, STAAD Pro, ETABS, Revit Architecture and ANSYS software for computer aided structural analysis and design.
- PSO 3.** Describe the principles of sustainable development and green buildings for environmental preservation.



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DEPARTMENT OF CIVIL ENGINEERING

VISION

To evolve into a centre of excellence for imparting holistic civil engineering education contributing towards sustainable development of the society.

MISSION

- To impart quality civil engineering education blended with contemporary and interdisciplinary skills.
- To provide enhanced learning facilities and professional collaborations to impart a culture of continuous learning.
- To involve in trainings and activities on communication skills, teamwork, professional ethics, environmental protection and sustainable development.



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DEPARTMENT OF CIVIL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES

The Graduates of the programme shall be able to:

- PEO 1:** Engage in planning, analysis, design, construction, operation and maintenance of built environment.
- PEO 2:** Apply the knowledge of civil engineering to pursue research or to engage in professional practice.
- PEO 3:** Work effectively as individuals and as team members in multidisciplinary projects with organizational and communication skills.
- PEO 4:** Demonstrate the spirit of lifelong learning and career enhancement aligned to professional and societal needs.



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Lab Rules of conduct, DO'S & DON'Ts

Engineering Graphics & Design Laboratory

DO'S

1. All the systems in the Laboratory should be handled with care.
2. Use of mobile phones is restricted in the Laboratory.
3. If any important data needs to be accessed or copied, take the help of an in-charge faculty or laboratory assistant.
4. All the users should save their files in their allotted directories only.
5. Bags and other items should be kept at the allocated place.
6. Shutdown the system before leaving the Laboratory.
7. Silence and discipline must be observed in the Laboratory

DON'Ts

1. Do not change the settings of the system.
2. Contact the Laboratory assistant for any clarification
3. CD's, Pen drives & other storage devices are not allowed in the Laboratory.
4. Antivirus checks are must if any inserting pen drives in the system.
5. Do not leave the system open after completing the drawing



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Course code	Course Title	Core/ Elective					
		Core					
M24ES53CE	Engineering Graphics Lab	L	T	P/D	Credits	CIE	SEE
		1	-	4	3	40	60

Prerequisite:

Course Objectives: The objective of this course is to make the student

- To inculcate a good understanding of engineering drawing conventions & their significance.
- To impart skills to make technical drawings.
- To impart capability to identify and draw engineering curves to scale.
- To develop skills of drafting projections of standard geometric entities (points, lines, planes, solids with section).
- To develop 3D visualization skills to understand 2D drawings in 3D space & vice versa.

Course Outcomes: After completion of the course, the student will be able to

- CO-1. Use appropriate instruments and apply the engineering conventions to draw engineering objects to scale on a drawing sheet. (PO1, PO5)
- CO-2. Make use of Drawing Sheets to draft engineering curves like conics, involutes & cycloids. (PO1, PO5)
- CO-3. Make use of Drawing Sheets to draft projections of lines, planes, solids and determine unknown lengths & angles in lines. (PO1, PO5)
- CO-4. Make use of AutoCAD software to draft sections of solids and development of surfaces. (PO1, PO5)
- CO-5. Make use of AutoCAD software to execute development of surface of solids and Isometric Projection. (PO1,PO5)

Sheet No	Description of the Topic	Contact Hours	
		Lecture	Drawing
1.	Principles of Engineering Graphics and their significance, Usage of drawing instruments. Lettering	1	2
2.	Introduction to AutoCAD Basic commands and simple drawings		
3.	Conic Sections – I Construction of ellipse, parabola and hyperbola given focus and eccentricity.	1	2
4.	Conic Sections – II Construction of ellipse (given major and minor axis), parabola (given base and	1	2



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	height), rectangular hyperbola.		
5.	Cycloids (cycloid & epicycloid) and Involutives (involute of triangle, square)	1	2
6.	Scales (plain & diagonal scales)	1	2
7.	Orthographic Projections - Projections of points placed in different quadrants.	1	2
8.	Projections of straight lines. Lines parallel to both the planes, line perpendicular to or inclined to one reference plane.	1	2+2
9.	Projections of planes – I: Orthographic projection of planes in different positions	1	2+2
10.	Projections of solids – I: Regular Prism/Pyramids, cylinders & cones, Projections of solids in simple positions.	1	2
11.	Projection of solids – II: Projections of solids when the axes inclined to one or both the reference planes.	1	2
12.	Section of solids – I: When the sectional plane is parallel or perpendicular to one reference plane.	1	2+2
13.	Section of solids – II: When the sectional plane is inclined to one reference plane.	1	2
14.	Development of surfaces-I Prism and Cylinders	1	2
15.	Development of Surfaces-II Pyramids and Cones	1	2
16.	Isometric projection – I: Conversion of 3D Isometric/oblique views of compound solids to 2D Orthographic views	1	2

Note: A minimum of Fourteen Drawing Work Sheets to be completed.

Text Books:

- T1. Engineering Drawing, ND Bhatt, Charotar Publication, 53rd Edition, 2014 (All sheets)
- T2. Engineering Drawing, KL Narayana & P Kannaiha, Scitech publications, 3rd Edition, 2013 (All sheets).

References:

- R1. Engineering Drawing and Graphics Technology, T.E French et al, Mc Graw Hill International.
- R2. Engineering Drawing Graphics & Auto cad, K Venugopal, New Age International.
- R3: Engineering Drawing with a primer on Auto cad, AN Siddique et al, Prentice Hall of India Ltd.
- R4: Engineering Drawing, Basant Agrawal & C M Agrawal, McGraw Hill Publications, Third edition 2019.



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Course Outcomes with Blooms Taxonomy

CO	Course Outcomes Statement	BTL
CO1	Use appropriate instruments and apply the engineering conventions to draw engineering objects to scale on a drawing sheet.	Applying
CO2	Make use of Drawing Sheets to draft engineering curves like conics, involutes & cycloids.	Applying
CO3	Make use of Drawing Sheets to draft projections of lines, planes, solids and determine unknown lengths & angles in lines.	Applying
CO4	Make use of AutoCAD software to draft sections of solids and development of surfaces.	Applying
CO5	Make use of AutoCAD software to execute development of surface of solids and Isometric Projection.	Applying



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Sheet No	Description of the Topic	CO	PO
1.	Principles of Engineering Graphics and their significance, Usage of drawing instruments. Lettering	CO1,CO2	PO1,PO5
2.	Introduction to AutoCAD Basic commands and simple drawings	CO1,CO2	PO1,PO5
3.	Conic Sections – I Construction of ellipse, parabola and hyperbola given focus and eccentricity.	CO1,CO2	PO1,PO5
4.	Conic Sections – II Construction of ellipse (given major and minor axis), parabola (given base and height), rectangular hyperbola.	CO1,CO2	PO1,PO5
5.	Cycloids (cycloid & epicycloid) and Involutives (involute of triangle, square)	CO1,CO2	PO1,PO5
6.	Scales (plain & diagonal scales)	CO3	PO1,PO5
7.	Orthographic Projections - Projections of points placed in different quadrants.	CO3	PO1,PO5
8.	Projections of straight lines. Lines parallel to both the planes, line perpendicular to or inclined to one reference plane.	CO3	PO1,PO5
9.	Projections of planes – I: Orthographic projection of planes in different positions	CO3	PO1,PO5
10.	Projections of solids – I: Regular Prism/Pyramids, cylinders & cones, Projections of solids in simple positions.	CO3	PO1,PO5
11.	Projection of solids – II: Projections of solids when the axes inclined to one or both the reference planes.	CO1,CO3	PO1,PO5
12.	Section of solids – I: When the sectional plane is parallel or perpendicular to one reference plane.	CO4	PO1,PO5
13.	Section of solids – II: When the sectional plane is inclined to one reference plane.	CO4	PO1,PO5
14.	Development of surfaces-I Prism and Cylinders	CO4	PO1,PO5
15.	Development of Surfaces-II Pyramids and Cones	CO4	PO1,PO5
16.	Isometric projection – I: Conversion of 3D Isometric/oblique views of compound solids to 2D Orthographic views	CO5	PO1,PO5



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Index

EXP. NO	EXPERIMENT NAME	DATE	PAGE NO	MARKS				REMARKS/SIG NATURE
				A	P	R	V	

A: ASSIGNMENT (10) P: PRACTICAL (10) R: RECORD (10) V: VIVA (10)



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A: ASSIGNMENT (10) P: PRACTICAL (10) R: RECORD (10) V: VIVA (10)

Experiment No:1

The Principles of Engineering Drawing

The art of Drawing is very old. Drawing is the language of Engineer. An engineering drawing, a type of technical drawing, is used to fully and clearly define requirements for engineered items. It must be understood by all Engineer, whatever their language, nationality or culture. Before trying to communicate with such a language, one should learn its basics principles, just like any other language.

Those basic of engineering Drawing are:

1. Line
2. Signs
3. Symbols

A variety of line styles graphically represent physical objects. Types of lines include the following:

- 1. Visible Line:** Visible line is continuous lines used to depict edges directly visible from a particular angle.
- 2. Hidden Line:** Hidden line is short-dashed lines that may be used to represent edges that are not directly visible.
- 3. Centre Line:** Centre line is alternately long- and short-dashed lines that may be used to represent the axes of circular features.
- 4. Cutting Plane Line:** Cutting plane line is thin, medium-dashed lines, or thick alternately long- and double short-dashed that may be used to define sections for section views.
- 5. Section Line:** Section line is thin lines in a pattern (pattern determined by the material being “cut” or “sectioned”) used to indicate surfaces in section views resulting from “cutting.” Section lines are commonly referred to as “cross-hatching.”
- 6. Phantom Line:** Phantom line (not shown) is alternately long- and double short-dashed thin lines used to represent a feature or component that is not part of the specified part or assembly. E.g. billet ends that may be used for testing, or the machined product that is the focus of a tooling drawing.

Lines can also be classified by a letter classification in which each line is given a letter.

- 1. Type A:** Type A lines show the outline of the feature of an object. They are the thickest lines on a drawing and done with a pencil softer than HB.
- 2. Type B:** Type B lines are dimension lines and are used for dimensioning, projecting, extending, or leaders. A harder pencil should be used, such as a 2H.
- 3. Type C:** Type C lines are used for breaks when the whole object is not shown. These are freehand drawn and only for short breaks. 2H pencil
- 4. Type D:** Type D lines are similar to Type C, except these are zigzagged and only for longer breaks. 2H pencil
- 5. Type E:** Type E lines indicate hidden outlines of internal features of an object. These are dotted lines. 2H pencil
- 6. Type F:** Type F lines are Type F[typo] lines, except these are used for drawings in electro technology. 2H pencil

7. **Type G:** Type G lines are used for centre lines. These are dotted lines, but a long line of 10–20 mm, then a gap, then a small line of 2 mm. 2H pencil

8. **Type H:** Type H lines are the same as Type G, except that every second-long line is thicker. These indicate the cutting plane of an object. 2H pencil

9. **Type K:** Type K lines indicate the alternate positions of an object and the line taken by that object. These are drawn with a long line of 10–20 mm, then a small gap, then a small line of 2 mm, then a gap, then another small line. 2H pencil.

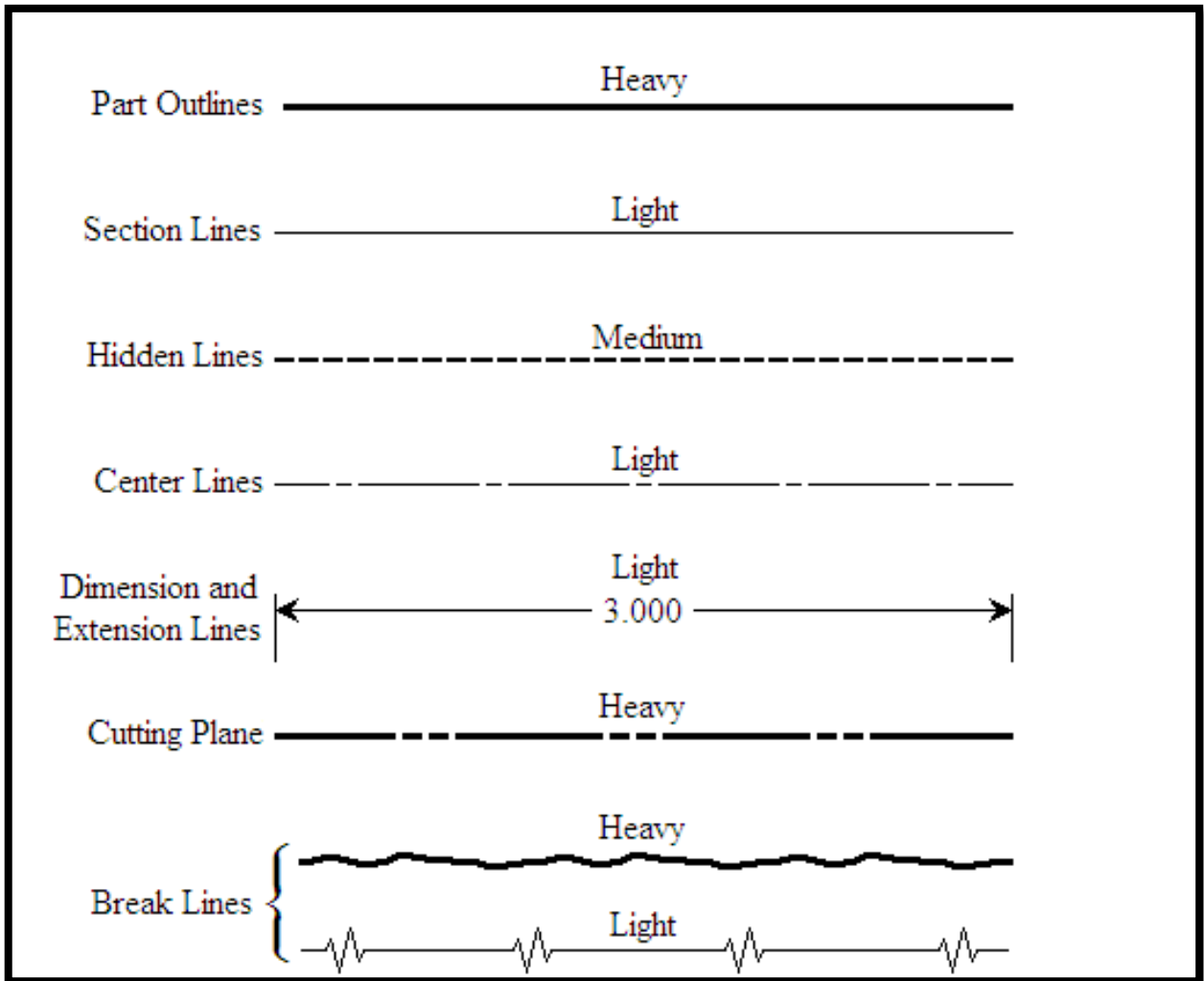


Fig:1 Different kinds of lines

Linetype	Description
ACAD_ISO02W100	ISO dash 
ACAD_ISO03W100	ISO dash space 
ACAD_ISO04W100	ISO long-dash dot 
ACAD_ISO05W100	ISO long-dash double-dot 
ACAD_ISO06W100	ISO long-dash triple-dot 
ACAD_ISO07W100	ISO dot 
ACAD_ISO08W100	ISO long-dash short-dash 
ACAD_ISO09W100	ISO long-dash double-short-dash 
ACAD_ISO10W100	ISO dash dot 
ACAD_ISO11W100	ISO double-dash dot 
ACAD_ISO12W100	ISO dash double-dot 
ACAD_ISO13W100	ISO double-dash double-dot 
ACAD_ISO14W100	ISO dash triple-dot 
ACAD_ISO15W100	ISO double-dash triple-dot 
BATTING	Batting SSS!
BORDER	Border 
BORDER2	Border (.5x) 
BORDERX2	Border (2x) 
CENTER	Center 
CENTER2	Center (.5x) 
CENTERX2	Center (2x) 
DASHDOT	Dash dot 
DASHDOT2	Dash dot (.5x) 
DASHDOTX2	Dash dot (2x) 
DASHED	Dashed 
DASHED2	Dashed (.5x) 
DASHEDX2	Dashed (2x) 
DIVIDE	Divide 
DIVIDE2	Divide (.5x) 
DIVIDEX2	Divide (2x) 
DOT	Dot 
DOT2	Dot (.5x) 
DOTX2	Dot (2x) 
FENCELINE1	Fenceline circle 
FENCELINE2	Fenceline square 
GAS_LINE	Gas line 
HIDDEN	Hidden 
HIDDEN2	Hidden (.5x) 
HIDDENX2	Hidden (2x) 
HOT_WATER_SUPPLY	Hot water supply 
PHANTOM	Phantom 
PHANTOM2	Phantom (.5x) 
PHANTOMX2	Phantom (2x) 
TRACKS	Tracks 
ZIGZAG	Zig zag 

Fig:2 Different kinds of lines in AutoCAD

Engineering Drawing requires three essential skills:

1. The ability to draw any object by representing its lines and features in a clear and precise way leading to the understanding of the drawing and imagining what the object drawn looks like.
2. Knowledge of the used conventions to save time and convey the exact information.
3. The ability to work very accurately with all drawing instruments and convey the exact information.

Engineering drawings common features:

Drawings convey the following critical information:

1. **Geometry** – the shape of the object; represented as views; how the object will look when it is viewed from various angles, such as front, top, side, etc.
2. **Dimensions** – the size of the object is captured in accepted units.
3. **Tolerances** – the allowable variations for each dimension.
4. **Material** – represents what the item is made of.
5. **Finish** – specifies the surface quality of the item, functional or cosmetic. For example, a mass-marketed product usually requires a much higher surface quality than, say, a component that goes inside industrial machinery.

Engineering Drawing Equipment:**1. Drawing Plate:**

Flat surface, the four sides are perpendicular, no change (bending compression and expansion) due to the weather.



Fig:3 Drawing Plate

2. Drawing Sheet:

Drawing Sheet should be strong paper, no damage due to hard pencils or erasing the drawing, no change in colour by time, draw by ink or graphite and no change due to the weather.

Drawing Sheet Size

Serial No.	Paper Code	Paper Dimensions in mm
1	A0	1189 x 841
2	A1	841 x 594
3	A2	594 x 420
4	A3	420 x 279
5	A4	279 x 210

Drawing Sheet in Drawing Plate

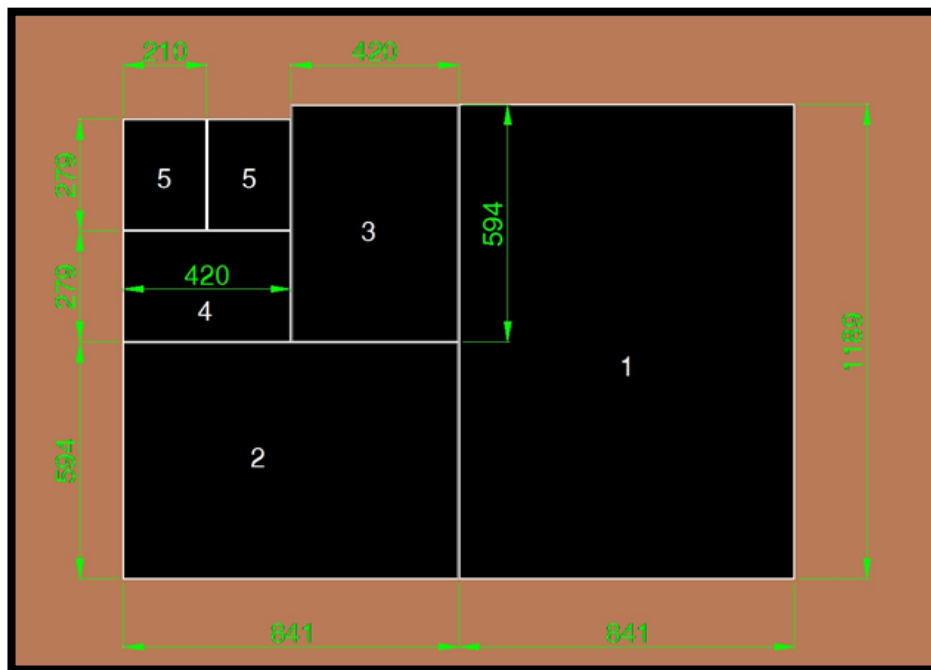


Fig:4 Drawing sheet in Drawing Plate

3. Pencils

Engineering Drawing Pencils mainly two kinds

1. Wooden Pencils &
2. Mechanical Pencils

Characteristics of Drawing Pencils

H = Hard (1-9), B = Soft (1-7) & HB = Medium Hard/Soft

9H - 6H	Extra Hard
5H - 4H	Hard
3H - 2H	Medium Hard
HB, B, F, H	Medium Soft
2B - 7B	Soft

4. T-square:

Flat surfaces, the two parts are perpendicular, no change (bending compression or expansion) due to the weather

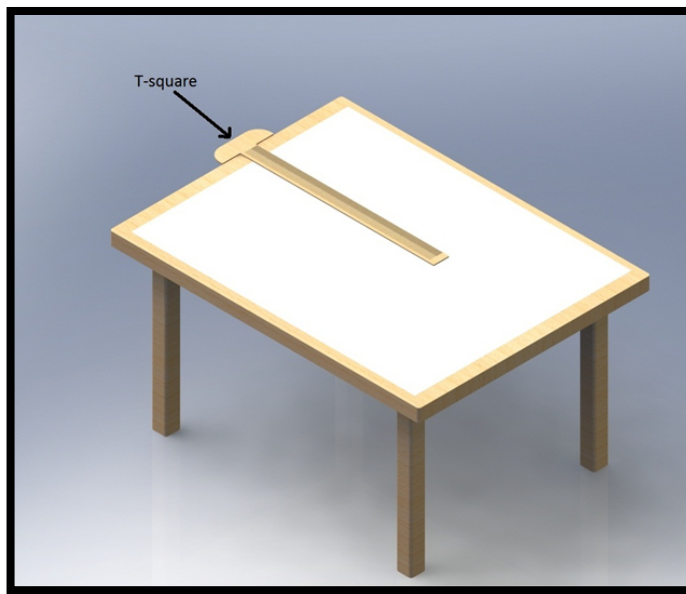


Fig:4 T- Square

5. Set-square (Triangle):

Triangle mainly two kinds 90° - 45° - 45° & 90° - 60° - 30° . These two triangles can be arranged into diverse angle (see figures below)

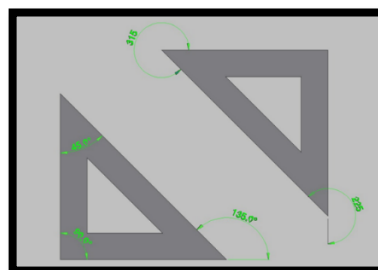
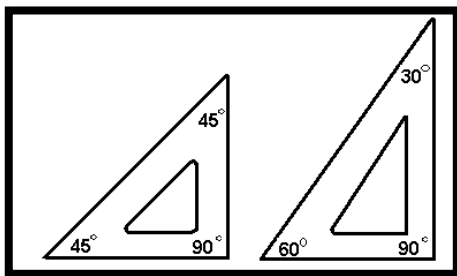


Figure 5: 90° - 45° - 45° & 90° - 60° - 30° Triangle Figure 6: 90° - 45° - 45° arranged angle

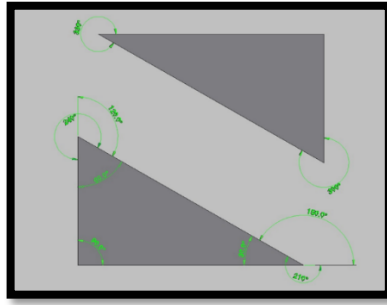


Figure 7: 90°-60°-30° arranged angle

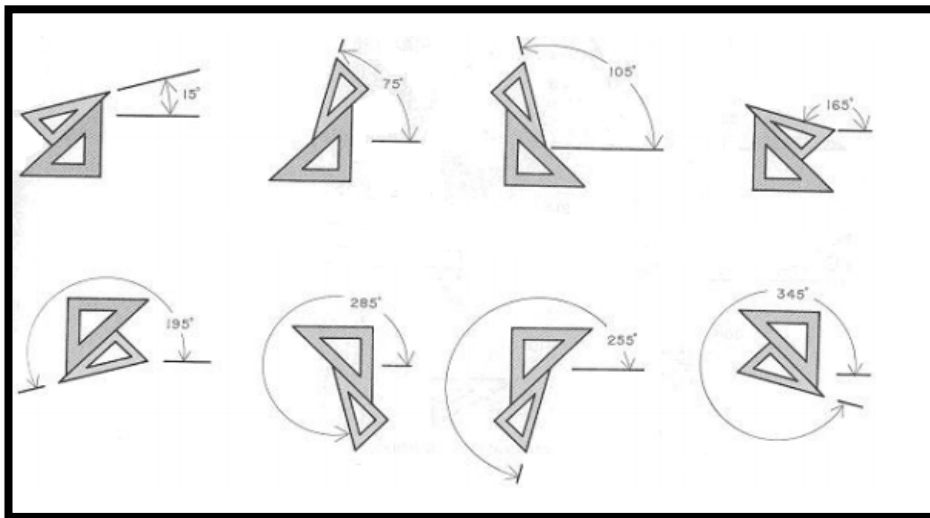


Figure 8: 90°-45°-45° & 90°-60°-30° arranged angle

6. Protractor:

Protractor is used for making different kinds angle. Protractor half circle is 180° and full circle is 360°

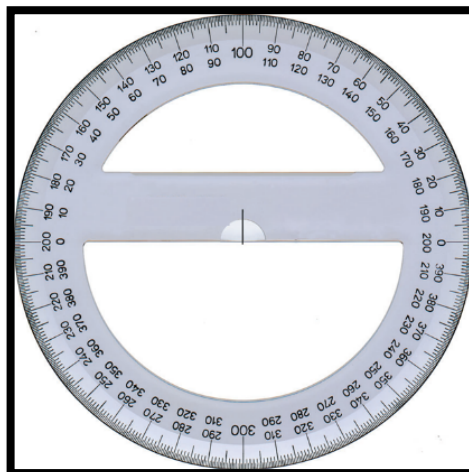


Fig:9 Protractor

7. Drafting angles (French Curves):

They are used to draw the different angles that cannot be drawn by the two triangles.

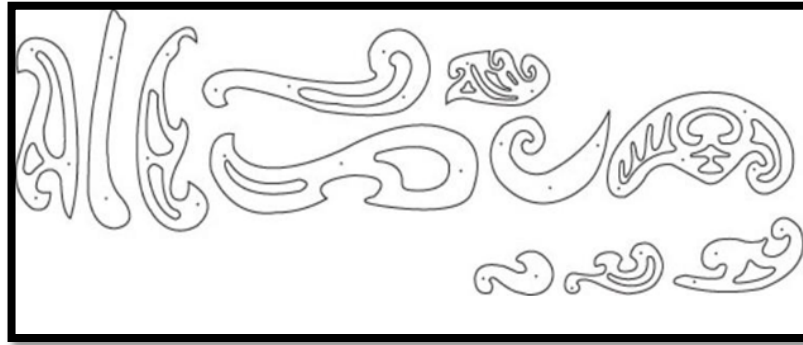


Fig 10: French Curves

8. Compass:

Compass is used to draw circles and curves.

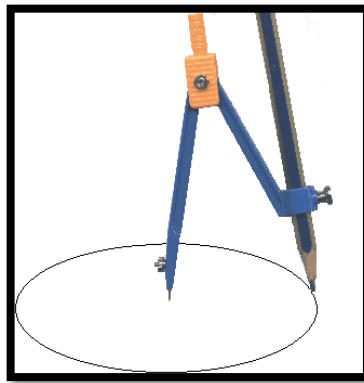


Fig:11 Compass

9. Measuring Ruler:

They are made of metal, wood or plastic. Some special rulers are used for letter, numbers and shapes.

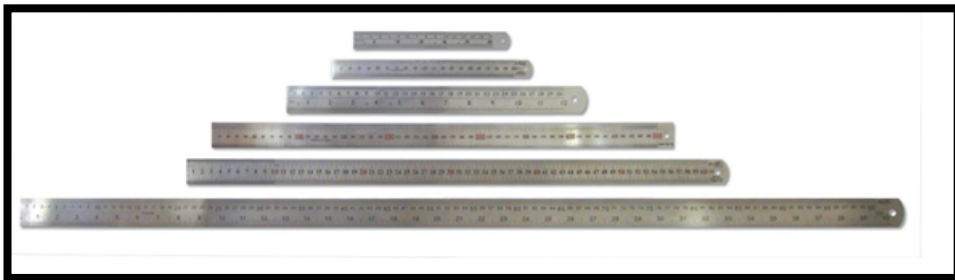


Fig:12 Measuring Ruler

10. Scales

The dimensions of some parts are very large or very small to be represented in their actual size on the drawing paper. In such cases, the drawing should be reduced or enlarged to be in good visible size.

Full Scale: 1:1

Enlarged Scale: 2:1, 5:1, 10:1, 100:1

Reduced Scales: 1:2, 1:5, 1:10, 1:100

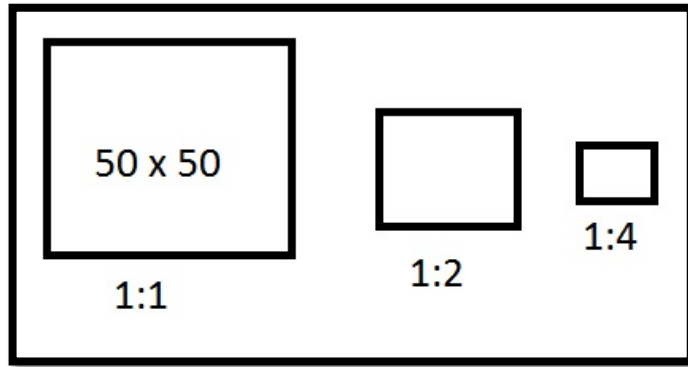


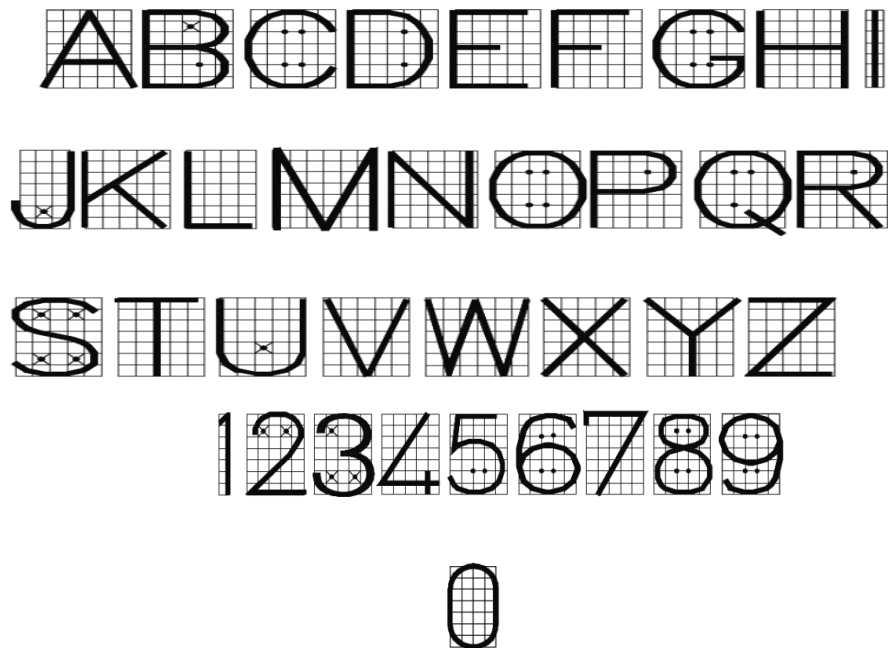
Fig:13 Scales

LETTERING:

Following types of lettering system is used in the drawing sheets:

- Single stroke capital letters also known as capital uppercase letters.
- Single stroke capital inclined letters.
- Double stroke capital letters.
- Double stroke inclined capital letters.
- Small vertical lowercase letters.
- Small inclined lowercase letters.

SINGLE STROKE LETTERS:



VERTICAL AND SLANT LETTERING:

- Further each lettering style may be either vertical or slant.
- In vertical lettering stems are perpendicular to the line of lettering.
- In slant lettering a slope of 75° to the horizontal is recommended by IS: 696 – 1972.

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

STANDARD HEIGHT AND WIDTH:

The letters are designated by their height. The stems of lower case letters, such as **b, d, h**, etc., which extend upward are known **Ascenders**. The stems of lowercase letters, such as **g, j, p, q, y** etc., which extend downward, are known as **Descenders**.

The standard heights recommended by BIS SP: 46-2003 are in the progressive ratio of “square root 2”. They are namely 2.5 – 3.5 – 5 – 7 – 10 – 14 and 20 mm. The height of lower case letter (without tail or stem) is 2.5, 3.5, 5, 7, 10 and 14 mm.

The height of the letters is usually kept as follows:

- Drawing number in title-block and letter denoting cutting plane or section should be 8, 10 or 12 mm.
- Title of drawing should be 6 or 8 mm.
- Sub-title headings should be 3, 4, 5 or 6 mm.
- Notes, such as legends, schedules, materials list, and dimensions should be 3, 4 or 5 mm.
- Alteration entries and the tolerances should be 2 to 3 mm.

There are two standard ratios for the line thickness “d”. They are A & B. In A = line thickness (d) is h/14 and in B=line thickness (d) is h/10.

The width of different letters in terms of “d” is as follows:

CAPITAL LETTER:

WIDTH (W)	CAPITAL LETTERS	WIDTH
1	I	1d
5	J,L	5d
6	C,E,F	6d
7	B,D,G,H,K,N,O,P,R,S,T,U & Z	7d
8	A,Q,V,X,Y	8d
9	M	9d
12	W	12d

LOWER CASE LETTERS AND NUMERALS:

WIDTH (W)	LETTERS/NUMERALS	WIDTH
1	i	1d
3	j,l	3d
4	f,t,l	4d
5	c,r	5d
6	a,b,d,e,g,h,k,n,o,p,q,s,u,v;3;5	6d
7	a,0 (zero), 2,4,6,7,8,9	7d
9	m	9d
10	w	10d

Uppercase Lettering BIS SP: 46-2003

WIDTH (W)	CAPITAL LETTERS
1	I
4	J
5	C,E,F,L
6	B,D,G,H,K,N,O,P,R,S,T,U & Z
7	A,M,Q,V,X,Y
9	W

Lower case letters and numerals

WIDTH (W)	LETTERS/NUMERALS
1	i
2	l
3	j,l
4	c,f,r,t
5	a,b,d,e,g,h,k,n,o,,q,s,u,v,x,y,x,0,2,3,5 to 9
6	a,4

Experiment No:2

INTRODUCTION TO AUTOCAD

A part to be manufactured is defined first in terms of its geometry which also includes dimensions, tolerances, surface finish, and in some cases the type of fit between two mating parts. The two-dimensional representation of a part, called an engineering drawing or a blueprint, shows three orthogonal views of the part. Sometimes, when three views are not enough to define the part, additional sectional views, auxiliary views may have to be added for conveying the right information.

Any design is finally represented in the form of orthographic views and auxiliary views so that production can be carried out. Hence, the computer aided drafting is an important tool for Computer Aided Design. The Computer Aided Drafting (CAD) system is the computerization of technical, production, electronics and architectural drawings. CAD is the product of computer era. Its development originated from early computer graphics systems. CAD can find its roots to the development of Interactive Computer Graphics (ICG). A system called Sketchpad was developed at Massachusetts Institute of Technology, U.S.A., in 1963 by Ivan Sutherland.

In the beginning, CAD systems were no more than graphics editors with some built-in design symbols. The geometry available to the user was limited to lines, circular arcs, and a combination of the two. The development of free-form curves and surfaces such as Coon's patch, Ferguson's patch, Bezier's curve, and 8-splines enabled a CAD system to be used for more sophisticated work. A 3D CAD system allows a user to do very sophisticated design and analysis work.

Computer aided drawing and drafting system uses the computer to assist in generation of blueprint data. CAD systems are essential in design and a large number of computer based systems are commercially available. 2D drawing systems correspond directly to traditional engineering drawings, and they are developed to substitute manual drafting.

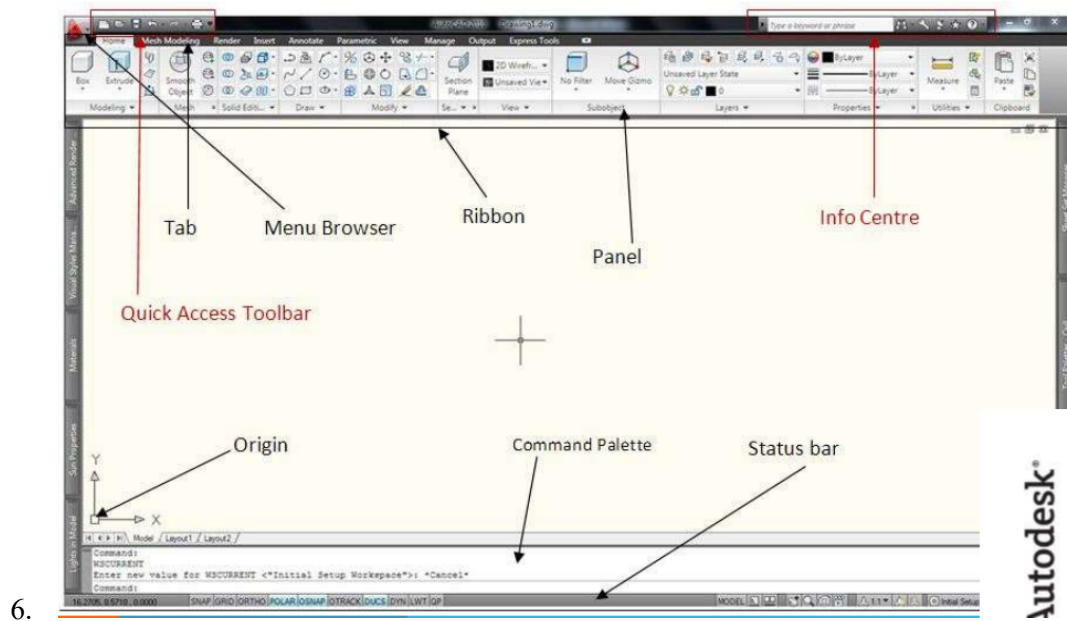
The advantages offered by computerized drafting systems can be summarized as:

- (a) It increases the accuracy and productivity of designer.
- (b) It allows design alterations to be made easily.
- (c) It offers better drawing visualization through colours.
- (d) It improves the quality of drawings produced.
- (e) Drawings are easier to store and retrieve.
- (f) Storage space required is less.
- (g) Transfer of drawings is faster and cheaper.
- (h) It permits the use of library of standard symbols for more productive CAD Work

VERSION OF AUTOCAD

1. AutoCAD software was firstly launched by Autodesk company in Dec. 1982. It comes in India in 1988.
2. The first version of AutoCAD was R1 after that R2, R3, R4..... and so on
3. In 2000, Autodesk launched a version of AutoCAD 2000 after that 2001,2002..... so on.
4. This time, we have the latest version of AutoCAD is 2014, which is launched on 27th march 2013
5. Latest version is easy to use and overcome the difficulties of old version.

AUTOCAD SCREEN

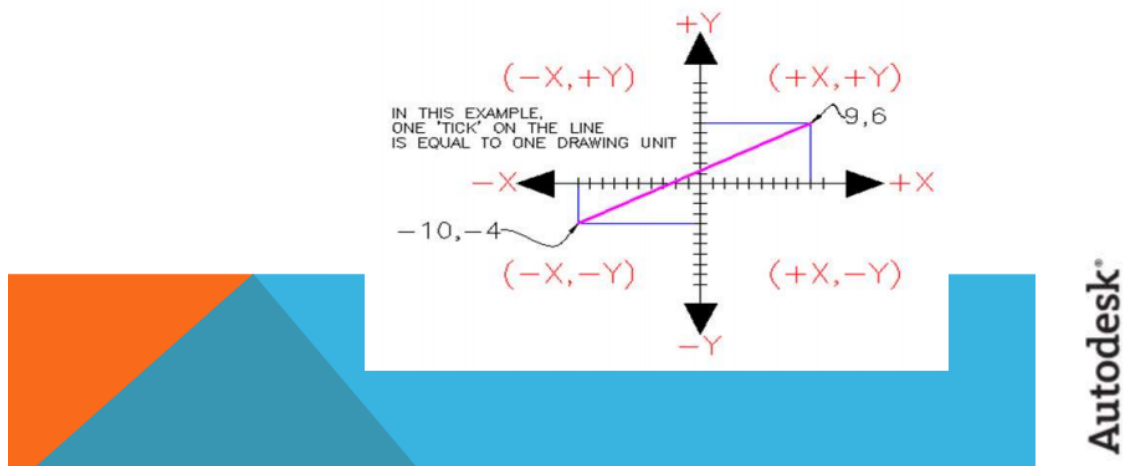


HOW AutoCAD WORKS

- ✓ There is a co-ordinate system used in AutoCAD.
- ✓ Every drawing shows its co-ordinate.
- ✓ In above next slide the line shows its co-ordinate that is (9,6) and (-10,-4).
- ✓ There is so many commands like copy, move, rotate, mirror in 2D, path array, rectangular array, polar array & more.
- ✓ Different types of drawing can be made in the same time by using a command that is LAYER.
- ✓ Using line, arc, circle, rectangle, ellipse & polygon, so many drawing of different type can be made.

CO-ORDINATE SYSTEM

- ✓ Every thing that we draw in AutoCAD is exact.
- ✓ All object drawn on screen is based on simple X-Y co-ordinate system.
- ✓ In AutoCAD it is known as world co-ordinate system (WCS).
- ✓ We are drawing a line, so we have two points A(-10,-4) and B(9,6). As shown in figure.

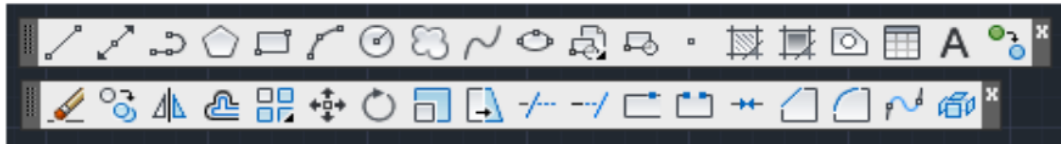


The UCS and WCS

- ✓ The AutoCAD world is 3 dimensional. However, if we want to draw a 2d object, such as a plan or a section, we will use only 2 dimensions (x and y).
- ✓ WCS (world coordinate system) is the imaginary plane that is parallel to the ground. It is the default coordinate system.
- ✓ Modifications made to the World Coordinate System (WCS) result in a User Coordinate System (UCS). It is the plane that you work on. It enables the user to draw 3 dimensional objects.
- ✓ To create a new UCS, type ucs on the command window, then say New and specify 3 points on your new UCS plane.

DRAW TOOLBAR AND MODIFY TOOLBAR :

Following image shows two very basic tool bars, these will be heavily used as you progress towards the end of your drawing. You can access these tool bars under Home tab.

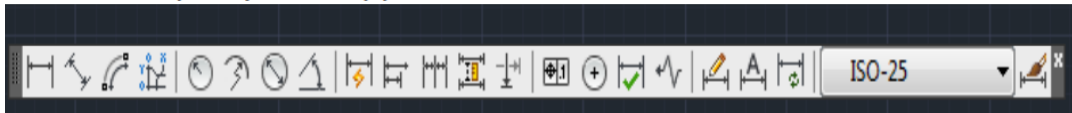


As we move cursor over any tool in the tool bar a tooltip appears stating the name of that tool. And if we further wait for about three seconds, it turns into a brief description about that particular tool. As shown by the following image.

DIMENSION TOOLBAR :

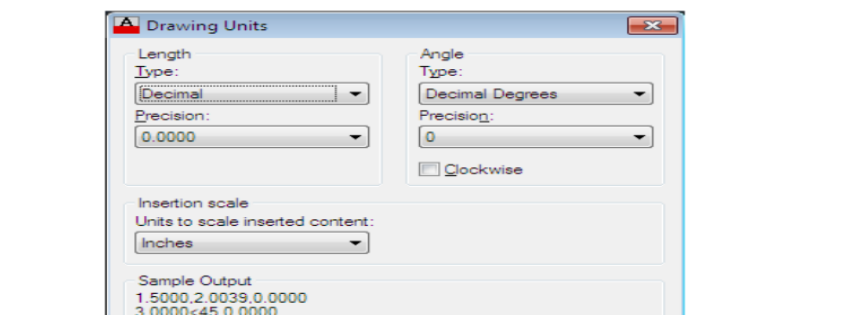
AutoCAD provides a whole range of dimensioning tools which can be used to quickly dimension any drawing without the need for measurement. Dimensioning in AutoCAD is automatic; lines, arrows and text are all taken care of by the dimension commands. AutoCAD dimensions are special blocks which can easily be edited or erased as necessary.

AutoCAD provides lots of control over the way dimensions look. Using a system similar to text styles, dimension styles allow you to design dimensions so that they look just the way you want them to.



HOW TO SET DRAWING UNITS:

To set the drawing units, go to the drop down window at the top left side of the AutoCAD 2013 screen labeled as **Format** or just press **Alt + u** key to do so. And from this menu select **units**. A pop up window will appear that will set our drawing units as shown below.



DRAW/BASIC COMMANDS OF AutoCAD

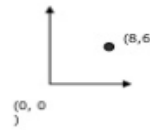
(Drawing Entities)

POINT

Plot a point at the location (8, 6)

Command: point ↵

Point: 8, 6 ↵



LINE

Lines can be drawn by any one of the following three methods using LINE command.

(a) Using Absolute Co-ordinates:

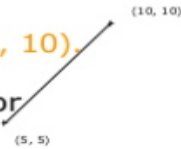
Drawing a line from point (5, 5) to point (10, 10).

Command: Line ↵

From point: 5, 5 (select the point by mouse or Enter the Co-ordinates by keyboard) ↵

To Point: 10, 10 ↵

To Point: ↵



(b) Using Relative Co-ordinates

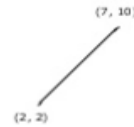
Draw a line from point (2, 2) to point 5 units in X-axis and 8 units in Y-axis relative to first co-ordinate.

Command: Line ↵

From point: 2, 2 ↵

To point: @ 5, 8 ↵

To point: ↵



(c) Using Polar Co-ordinates

Draw a line from point (1, 2) to a length of 6 units at 90 degree.

Command: Line ↵

From point: 1, 2 ↵

To point: @6<90 ↵

To point: ↵



Toggle Drawing Modes

F1	Display Help
F2	Toggle text screen
F3	Toggle object snap mode
F4	Toggle 3DOsnap
F5	Toggle Isoplane
F6	Toggle Dynamic UCS

F7	Toggle grid mode
F8	Toggle ortho mode
F9	Toggle snap mode
F10	Toggle polar mode
F11	Toggle object snap tracking
F12	Toggle dynamic input mode

<u>DRAW COMMANDS</u>	<u>MODIFY COMMANDS</u>	<u>VIEW COMMANDS & OTHERS</u>
LINE	MOVE	REDRAW
CIRCLE	COPY	REGEN
ARC	OFFSET	ZOOM
PLINES	TRIM	PAN
RECTANGLE	EXTEND	3DORBIT
ELLIPSE	ROTATE	HIDE
MLINE	SCALE	SHADE
XLINE	CHAMFER	RENDER
RAY	LENGTHEN	VIEWPORT
DONUT	ARRAY	DDEDIT
SPLINE	BREAK	SNAP
MLSTYLE	MEASURE	GRID
MLEDIT	PROPERTIES	OSNAP
POLYGON	ERASE	LIMITS
TEXT	FILLET	EXPLODE
DTEXT	BLOCK	LIST
MTEXT	WBLOCK	AREA
LINETYPE	INSERT	TIME
LTSCALE	PEDIT	STATUS
HATCH	DIVIDE	DIM
LAYERS	MIRROR	PLOT

VIVA QUESTIONS:

1. Define AutoCAD
2. What are the draw commands?
3. What the modify commands
4. What is use of the function keys?
5. What are the methods to draw a line?
6. Define WCS & UCS?
7. What are the advantages of AutoCAD?
8. Define Coordinates?

CONIC SECTIONS

Definition:

Conic sections are mathematically defined as the curves formed by the locus of a point which moves a plane such that its distance from a fixed point is always in a constant ratio to its perpendicular distance from the fixed-line.

The three types of curves sections are

1. **Ellipse**
2. **Parabola**
3. **Hyperbola.**

The curves, Ellipse, Parabola and Hyperbola are also obtained practically by cutting the curved surface of a cone in different ways.

The profiles of the cut-flat surface from these curves hence called **conic sections**.

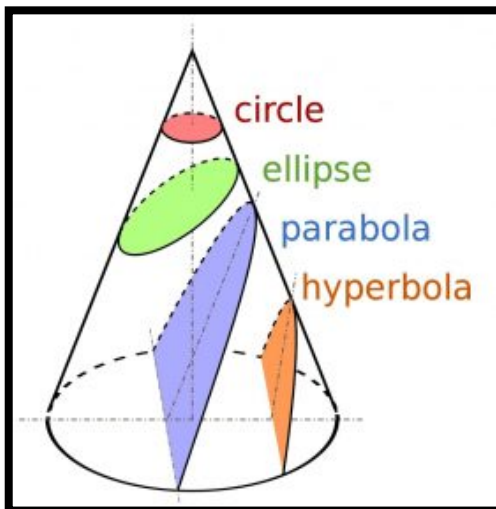


Figure:1

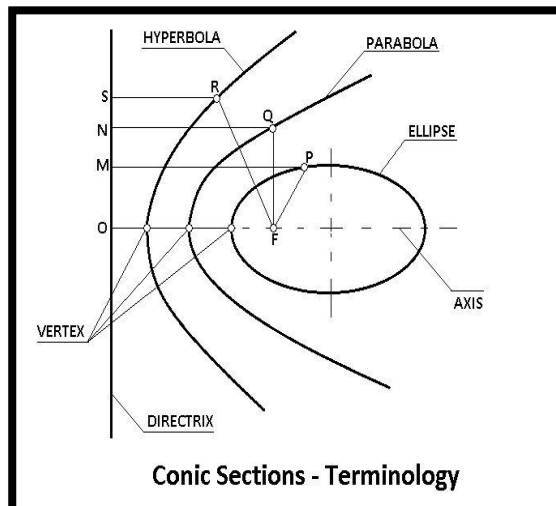


Figure:2

These are the loci of points moving in a plane such that the ratio of its distances from a **fixed point** and a **fixed line** always remains constant.

The Ratio is called **ECCENTRICITY. (E)**

- A) For Ellipse $E < 1$
- B) For Parabola $E = 1$
- C) For Hyperbola $E > 1$

Experiment No:3

CONIC SECTIONS (Focus And Eccentricity Method)

1. A fixed point is 50mm away from a fixed line. Draw the path traced by a point P moving such that its distance from the fixed point is
 - i) $\frac{2}{3}$ times its distance from the fixed line ($E=\frac{2}{3}$; ellipse)
 - ii) Equal to its distance from the fixed line ($E=1$; Parabola)
 - iii) $\frac{3}{2}$ times its distance from the fixed line. ($E=\frac{3}{2}$; Hyperbola)

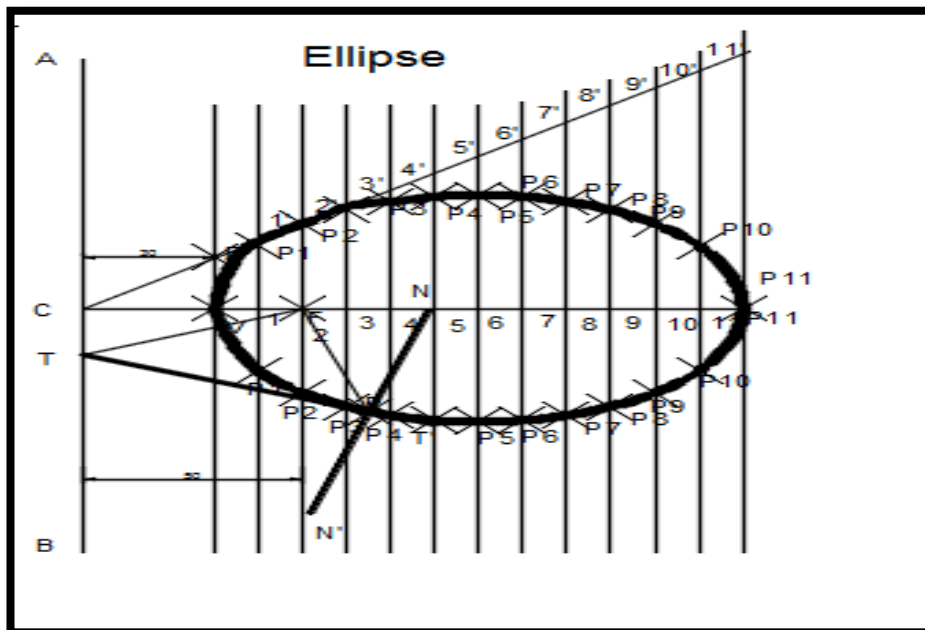


Figure:1 ELLIPSE

Commands:

1. Line
2. Offset
3. Spline
4. Arc/ Circle
5. Dtext
6. Rotate
7. Dimlin/ Dimalign/Dimang

Procedure:

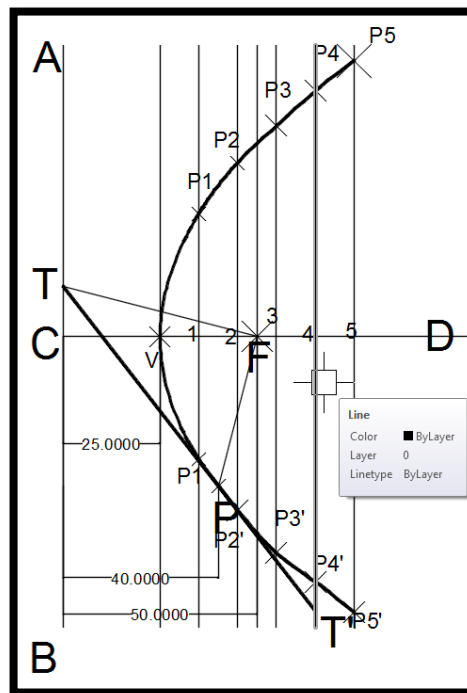
1. Draw a vertical line AB as Directrix.
2. At mid-point of AB mark, it as C, draw the axis perpendicular to AB (Directrix).
3. Mark a focus F on the axis such that $CF=50\text{mm}$.
4. Divide CF into 5 equal divisions

5. Mark the vertex V on the third division-point from C ($e=2/3$)
6. At V, draw a perpendicular VE equal to VF. Draw a line joining C & E. Thus, in the triangle CVE, $(VE/VC) = (VF/VC) = 2/3$.
7. Mark any point 1 on the axis & through it, draw perpendicular to meet CE- produced at 1'
8. With centre F and radius equal to 1-1', draw arcs to intersect the perpendicular through 1 at point P₁ and P'₁
9. These are the points on the Ellipse, because the distance of P₁ from AB is equal to C1
P₁ F= 1-1', similarly mark points 2,3 etc. on the axis and obtain points P₂ and P'₂, P₃ and P'₃ etc.
- 10. Draw the ellipse through these points. It is a closed curve having two foci and two directrices**

To draw tangent & normal:

11. Join P with F.
12. From F, draw a line perpendicular to PF to meet AB at T.
13. Draw a line through T and P. This line is the tangent to the curve.
14. Through P, draw a line NM perpendicular to TP. NM is the normal to the curve.

ii)

**Figure:2 PARABOLA****Commands:**

1. Line
2. Offset
3. Spline
4. Arc/ Circle
5. Dtext
6. Rotate
7. Dimlin/ Dimalign/Dimang

Procedure:

1. Draw the directrix AB and the axis CD
2. Mark focus F on CD, 50 mm from C.
3. Bisect CF in V the Vertex (E=1)
4. Mark a number of points 1,2,3 etc on the axis and through them, draw the perpendiculars to it
5. With centre F and radius equal to CF, draw arcs cutting the perpendicular through 1 at P₁ and P'₁
6. Similarly locate points P₂ and P'₂, P₃ and P'₃ etc. on both sides of axis.
7. Draw a smooth curve through these points. This curve is required Parabola. It is an open curve.

To Draw Tangent & Normal

8. Join P with F.
9. From F, draw a line perpendicular to PF to meet AB at T.
10. Draw a line through T and P. This line is the tangent to the curve.
11. Through P, draw a line NM perpendicular to TP. NM is the normal to the curve.

iii)

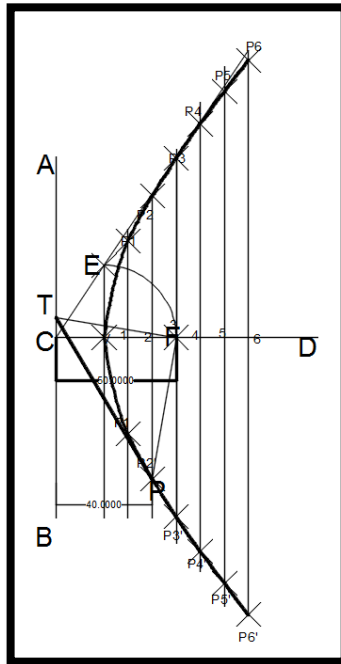


Figure:3 HYPERBOLA

Commands:

1. Line
2. Offset
3. Spline
4. Arc/ Circle
5. Dtext
6. Rotate
7. Dimlin/ Dimalign/Dimang

Procedure:

1. Draw the directrix AB and the axis CD
2. Mark the focus F on CD and 65mm from C
3. Divide CF into 5 equal divisions and mark V the vertex, on the second division from C.
Thus, eccentricity = $VF / VC = 3/2$
4. To construct the scale for the ratio, draw a line VE perpendicular to CD such that $VE = VF$. Join C with E.
Thus, in triangle CVE, $VE/VC = VF/VC = 3/2$.
5. Mark any point 1 on the axis and through it, draw a perpendicular to meet CE-produced at 1'.
6. With centre F and radius equal to 1-1', draw arcs intersecting the perpendicular through 1 at P₁ and P'₁.
7. Similarly, mark a number of points 2, 3 etc. and obtain points P₂ and P'₂, P₃ and P'₃ etc.
8. Draw the hyperbola through these points.

To draw tangent & normal:

1. Join P with F.
2. From F, draw a line perpendicular to PF to meet AB at T.
3. Draw a line through T and P. This line is the tangent to the curve.
4. Through P, draw a line NM perpendicular to TP. NM is the normal to the curve.

Experiment No:4

CONIC SECTIONS II

ELLIPSE

1. Draw the ellipse whose major axis is 150mm & minor axis is 100mm by using
 - (i) Concentric circle method
 - (ii) Oblong Method

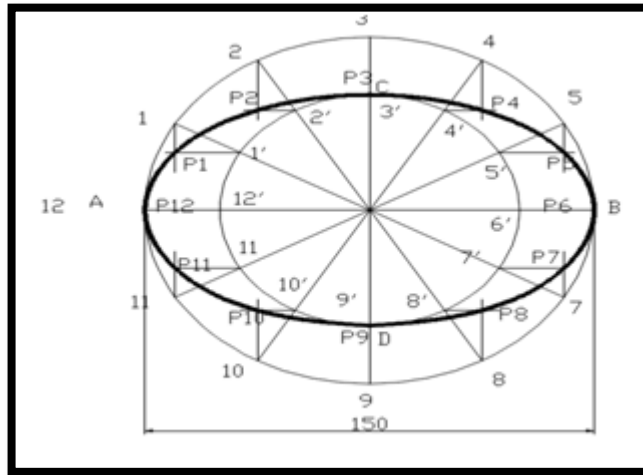


Figure:1 CONCENTRIC CIRCLE METHOD

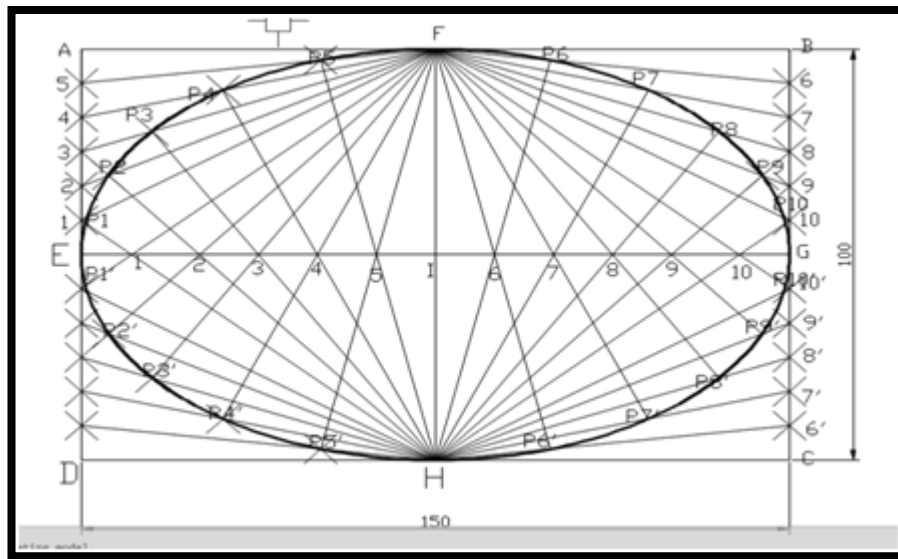
Commands:

1. Units
2. Limits
3. Line
4. Circle
5. Dtext
6. Point
7. Ptype
8. Spline
9. Array

Procedure:

1. Draw the major axis AB and the minor axis CD intersecting each other at O
2. With centre O and diameters AB and CD respectively, draw two circles.
3. Divide the major-axis-circle into a number of equal divisions, say 12 and mark points 1, 2 etc. as shown.
4. Draw lines joining these points with the centre O and cutting the minor-axis-circle at points 1', 2' etc.
5. Through point 1 on the major-axis-circle, draw a line parallel to CD, the minor axis
6. Through point 1' on the minor-axis-circle, draw a line parallel to AB, the major axis. The point P1, where these two lines intersect is on the required ellipse.
7. Repeat the construction through all the points. Draw the ellipse through A, P1, P2, etc

ii)

**Figure:2 OBLONG METHOD****Commands:**

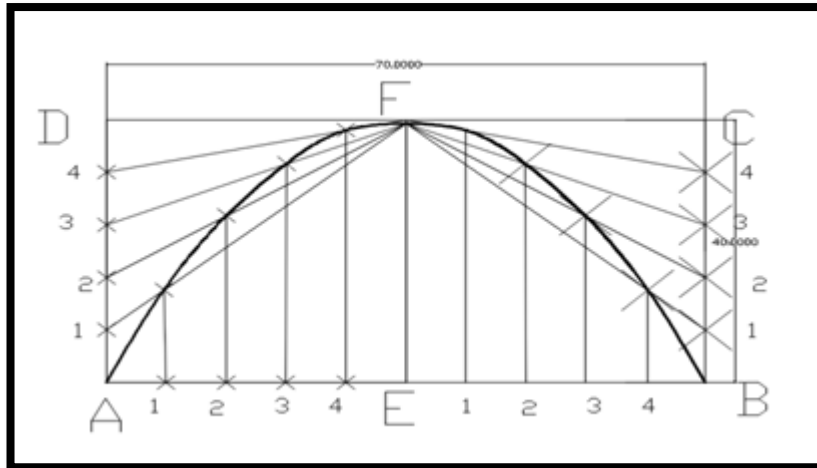
1. Units
2. Limits
3. Line
4. Circle
5. Dtext
6. Point
7. Ptype
8. Spline
9. Division

Procedure:

1. Draw the two axes AB and CD intersecting each other at O.
2. Construct the oblong EFGH having its sides equal to the two axes.
3. Divide the semi-major-axis AO into a number of equal parts, say 4, and AE into the same number of equal parts, numbering them from A as shown.
4. Draw lines joining 1', 2' and 3' with C.
5. From D, draw lines through 1, 2 and 3 intersecting C'1, C'2 and C'3 at points P1, P2 and P3 respectively.
6. Draw the curve through A, P1. C. It will be one quarter of the ellipse.
7. Complete the curve by the same construction in each of the three remaining quadrants.

PARABOLA

2. A ball thrown up in the air reaches a maximum height of 45 metres and travels a horizontal distance of 75 metres. Trace the path of the ball, assuming it to be parabolic. (Rectangle method)

**Figure:3 RECTANGLE METHOD****Commands:**

1. Units
2. Limits
3. Line
4. Dtext
5. Spline
6. Dimlin
7. Ptype
8. Point
9. Division

Procedure:

1. Draw the base AB.
2. At its mid-point E, draw the axis EF at right angles to AB.
3. Construct a rectangle ABCD, making side BC equal to ff.
4. Divide AE and AD into the same number of equal parts and name them as shown (starting from A).
5. Draw lines joining F with points 1, 2 and 3. Through 1', 2' and 3', draw perpendiculars to AB intersecting F1, F2 and F3 at points P1, P2 and P3 respectively.
6. Draw a curve through A, P1, P2 etc. It will be a half parabola.

3. A fountain jet discharges water from the ground level at an angle of 45° to the ground. It travels a maximum horizontal distance of 8.5m from the point of discharge and falls on the ground. Trace the path of the jet. Assuming it to be Parabolic (Tangent method)

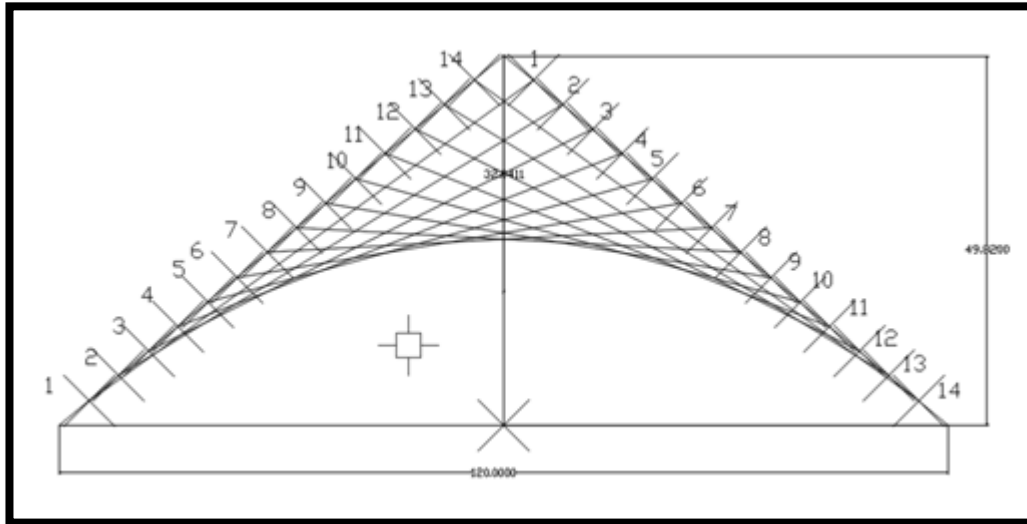


Figure:4 PARABOLIC (TANGENT METHOD)

Commands:

1. Units
2. Limits
3. Line
4. Dtext
5. Spline
6. Dimlin
7. Ptype
8. Point
9. Division

Procedure:

1. Draw the base AB and the axis EF.
2. Produce EF to O so that $EF = FO$. 112 Engineering Drawing.
3. Join O with A and B. Divide lines OA and OB into the same number of equal parts, say 8.
4. Mark the division-points as shown in the figure.
5. Draw lines joining 1 with 1', 2 with 2' etc. Draw a curve starting from A and tangent to lines 1-1', 2-2' etc. This curve is the required parabola.

HYPERBOLA

- A point P is 40 mm and 50 mm respectively from two straight lines which are at right angles to each other. Draw a rectangular hyperbola from P within 10 mm distance from each line.

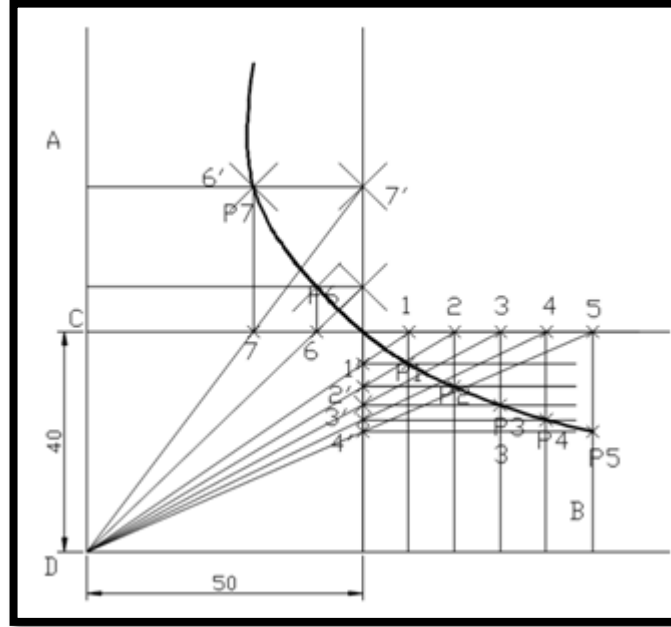


Figure:5 HYPERBOLA (RECTANGLE METHOD)

Commands:

- Units
- Limits
- Line
- Dtext
- Spline
- Dimlin
- Ptype
- Point
- Division

Procedure:

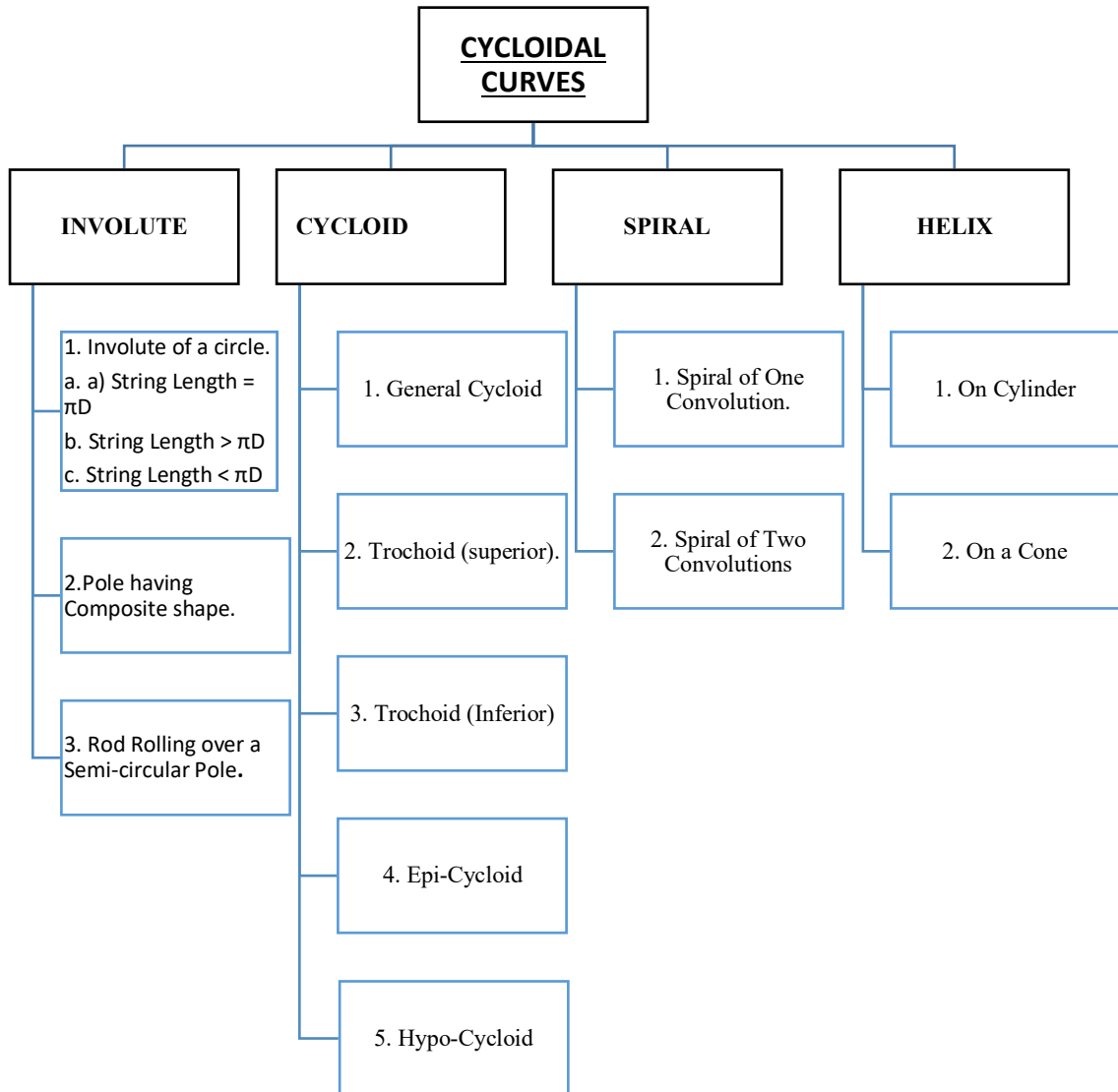
- Draw lines OA and OB at right angles to each other.
- Mark the position of the point P.
- Through P, draw lines CD and EF parallel to OA and OB respectively.
- Along PD, mark a number of points 1, 2, 3 etc. not necessarily equidistant.
- Draw lines 01, 02 etc. cutting PF at points 1', 2' etc.
- Through point 1, draw a line parallel to OB and through 1', draw a line parallel to OA, intersecting each other at a point P1.
- Obtain other points in the same manner.
- For locating the point, say P6, to the left of P, the line 06 should be extended to meet PE at 6'.
- Draw the hyperbola through the points P6, P, P1 etc.

Viva Questions:

1. What are conic sections and why are they called so?
2. Define eccentricity?
3. Define Ellipse?
4. Name the methods to draw an ellipse?
5. Define Parabola?
6. Name the methods to draw Parabola?
7. Define Hyperbola?
8. Name the methods to draw Hyperbola?
9. What is the significance of normal and tangent on a curve?
10. What are the methods to draw normal and tangent on conics?
11. What are applications of conic sections?

CYCLOIDAL CURVES

These curves are generated by a fixed point on the circumference of a circle, which rolls without slipping along a fixed straight line or a circle. The rolling circle is called generating circle and the fixed straight line or circle is termed directing line or directing circle. Cycloidal curves are used in tooth profile of gears of a dial gauge.



CYCLOID: It is a locus of a point on the periphery of a circle which rolls on a straight line path.

SUPERIOR TROCHOID: If the point in the definition of cycloid is outside the circle

INFERIOR TROCHOID: If it is inside the circle

EPI-CYCLOID: If the circle is rolling on another circle from outside

HYPO-CYCLOID: If the circle is rolling from inside the other circle

INVOLUTE: It is a locus of a free end of a string when it is wound round a circular pole

SPIRAL: It is a curve generated by a point which revolves around a fixed point and at the same time moves towards it.

HELIX: It is a curve generated by a point which moves around the surface of a right circular cylinder / cone and at the same time advances in axial direction at a speed bearing a constant ratio to the speed of rotation.

Experiment No:5

CYCLOIDS

1. A circle of 50 mm diameter rolls along a straight line without slipping. Draw the curve traced out by a point P on the circumference, for one complete revolution of the circle. Name the curve. Draw a tangent to the curve at a point on it 40 mm from the line.

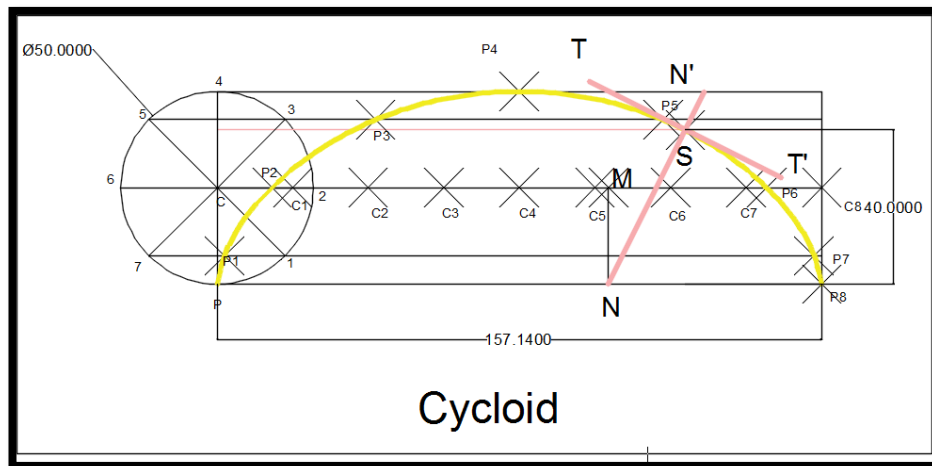


Figure:1 CYCLOIDS

Commands:

1. Units
2. Limits
3. Line
4. Dtext
5. Spline
6. Dimlin/ Dimalign/ Dimangle
7. Ptype
8. Point
9. Division
10. Circle
11. Polar Array
12. Copy
13. Rotate

Procedure:

1. With centre C and given radius R, draw a circle. Let P be the generating point.
2. Draw a line PA tangential to and equal to the circumference of the circle.
3. Divide the circle and the line PA into the same number of equal parts, say 12, and mark the division-points as shown.
4. Through C, draw a line CB parallel and equal to PA.
5. Draw perpendiculars at points 1, 2 etc. cutting CB at points C1, C2 etc.
6. Assume that the circle starts rolling to the right.

7. When point 1' coincides with 1, centre C will move to C1
8. In this position of the circle, the generating point P will have moved to position P1 on the circle, at a distance equal to P'1 from point 1.
9. It is evident that P1 lies on the horizontal line through 1' and at a distance R from C1.
10. Similarly, P2 will lie on the horizontal line through 2' and at the distance R from C2
11. Through the points 1', 2' etc. draw lines parallel to PA.
12. With centres C1, C2 etc. and radius equal to R, radius of generating circle, draw arcs cutting the lines through 1', 2' etc. at points P1, P2 etc. respectively.
13. Draw a smooth curve through points P, P1, P2 ••• A. This curve is the required cycloid.

Tangent and Normal

1. With centre N and radius equal to R, draw an arc cutting CB at M.
2. Through M, draw a line MO perpendicular to the directing line PA and cutting it at O. O is the point of contact and M is the position of the centre of the generating circle, when the generating point P is at N.
3. Draw a line through N and O. This line is the required normal.
4. Through N, draw a line ST at right angles to NO. ST is the tangent to the cycloid.

2. A circle of 50 mm diameter rolls on the circumference of another circle of 150 mm diameter and outside it. Trace the locus of a point on the circumference of the rolling circle for one complete revolution. Name the curve. Draw a tangent and a normal to the curve at a point 85 mm from the centre of the directing circle.

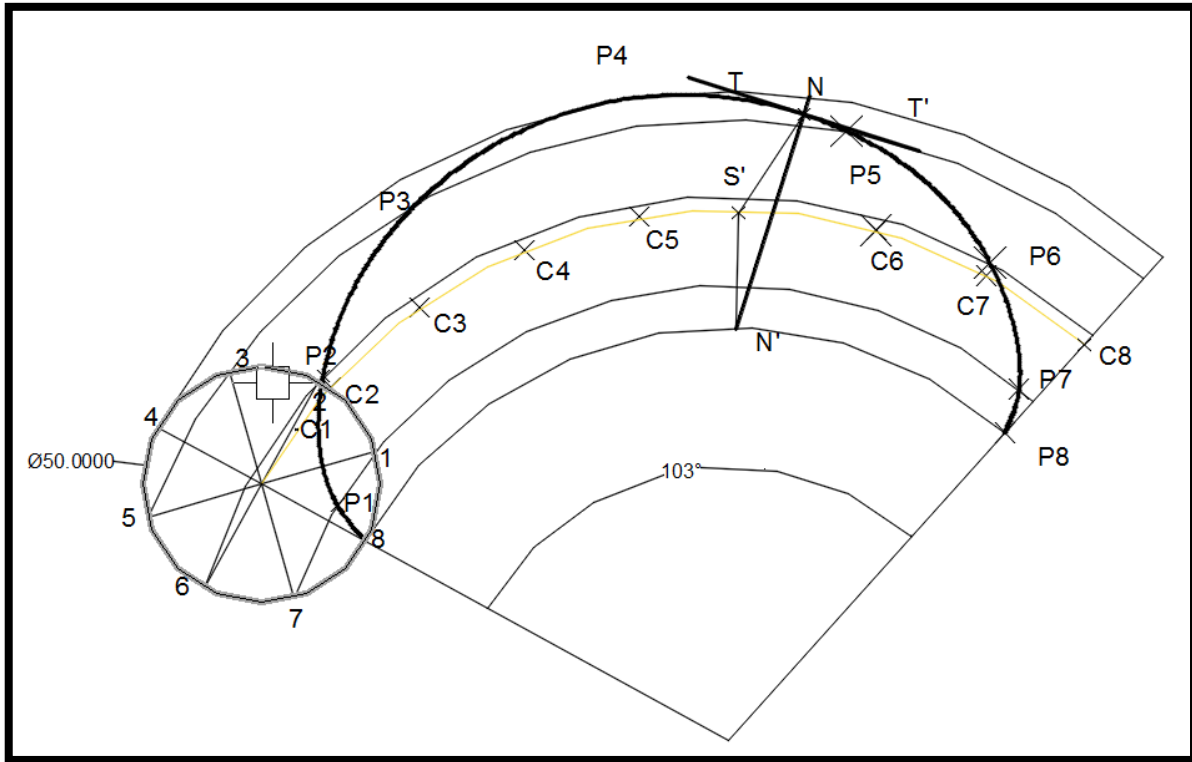


Figure:2 EPI-CYCLOIDS

Commands:

1. Units
2. Limits
3. Line
4. Dtext
5. Spline
6. Dimlin/ Dimalign/ Dimangle
7. Ptype
8. Point
9. Division
10. Circle
11. Polar Array
12. Copy
13. Rotate

Procedure:

1. With centre O and radius R, draw the directing circle (only a part of it may be drawn). Draw a radius OP and produce it to C, so that $CP = r$.
2. With C as centre, draw the generating circle. Let P be the generating point.

3. In one revolution of the generating circle, the point P will move to a point A, so that the arc PA is equal to the circumference of the generating circle.
4. The position of A may be located by calculating the angle subtended by the arc PA at centre O, by the formula,

$$\frac{\angle POA}{360} = \frac{\text{Arc } PC}{\text{Circumference of directing circle}} = \frac{2\pi r}{2\pi R} = \frac{r}{R}$$

Therefore $\angle POA = \frac{r}{R}$

5. Set-off this angle and obtain the position of A.
6. With centre O and radius equal to OC, draw an arc intersecting QA-produced at B. This arc CB is the locus of the centre C.
7. Divide CB and the generating circle into twelve equal parts.
8. With centre O, describe arcs through points 1', 2', 3' etc.
9. With centres C1, C2 etc. and 2 TC r 2 TC R radius equal to r, draw arcs of r = R M cutting the arcs through 1', Hypocycloid 2' etc. at points P1, P2 etc. FIG. 6-35 Draw the required epicycloid through the points P, P1, P2. A.

Tangent and Normal

1. With centre N and radius equal to r, draw an arc cutting the locus of the centre C at a point D.
2. Draw a line through O and D, cutting the directing circle at M.
3. Draw a line through N and M. This line is the normal.
4. Draw a line ST through N and at right angles to NM. ST is the tangent.

Viva questions:

1. What are cycloidal curves?
2. Define Cycloid?
3. Define Epicycloid?
4. What property of cycloidal curves is used to draw?
5. What are the applications of cycloidal curves?

INVOLUTES

1. Draw the Involutés of the following:
 - a. Square of 30mm sides

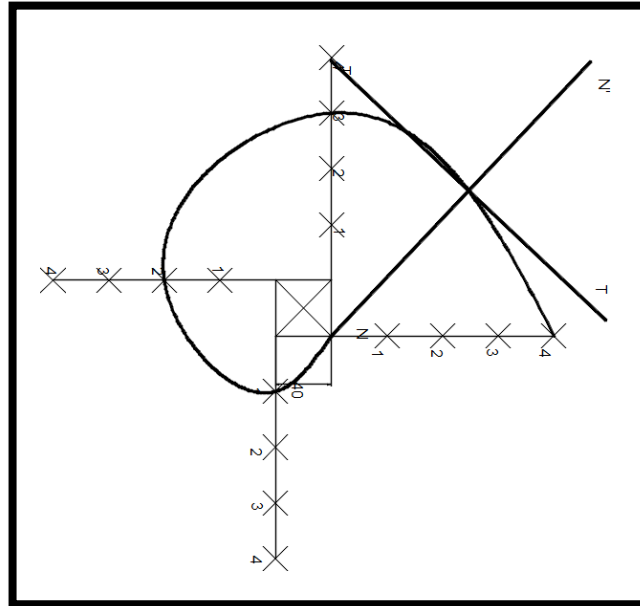


Figure:2 SQUARE INVOLUTE

Commands:

1. Units
2. Limits
3. Line
4. Dtext
5. Spline
6. Dimlin/ Dimalign/ Dimangle
7. Ptype
8. Point
9. Division
10. Copy
11. Rotate

Procedure:

1. let ABCD be the given square.
2. With centre A and radius AD, draw arc to cut the line BA-produced at a point P₁.
3. With centre B and radius BP₁ (i.e. BA + AD) draw an arc to cut the line CB-produced at a point P₂.
4. Similarly, with centres C and D and radii CP₂ (i.e. CB + BA + AD) and DP₃ (i.e. DC + CB + BA + AD = perimeter) respectively, draw arcs to cut DC-produced at a point P₃ and AD-produced at a point P₄.
5. The curve thus obtained is the involute of the square.

SCALES

DIMENSIONS OF LARGE OBJECTS MUST BE REDUCED TO ACCOMMODATE ON STANDARD SIZE DRAWING SHEET. THIS REDUCTION CREATES A SCALE OF THAT REDUCTION RATIO, WHICH IS GENERALLY A FRACTION..

**SUCH A SCALE IS CALLED REDUCING SCALE
AND
THAT RATIO IS CALLED REPRESENTATIVE FACTOR.**

SIMILARLY IN CASE OF TINY OBJECTS DIMENSIONS MUST BE INCREASED FOR ABOVE PURPOSE. HENCE THIS SCALE IS CALLED ENLARGING SCALE. HERE THE RATIO CALLED REPRESENTATIVE FACTOR IS MORE THAN UNITY.

FOR FULL SIZE SCALE

R.F.=1 OR (1:1)

MEANS DRAWING
& OBJECT ARE OF
SAME SIZE.

Other RFs are described
as

1:10, 1:100,
1:1000, 1:1,00,000

USE FOLLOWING FORMULAS FOR THE CALCULATIONS IN THIS TOPIC.

A REPRESENTATIVE FACTOR (R.F.) = $\frac{\text{DIMENSION OF DRAWING}}{\text{DIMENSION OF OBJECT}}$

$$= \frac{\text{LENGTH OF DRAWING}}{\text{ACTUAL LENGTH}}$$

$$= \sqrt{\frac{\text{AREA OF DRAWING}}{\text{ACTUAL AREA}}}$$

$$= \sqrt[3]{\frac{\text{VOLUME AS PER DRWG.}}{\text{ACTUAL VOLUME}}}$$

B LENGTH OF SCALE = R.F. X MAX. LENGTH TO BE MEASURED.

BE FRIENDLY WITH THESE UNITS.

1 KILOMETRE = 10 HECTOMETRES
1 HECTOMETRE = 10 DECAMETRES
1 DECAMETRE = 10 METRES
1 METRE = 10 DECIMETRES
1 DECIMETRE = 10 CENTIMETRES
1 CENTIMETRE = 10 MILIMETRES

TYPES OF SCALES:

1. PLAIN SCALES (FOR DIMENSIONS UP TO SINGLE DECIMAL)
2. DIAGONAL SCALES (FOR DIMENSIONS UP TO TWO DECIMALS)
3. VERNIER SCALES (FOR DIMENSIONS UP TO TWO DECIMALS)
4. COMPARATIVE SCALES (FOR COMPARING TWO DIFFERENT UNITS)
5. SCALE OF CORDS (FOR MEASURING/CONSTRUCTING ANGLES)

Experiment No:6

SCALES

1. Construct a scale of 1 : 4 to show centimetres and long enough to measure upto 5 decimetres.

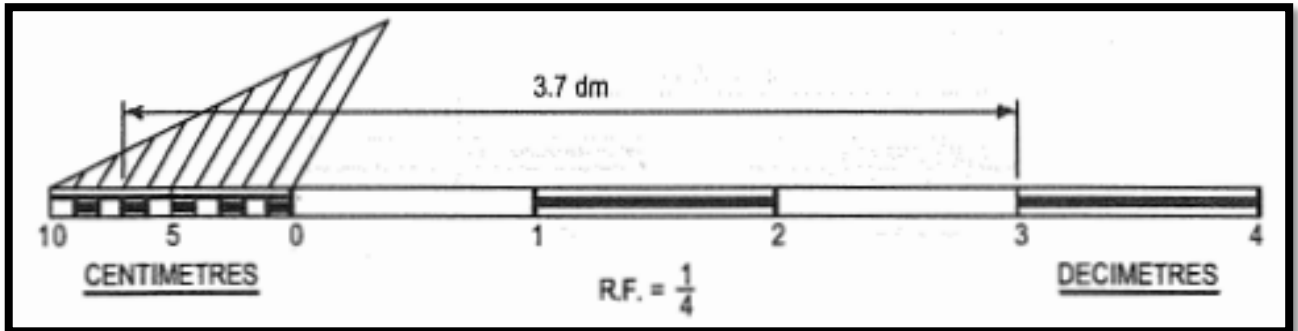


Figure:1

Commands:

1. Units
2. Limits
3. Line
4. Division
5. Points
6. Ptype
7. Dimlin
8. Dtext

Procedure:

1. Determine R.F. of the scale. Here it is $\frac{1}{4}$.
2. Determine length of the scale.
3. Length of the scale == R.F. x maximum length = $\frac{1}{4} \times 5 \text{ dm} = 12.5 \text{ cm}$.
4. Draw a line 12.5 cm long and divide it into 5 equal divisions, each representing 1 dm.
5. Mark O at the end of the first division and 1, 2, 3 and 4 at the end of each subsequent division to its right.
6. Divide the first division into 10 equal sub-divisions, each representing 1 cm.
7. Mark cms to the left of O as shown in the figure.

2. Draw a plain scale of 1:60 showing meters & decimetre & to measure upto 6 meters. Show the length of 3.7m & 4.9m

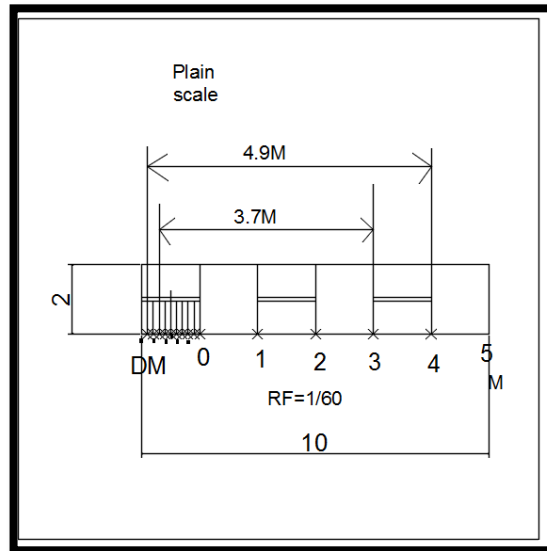


Figure:2

Commands:

1. Units
2. Limits
3. Line
4. Division
5. Points
6. Ptype
7. Dimlin
8. Dtext

Procedure:

1. Determine R.F. of the scale, here R.F. = 1/60
2. Determine length of the scale.
3. Length of the scale = $1/60 \times 6 \text{ m} = 1/10 \text{ metre} = 10 \text{ cm}$.
4. Draw a line 10 cm long and divide it into 6 equal parts.
5. Divide the first part into 10 equal divisions and complete the scale as shown.
6. The length 3.7 metres is shown on the scale.

- Construct a diagonal scale of 3: 200 i.e. $1:66\frac{2}{3}$ showing meters, decimetres and centimetres and to measure upto 6 metre

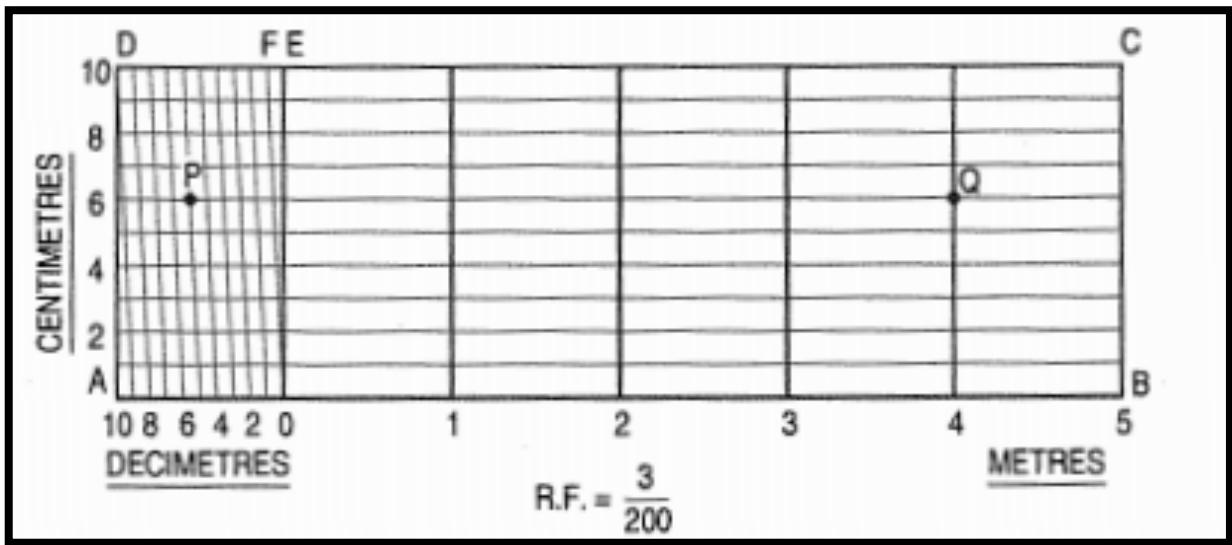


Figure:3

Commands:

- Units
- Limits
- Line
- Division
- Points
- Ptype
- Dimlin
- Dtext

Procedure:

- Draw a line AB 9 cm long and divide it into 6 equal parts. Each part will show a metre.
- Divide the first part AO into 10 equal divisions, each showing a decimetre or 0.1 m.
- At A erect a perpendicular and step-off along it, 10 equal divisions of any length, ending at 0. Complete the rectangle ABCD.
- Erect perpendiculars at metre-divisions 0, 1, 2, 3 and 4.
- Draw horizontal lines through the division-points on AD.
- Join O with the end of the first division along AO, viz. the point 9.
- Through the remaining points i.e. 8, 7, 6 etc. draw lines parallel to D9.

Assignments

- Draw a scale of 1: 60 to show metres and decimetres and long enough to measure upto 6 metres.
- Construct a scale of 1.5 inches = 1 foot to show inches and long enough to measure up to 4 feet.
- Construct a diagonal scale of R. F= 1/32 showing yards, feet and inches and to measure up to 4 yards.

4. Draw a scale of full-size, showing 1/100 inch and to measure up to 5 inches.

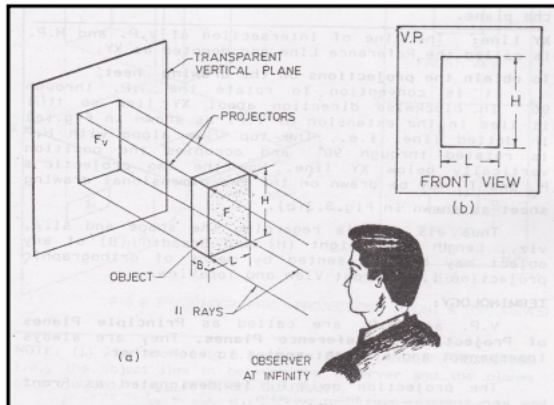
Viva Questions:

1. Define R.F.?
2. How will you find L.O.S?
3. How many types of scales are used in Engineering Drawing?
4. What is the difference between Plain Scale and Diagonal Scale?
5. What is scale of chords and why it is called so?
6. What is RF of scale of chords?
7. How will you measure given angle using scale of chords?
8. How will you draw given angle using scale of chords?

PROJECTIONS

WHAT IS PROJECTION?

The figure or view formed by joining, in correct sequence, the points at which these lines meet the plane is called the **Projection of the object**.



■ The lines or rays drawn from the object to the plane are called **Projectors**.

■ The transparent plane on which the projections are drawn is known as **Plane of Projection**.

Note: It is obvious that the outlines of the shadow are the projections of an object.

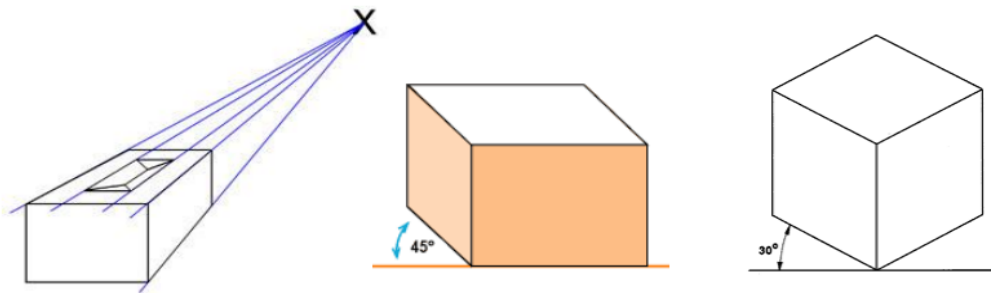
TYPES OF PROJECTION

- Pictorial Projections
 - Perspective Projections
 - Isometric Projections
 - Oblique Projections
- Orthographic Projections

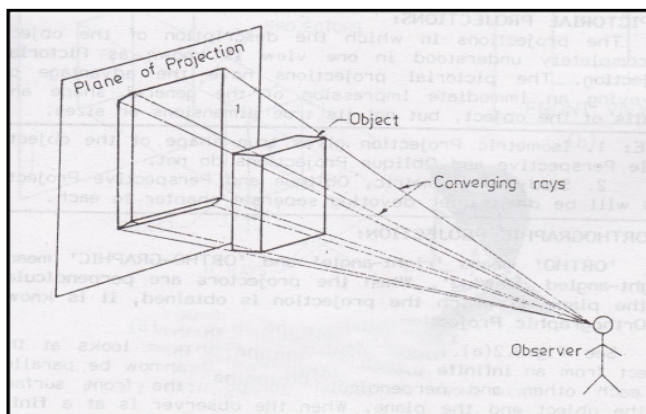
PICTORIAL PROJECTION

The Projection in which the description of the object is completely understood in one view is known as **Pictorial Projection**.

The pictorial projections have the advantage of conveying an immediate impression of the general shape and details of the object, but no its true dimensions or sizes.



PERSPECTIVE PROJECTION



If any transparent plane is introduced such that the object is in between the observer and the plane. The image obtained on the plane/screen is as shown. This is called **Perspective View** of the object.

Here straight lines (rays) are drawn from various points on the contour of the object to meet the transparent plane, thus the object is said to be projected on that plane

ISOMETRIC PROJECTION

“**Iso**” means ‘equal’ and “**metric projection**” means ‘a projection to a reduced measure’.

An *Isometric Projection* is one type of pictorial projection in which the three dimensions of a solid are not only shown in one view, but also their dimension can be scaled from this drawing.

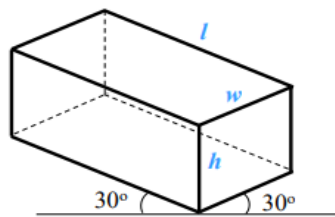


Fig. Isometric Projection

OBLIQUE PROJECTION

The word “**oblique**” means “**slanting**” There are three axes-vertical, horizontal and oblique. The oblique axis, called receding axis is drawn either at 30° or 45°. Thus an oblique drawing can be drawn directly without resorting to projection techniques

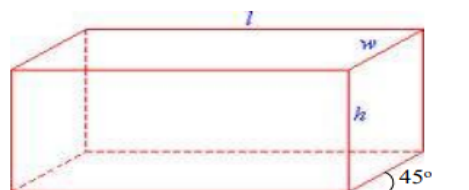
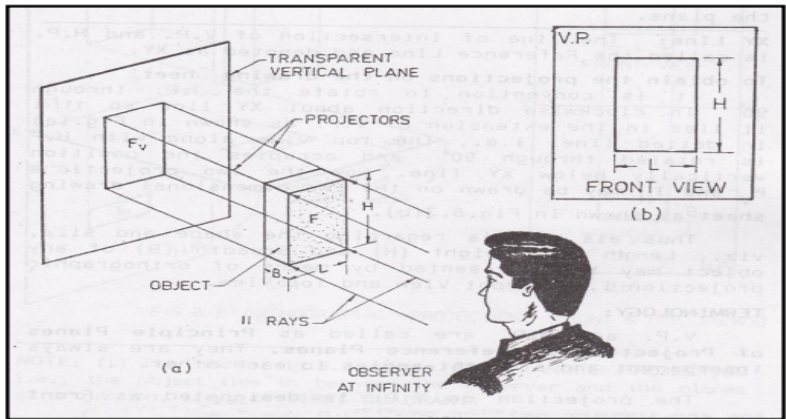


Fig. Oblique Projection

ORTHOGRAPHIC PROJECTION

‘Ortho’ means ‘right-angle’ and ‘Ortho-graphic’ means ‘right-angled drawing.’

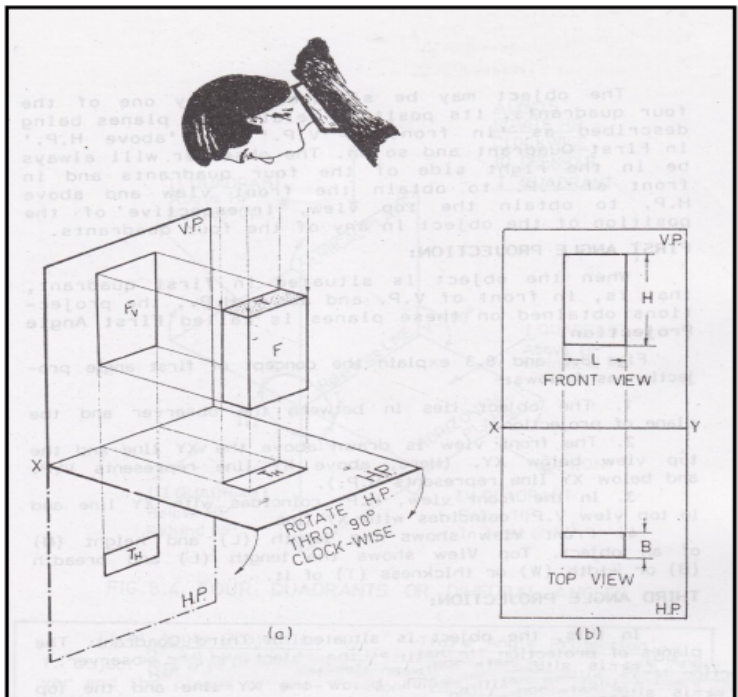
When the projections are perpendicular to the plane on which the projection is obtained, it is known as **Orthographic Projection.**



Vertical Plane:

Extend the rays or projectors further to meet a Vertical (Transparent) Plane (V.P) located behind the object. Join the points at which the projectors meet the plane, in correct sequence. The resulting view (F_v) is called the Front View of the object which is shown in fig. (b)

Front view shown only two dimensions of the object i.e. Length (L) and Height (H). It does not show the breadth (B). Thus one view or projection is insufficient for the complete description of the object.



Look at the object from the top. The projection of the top surface T is T_H . T_H is the Top View of the object. Both T and T_H are of exactly the same shape and size.

Thus T_H gives the Length (L) and Breadth (B) of the block but not the Height (H).

Difference between first- and third-angle projections

First angle projection

Object is kept in the first quadrant.

Object lies between observer and the plane of projection.

The plane of projection is assumed to be non-transparent.

Front (elevation) view is drawn above the XY line

Top (plan) view is drawn below the XY line

Left view is projected on the right plane and vice versa

Followed in India, European countries

Third-angle projection

Object is assumed to be kept in the third quadrant.

Plane of projection lies between the observer and the object.

The plane of projection is assumed to be transparent.

Front (elevation) view is drawn below the XY line

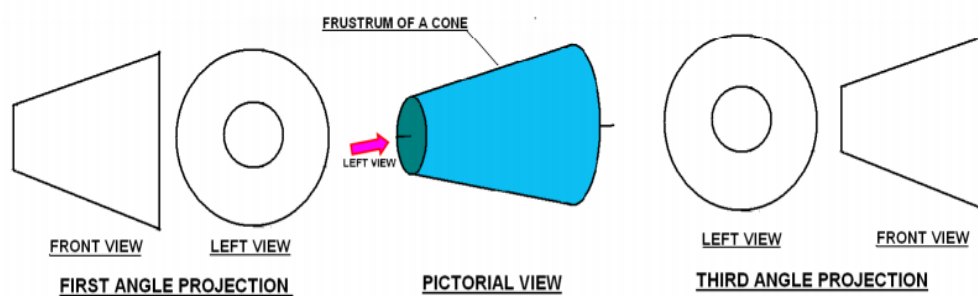
Top (plan) view is drawn above the XY line

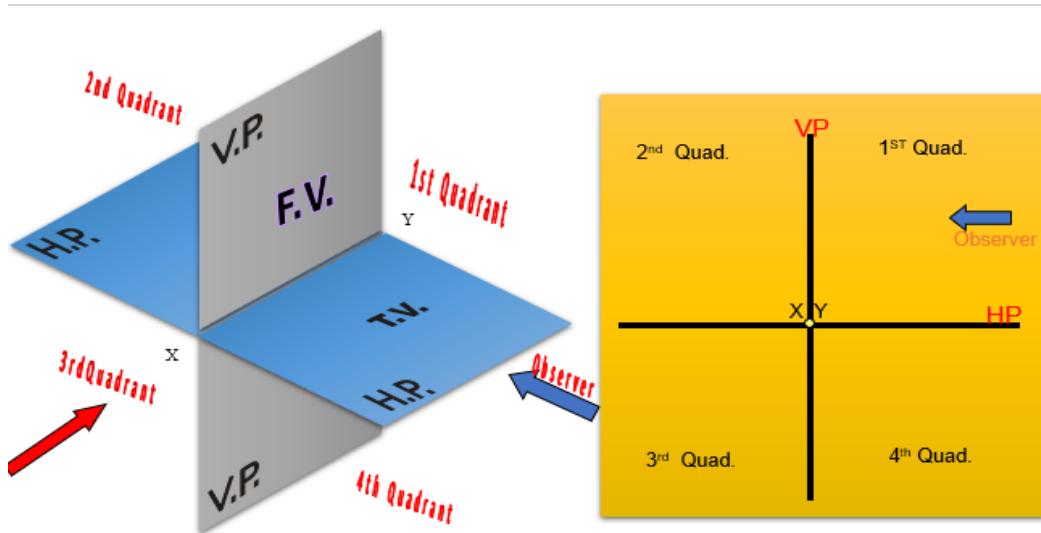
Left view is projected on the left plane itself.

Followed in USA

Symbol of projection

The method of projection used should be indicated in the space provided for the purpose in the title box of the drawing sheet. The symbol recommended by BIS is to draw the two sides of a frustum of a cone placed with its axis horizontal.



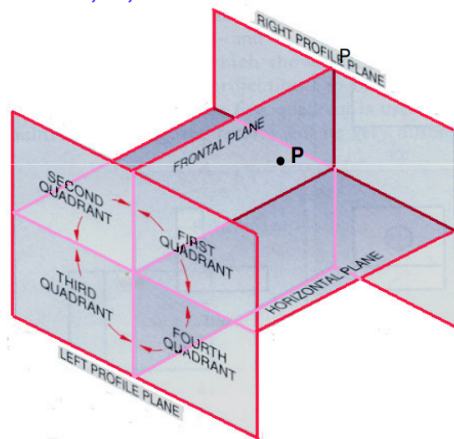


THIS QUADRANT PATTERN, IF OBSERVED ALONG X-Y LINE (IN RED ARROW DIRECTION) WILL EXACTLY APPEAR AS SHOWN ON RIGHT SIDE AND HENCE, IT IS FURTHER USED TO UNDERSTAND ILLUSTRATION PROPERLLY.

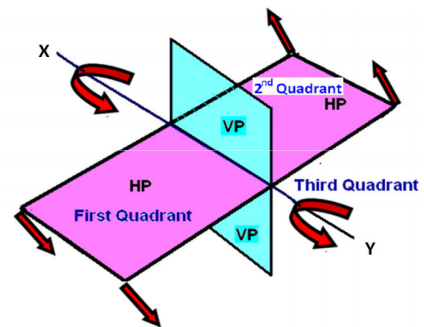
A POINT

Define its position with respect to the coordinates.

With respect to the VP, HP, & PP



Direction of rotation of the HP



- **Top views are represented by only small letters eg. *a*.**
- **Their front views are conventionally represented by small letters with dashes eg. *a'***
- **Profile or side views are represented by small letters with double dashes eg. *a''***

Experiment No:7

PROJECTION OF POINTS

1. Draw the projections of the following points on the same ground line, keeping the projectors 25 mm apart.
 - a. A, in the H.P. and 20 mm behind the V.P.
 - b. B, 40 mm above the H.P. and 25 mm in front of the V.P.
 - c. C, in the V.P. and 40 mm above the H.P.
 - d. D, 25 mm below the H.P. and 25 mm behind the V.P.
 - e. E, 15 mm above the H.P. and 50 mm behind the V.P.
 - f. F, 40 mm below the H.P. and 25 mm in front of the V.P.

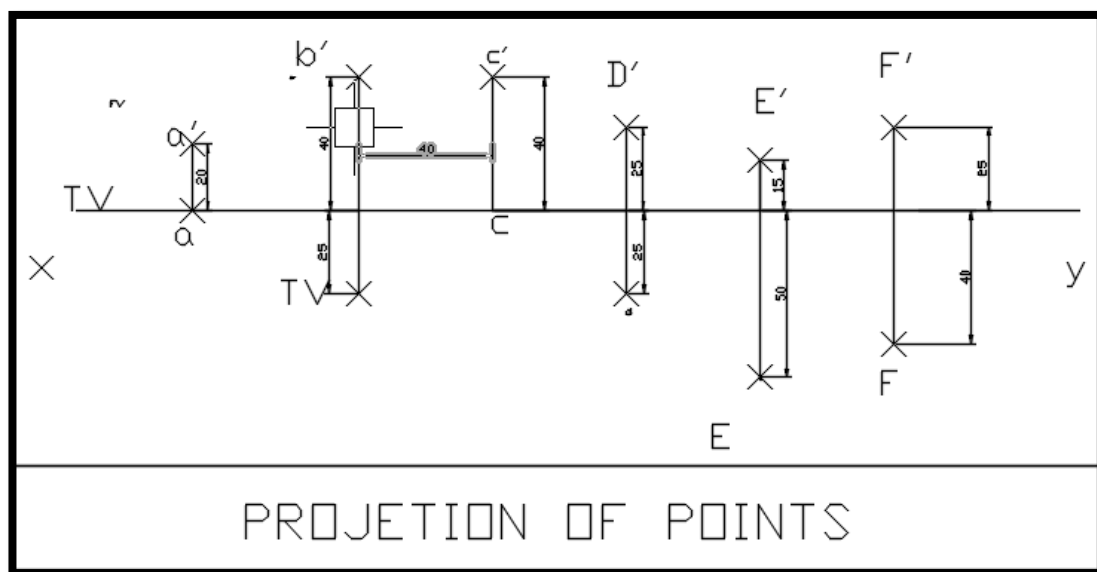


Figure:1

Commands:

1. Units
2. Limits
3. Line
4. Points
5. Dtext
6. Dimlin

Procedure:

1. Draw the reference line xy
2. On xy line mark a point a and mark a point a' 20mm above xy line
3. Mark a point below xy line, b 25mm & above xy line 40mm mark as b'
4. On xy line mark a point c and mark a point c' 40mm above xy line
5. Mark a point below xy line, d' 25mm & above xy line 25mm mark as d
6. Mark a point above xy line e' 15mm & 50mm on the e' line and denote it as e
7. Mark a point below xy line f' 25mm & 40mm on the f' line and denote it as f'

Assignments:

1. A point P is 50 mm from both the reference planes. Draw its projections in all possible positions.
2. A point P is 15 mm above the H.P. and 20 mm in front of the V.P. Another point Q is 25 mm behind the V.P. and 40 mm below the H.P. Draw projections of P and Q keeping the distance between their projectors equal to 90 mm. Draw straight lines joining (i) their top views and (ii) their front views.
3. A point P is 20 mm below H.P. and lies in the third quadrant. Its shortest distance from xy is 40 mm. Draw its projections.
4. A point A is situated in the first quadrant. Its shortest distance from the intersection point of H.P., V.P. and auxiliary plane is 60 mm and it is equidistant from the principal planes. Draw the projections of the point and determine its distance from the principal planes.
5. A point 30 mm above xy line is the plan-view of two points P and Q. The elevation of P is 45 mm above the H.P. while that of the point Q is 35 mm below the H.P. Draw the projections of the points and state their position with reference to the principal planes and the quadrant in which they lie.

Viva questions:

1. What is orthographic projection and why it is called so?
2. What is the difference between first angle projection and third angle projection?
3. What is symbol of first angle projection?
4. What is symbol of third angle projection?
5. What do you mean by elevation?
6. What do you mean by plan?
7. If Front of a Line is A Point, What Will be its Top View
8. What are principle plane of projection?
9. What do you mean by four quadrants?
10. Normally projection in 1st angle or 3rd angle projection system. Why not in II and IV angle projection systems
11. Students should know to draw the projection of a point, when point lies in either of four quadrants.

PROJECTION OF LINES

Definition: A straight line is the shortest distance between two points. Hence, the projections of a straight line may be drawn by joining the respective projections of its ends which are points.

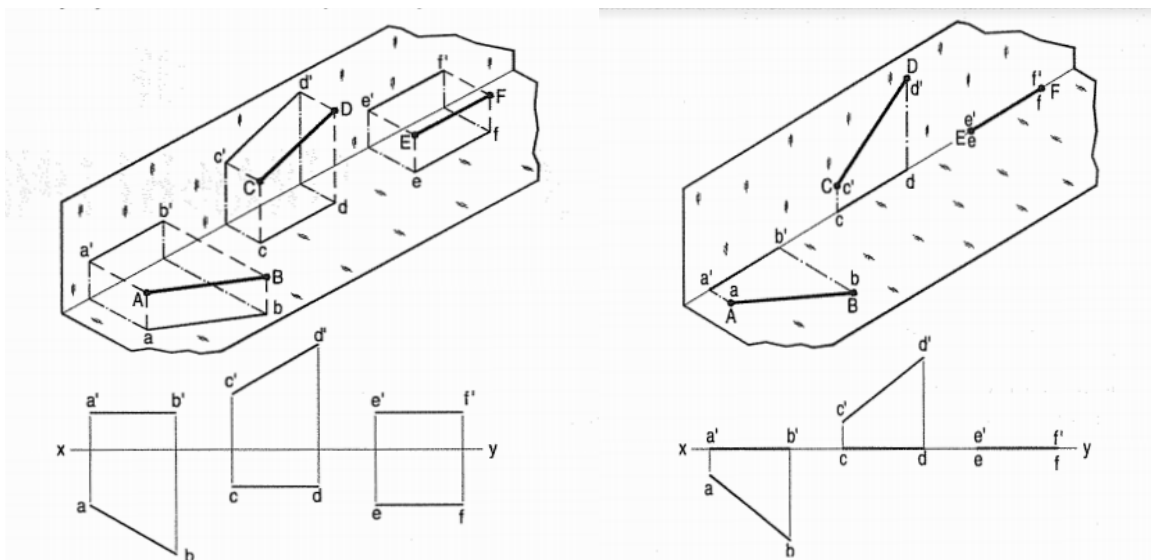
PROJECTIONS OF STRAIGHT LINES.

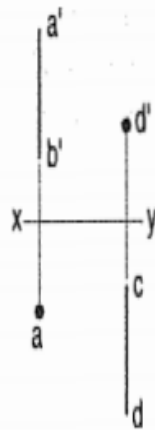
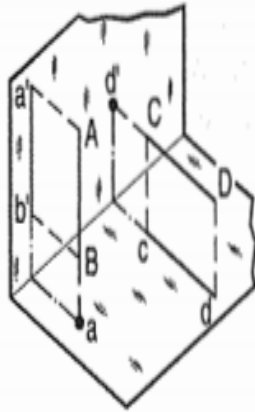
INFORMATION REGARDING A LINE *means*
IT'S LENGTH,
POSITION OF IT'S ENDS WITH HP & VP
IT'S INCLINATIONS WITH HP & VP WILL BE GIVEN.

AIM:- TO DRAW IT'S PROJECTIONS - MEANS FV & TV.

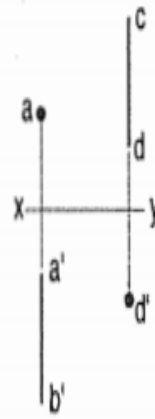
SIMPLE CASES OF THE LINE

1. A VERTICAL LINE (LINE PERPENDICULAR TO HP & // TO VP)
2. LINE PARALLEL TO BOTH HP & VP.
3. LINE INCLINED TO HP & PARALLEL TO VP.
4. LINE INCLINED TO VP & PARALLEL TO HP.
5. LINE INCLINED TO BOTH HP & VP.

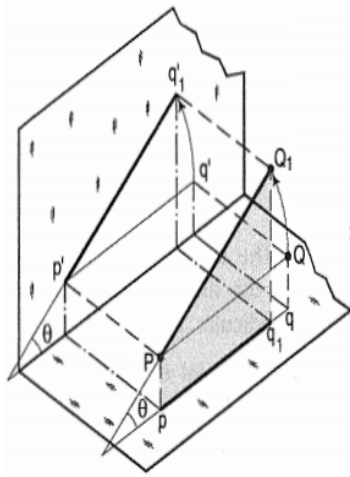




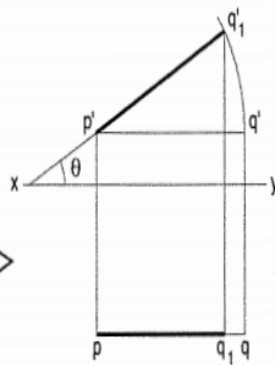
(FIRST-ANGLE PROJECTION)



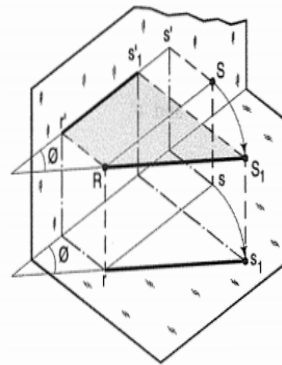
(THIRD-ANGLE PROJECTION)



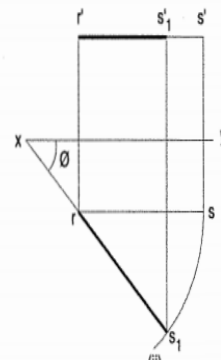
(i)



(ii)



(i)



(ii)

Notations used for Straight Line

True length of the line:

Denoted by Capital letters. e.g. AB=100 mm, means that *true length* of the line is 100 mm.

Front View Length:

Denoted by small letters. e.g. a'b'=70 mm, means that *Front View Length* is 70 mm.

Top View Length:

Denoted by small letters. e.g. ab=80 mm, means that *Top View Length* is 80 mm.

End Projector Distance:

It is the distance between two projectors passing through end points of F.V. & T.V. measured parallel to XY line.

SR. NO	POSITION OF LINE	FRONT VIEW	TOP VIEW
1	LINE PERPENDICULAR TO H.P AND PARALLEL TO V.P	VERTICAL LINE SHOWING T.L	POINT
2	LINE PERPENDICULAR TO V.P AND PARALLEL TO H.P	POINT	VERTICAL LINE SHOWING T.L
3	LINE PARALLEL TO BOTH V.P & H.P	HORIZONTAL LINE PARALLEL TO XY SHOWING T.L	HORIZONTAL LINE PARALLEL TO XY SHOWING T.L
4	LINE PARALLEL TO H.P AND INCLINED TO V.P AT ANGLE "θ"	LINE PARALLEL TO XY WITH APPARENT LENGTH	INCLINED LINE SHOWING TRUE LENGTH
5	LINE PARALLEL TO V.P AND INCLINED TO H.P AT ANGLE "θ"	INCLINED LINE SHOWING TRUE LENGTH	LINE PARALLEL TO XY WITH APPARENT LENGTH
6	LINE INCLINED TO V.P AT ANGLE "θ" AND INCLINED TO H.P AT ANGLE "θ"	INCLINED LINE SHOWING APPARENT LENGTH	INCLINED LINE SHOWING APPARENT LENGTH

TRACES OF A LINE

Definition: When a line is inclined to a plane, it will meet that plane, produced if necessary. The point where the line or line produced **meets the plane** is called **trace**.

Horizontal Trace: The point of intersection of the inclined line with the H.P. is called **Horizontal Trace** or simply **H.T.**

A line itself or it's extension, where ever touches H.P., That point is called trace of the line on H.P. (It is called H.T.)

H.T.:- It is a point on HP.
It's FV comes on XY line (point h).

Traces of A line

Vertical Trace: The point of intersection of the inclined line with the V.P. is called **Vertical Trace** or simply **V.T.**

Similarly, a line itself or it's extension, where ever touches V.P., That point is called trace of the line on V.P.(It is called V.T.)

V.T.:- It is a point on VP.
It's TV comes on XY line (point V).

Experiment No:8 PROJECTION OF LINES

1. Draw the projections of a 75 mm long straight line, in the following positions:
 - a. Parallel to both the H.P. and the V.P. and 25 mm from each.
 - b. Parallel to and 30 mm above the H.P. and in the V.P.
 - c. Parallel to and 40 mm in front of the V.P. and in the H.P.

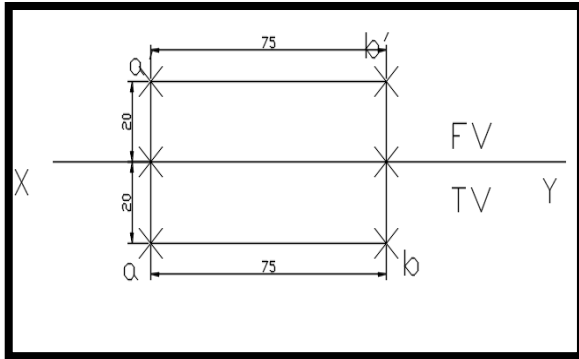


Figure:1

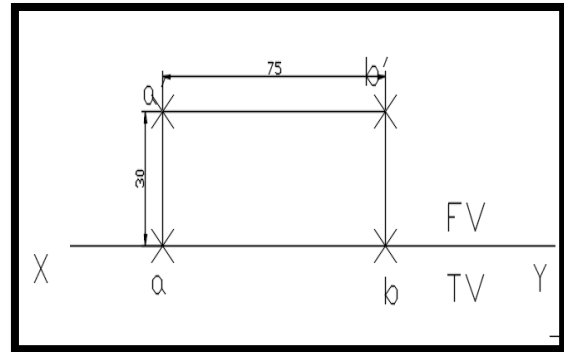


Figure:2

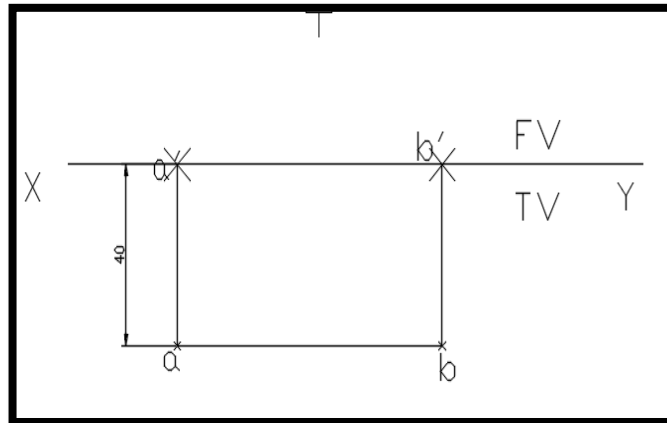


Figure:3

Commands:

1. Units
2. Limits
3. Line
4. Dtext
5. Dimlin

Procedure:

1. Draw the reference line xy
2. Draw a line 20mm above xy of length 75mm, denote it a'&b'
3. Draw a line 20mm below xy of length 75mm, denote it a&b
4. Draw a line on xy line of length 75mm denote it as c & d
5. Draw a line 30mm above xy of length 75mm, denote it c'&d'

6. Draw a line on xy line of length 75mm denote it as e' & f'
7. Draw a line 40mm below xy of length 75mm, denote it e & f

Assignment:

1. **Line perpendicular to H.P and parallel to V.P:**
 - a. A line AB 25 mm long is perpendicular to H.P and parallel to VP. Its end A is 10 mm in above H.P and the line is 20 mm in front of V.P. draw the projections of the line.
 - b. A line AB of 60 mm long has its end A 15 mm above the HP. The line is perpendicular to HP and 30 mm in front of VP. Draw its projection.
2. **Line perpendicular to V.P and parallel to H.P:**
 - a. A line AB 50 mm long is perpendicular to V.P and parallel to HP. Its end A is 20 mm in front of V.P and the line is 40 mm above HP. Draw the projections of the line.
 - b. A line AB of 70 mm long has its end A 25 mm in front of VP. The line is perpendicular to VP and 50 mm above the HP. Draw its projection.
3. **Line parallel to V.P and inclined to H.P.**
 - a. A line AB 40 mm long is parallel to V.P and inclined at an angle of 30° to HP. The end A is 15 mm above HP and 20 mm in front of V.P. Draw the projections of the line.
 - b. A line AB of 70 mm long is inclined at 35° to the HP and parallel to VP. The end A of the line is 30 mm above HP and 20 mm in front of VP. Draw its projections.
 - c. A 80mm long line AB has the end A at a distance of 20mm above HP and 40mm in front of V.P. The line is inclined at 30° to H.P and parallel to V.P, draw the projection of the line.
 - d. Draw the projections of 70mm long line AB situated in the V.P and inclined at 30° to H.P. The end A is 25 mm above H.P.
4. **Line parallel to H.P and inclined to V.P.**
 - a. Draw the projections of straight line AB 60 mm long parallel to HP and inclined at an angle of 40° to V.P. The end A is 30 mm above HP. and 20 mm in front of V.P.
 - b. A line AB of 70 mm long is inclined at 30 deg to the VP and parallel to HP. The end A of the line is 20 mm above HP and 30 mm in front of V.P Draw its projections.
 - c. An 80mm long line AB is inclined at 30 deg to V.P and is parallel to H.P. The end A is 20mm above the H.P and 20mm in front of the V.P, draw the projection of the line.
 - d. A line AB 60mm long is situated in H.P and inclined to V.P at 30 deg. The end A is 20mm in front of V.P, draw the projection of line.

Viva questions:

1. What are traces of a straight line and how are they located?
2. What is the difference between true inclination and apparent inclination?
3. What do you mean by HT & VT of a line?
4. What Do You Infer When the Top View & Front View of a Point Are 15mm Below The XY Line?
5. What is The Difference B/W True Inclination of a Line and Apparent Angles?
6. If Front of a Line is A Point, What Will be its Top View

PROJECTIONS OF PLANES

A plane is a two dimensional object having length and breadth only. Its thickness is always neglected. Various shapes of plane figures are considered such as square, rectangle, circle, pentagon, hexagon, etc.

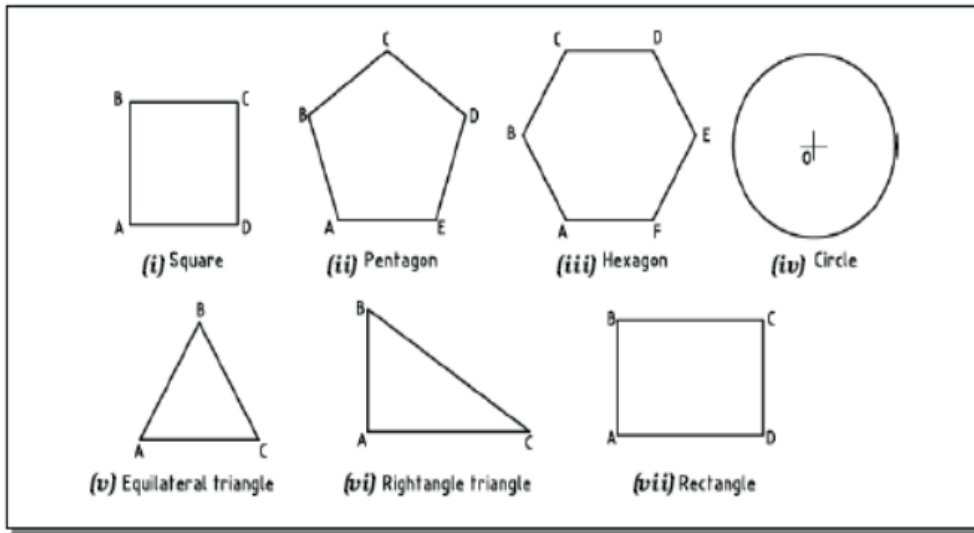


Figure:1

Position with HP & VP will be:

1. Inclination of its SURFACE with one of the reference planes will be given.
2. Inclination of one of its EDGES with other reference plane will be given (Hence this will be a case of an object inclined to both reference Planes.)

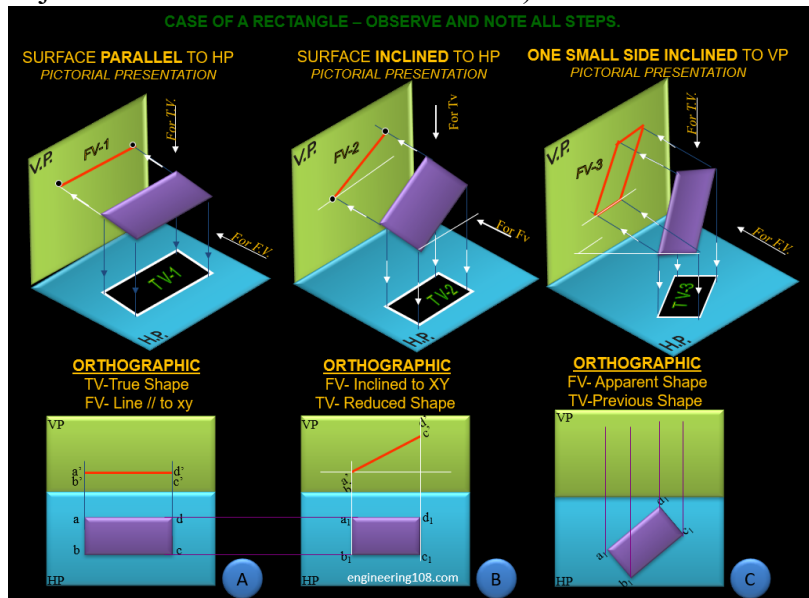


Figure:2

Experiment No:9

PROJECTION OF PLANES-I

1. An equilateral triangle of 50 mm side has its V.T. parallel to and 25mm above xy. It has no H. T. Draw its projections when one of its sides is inclined at 45° to the V.P.

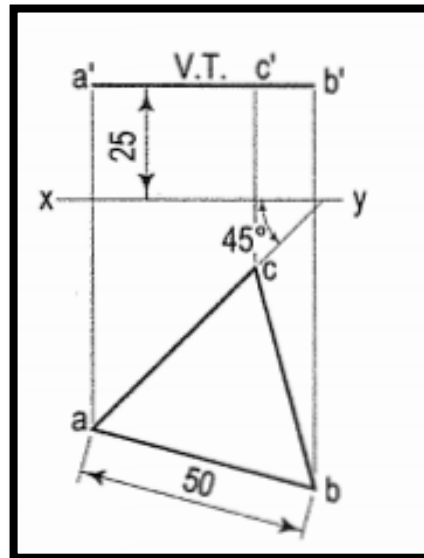


Figure:1

Commands:

1. Units
2. Limits
3. Line
4. Dtext
5. Dimlin/Dimalign

Procedure:

1. As the V.T. is parallel to xy and as there is no H.T. the triangle is parallel to the H.P. Therefore, begin with the top view.
2. Draw an equilateral triangle abc of 50 mm side, keeping one side, say ac, inclined at 45° to xy.
3. Project the front view, parallel to and 25 mm above xy, as shown.

2. A square ABCD of 40 mm side has a corner on the H.P. and 20 mm in front of the V.P. All the sides of the square are equally inclined to the H.P. and parallel to the V.P. Draw its projections and show its traces.

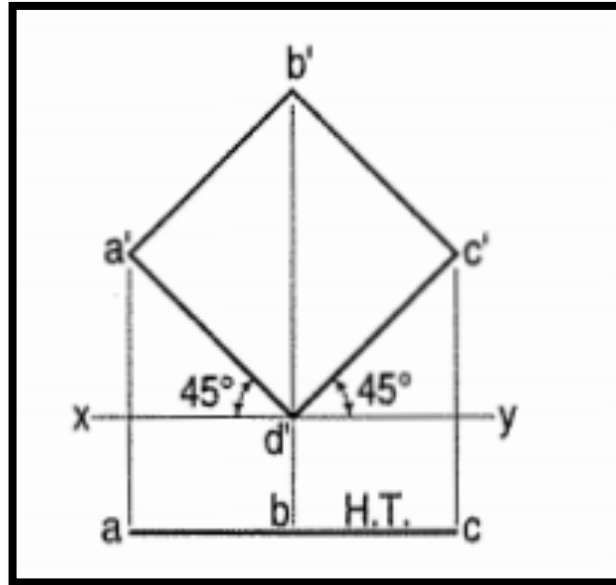


Figure:2

Commands:

1. Units
2. Limits
3. Line
4. Dtext
5. Dimlin/Dimalign

Procedure:

1. As all the sides are parallel to the V.P., the surface of the square also is parallel to it. The front view will show the true shape and position of the square.
2. Draw a square a'b'c'd' in the front view with one corner in xy and all its sides inclined at 45° to xy.
3. Project the top view keeping the line ac parallel to xy and it. The top view is its H.T. It has no V.T.

3. A regular pentagon of 25 mm side has one side on the ground. Its plane is inclined at 45° to the H.P and perpendicular to the V.P Draw its projections and show its traces.

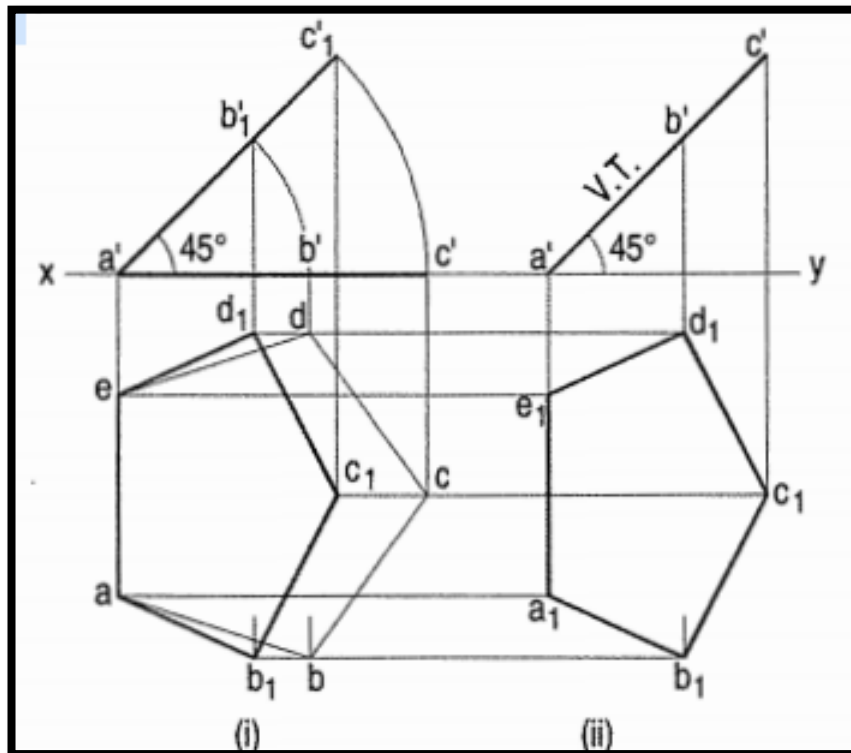


Figure:1

Commands:

1. Units
2. Limits
3. Line
4. Dtext
5. Polygon (pentagon)
6. Dimlin/dimalign/dimang

Procedure:

1. Assuming it to be parallel to the H.P.
2. Draw the pentagon in the top view with one side perpendicular to xy. Project the front view. It will be the line a'c' contained by xy.
3. Tilt the front view about the point a', so that it makes 45° angle with xy.
4. Project the new top view $ab_1c_1d_1e$ upwards from this front view and horizontally from the first top view.
5. It will be more convenient if the front view is reproduced in the new position separately and the top view projected from it.
6. The V.T. coincides with the front view and the H.T. is perpendicular to xy, through the point of intersection between xy and the front view-produced.

4. Draw the projections of a regular hexagon of 25 mm side, having one of its sides in the H.P. and inclined at 60° to the V.P. and its surface making an angle of 45° with the H.P.

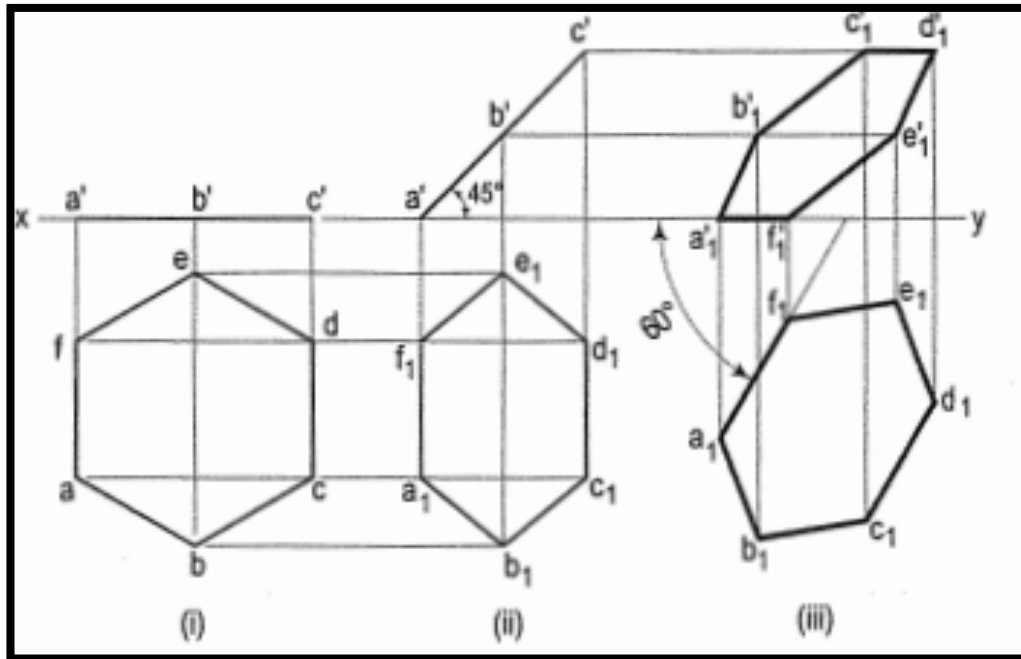


Figure:2

Commands:

1. Units
2. Limits
3. Line
4. Dtext
5. Polygon (hexagon)
6. Dimlin/dimalign/dimang

Procedure:

1. Draw the hexagon in the top view with one side perpendicular to xy .
2. Project the front view $a'c'$ in xy .
3. Draw $a'c'$ inclined at 45° to xy keeping a' or c' in xy and project the second top view.
4. Reproduce this top view making all inclined at 60° to xy and project the final front view.

Assignment:

1. A Square plane with a 40mm side has its surface parallel to and 20mm above the HP. Draw its Projections, when (a) A side is parallel to VP (b) A side is inclined at 30° to VP and (c) All sides are equally inclined to VP.
2. A square ABCD of 40 mm side has a corner on the H.P. and 20 mm in front of the V.P. All the sides of the square are equally inclined to the H.P. and parallel to the V.P. Draw its projections and show its trace.
3. An equilateral triangle of 50 mm side has its V.T. parallel to and 25 mm above XY. it has no H.T. Draw its projections when one of its sides is inclined at 45° to the V.P.
4. **A Plane perpendicular to HP and parallel to VP**
 - a. A Hexagonal plane with a 30mm side has its surface parallel to and 20mm in front of the VP. Draw it's Projections, when (a) a side is perpendicular to HP (b) a side is parallel to the HP (c) Side is inclined at 45° to the HP.
5. **Plane perpendicular to both H.P and V.P.**
 - a. Draw the projections of a rectangular plane ABCD and its dimensions are 60mmX40mm, when one of its longer edges is parallel to H.P. Here, the lengths of the front and top views are equal to the true lengths of the edges.
6. **A Plane is inclined to HP and perpendicular to VP:**
 - a. A Pentagonal plane with a 30mm side has an edge on the HP, the surface of the Plane is inclined at 45° to the HP. Draw it's Projections?
 - b. A regular pentagon of 25 mm side has one side on the ground. Its plane is inclined at 45° to the H.P and perpendicular to the V.P Draw its projections and show its traces
7. **Plane is inclined to VP and Perpendicular to HP:**
 - a. A Hexagonal plate with a 30mm side and negligible thickness has its surface perpendicular to the HP and inclined at 45° to the VP. Draw it's Projections? When one of it's sides of the Plane is Parallel to and 15 mm in front of the VP.
 - b. A Circular plane with a 60mm Diameter is resting on a point it's circumference on the VP. The center is 40 mm above the HZ, and the surface is inclined at 45° to the VP. And perpendicular to the HP Draw It's Projections?
8. **Plane is inclined to Both the planes:**
 - a. A regular pentagon of 30 mm sides is resting on HP, on one of it's sides with it's surface 45° inclined to HP. Draw it's projections when the side in HP makes 30° angle with VP?
 - b. A square ABCD of 50 mm side has its corner A in the H.P., its diagonal AC inclined at 30° to the H.P. and the diagonal BO inclined at 45° to the V.P. and parallel to the H.P. Draw its projections.
 - c. A rectangular plane surface of size L x W is positioned in the first quadrant and is inclined at an angle of 60° with the H.P. and 30° with the V.P. Draw its projections.
 - d. Draw the projections of a regular hexagon of 25 mm side, having one of its sides in the H.P. and inclined at 60° to the V.P., and its surface making an angle of 45° with the H.P.
 - e. Draw the projections of a circle of 50 mm diameter resting in the H.P. on a point A on the circumference, its plane inclined at 45° to the H.P. and (a) the

Date: _____

top view of the diameter AB making 30° angle with the V.P.; (b) the diameter AB making 30° angle with the V. P.

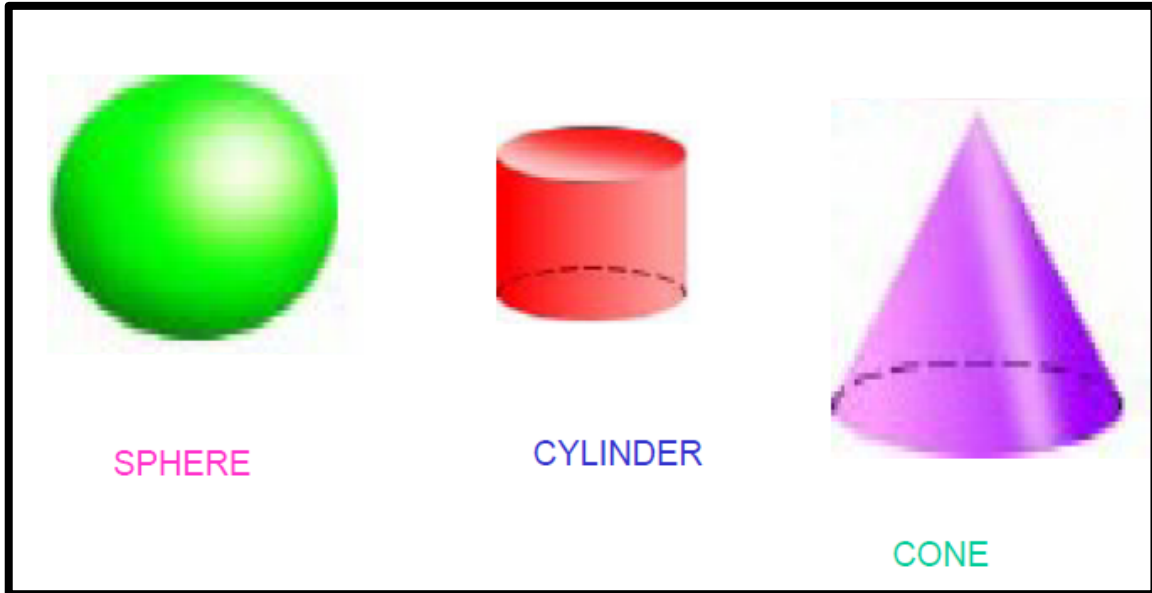
Viva Questions:

1. What do you mean by oblique plane?
2. Describe the strategy to draw projections of an oblique plane?
3. What is auxiliary plane?
4. How will you classify auxiliary planes?
5. What do you mean by A.I.P.?
6. What do you mean by A.V.P.?
7. What do you mean by P.P.?
8. How auxiliary planes are represented?
9. What is the Difference in The Shape of Trace of a Line & Trace of a Plane?

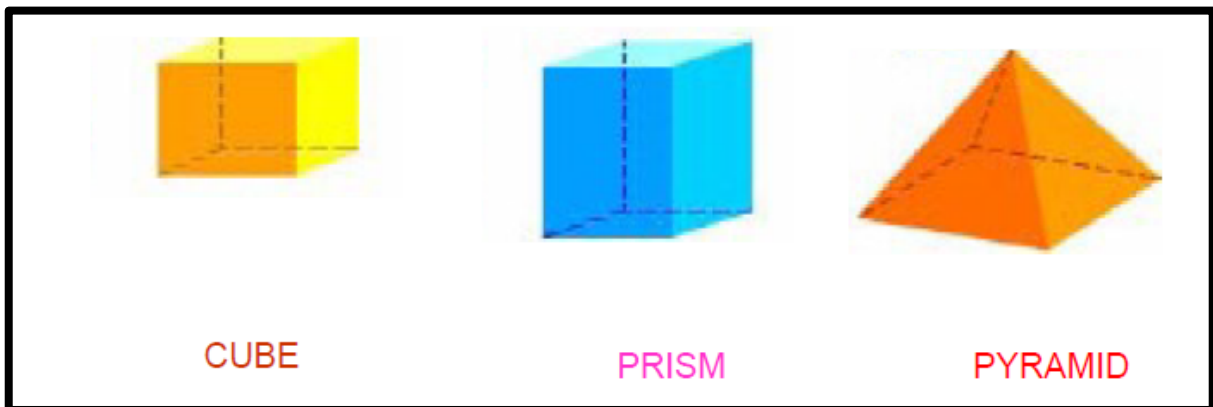
PROJECTION OF SOLIDS

INTRODUCTION

A solid has three dimensions, viz. length, breadth and thickness. To represent a solid on a flat surface having only length and breadth, at least two orthographic views are necessary.



SOLIDS OF REVOLUTION



POLYHEDRONS

Types of Solids

Solids may be divided into two main groups:

i. Polyhedron

ii. Solids of revolution.

i. Polyhedron: A polyhedron is defined as a solid bounded by planes called faces. When all the faces are equal and regular, the polyhedron is said to be regular.

There are six regular polyhedron

- **Tetrahedron :**

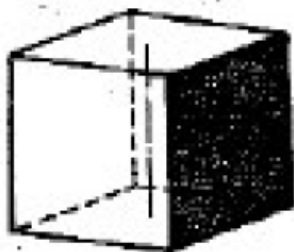
It has four equal faces, each an equilateral triangle.



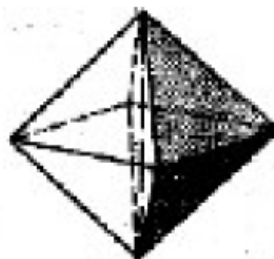
b. **Cube or Hexahedron :** It has six faces, all equal squares.

c. **Octahedron :** It has eight equal equilateral triangles as faces.

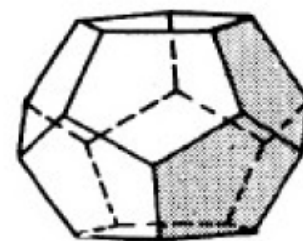
d. **Dodecahedron :** It has twelve equal and regular pentagons as faces.



Cube



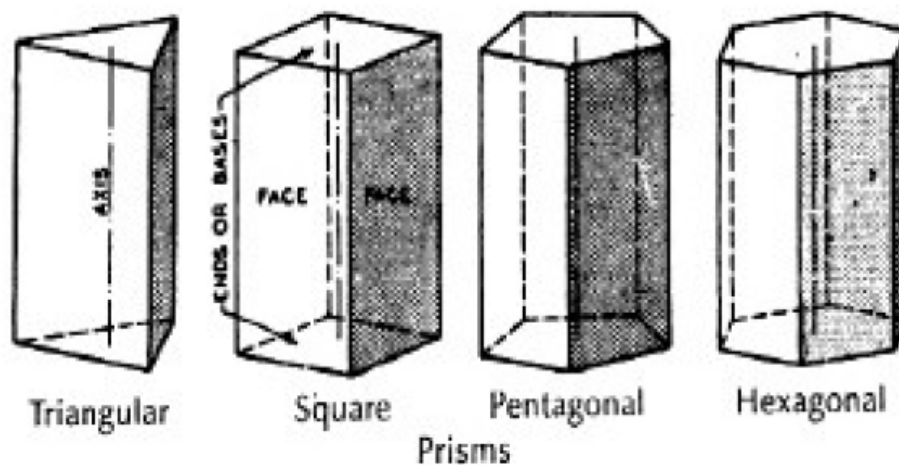
Octahedron



Dodecahedron

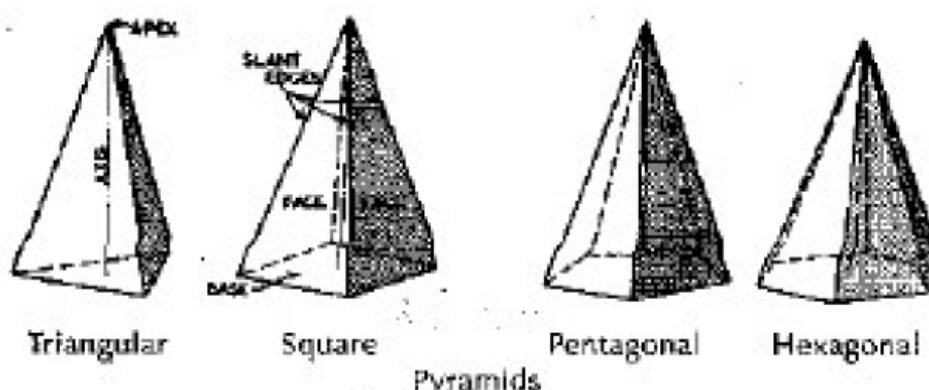
Prism: This is a polyhedron having two equal and similar faces called its ends or bases, parallel to each other and joined by other faces, which are parallelograms. The imaginary line joining the centers of the bases is called the axis.

A right and regular prism has its axis perpendicular to the bases. All its faces are equal rectangles.



Pyramid: This is a polyhedron having a plane figure as a base and a number of triangular faces meeting at a point called the vertex or apex. The imaginary line joining the apex with the centre of the base is its axis.

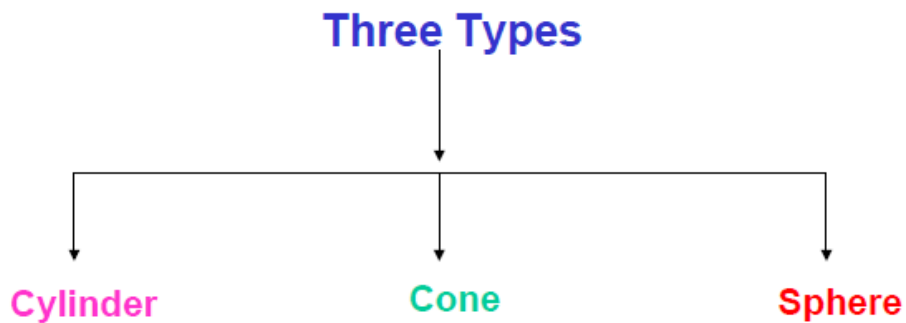
A right and regular pyramid has its axis perpendicular to the base, which is a regular plane figure. Its faces are all equal isosceles triangles.



Solids of Revolution

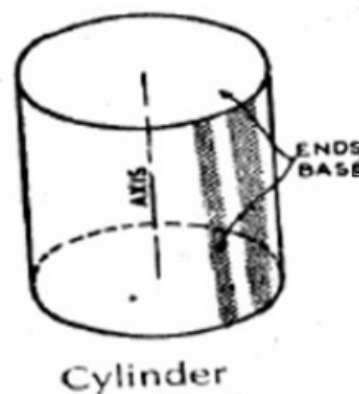
Definition:

Solids which are generated by rotating a plane surface about one of its sides



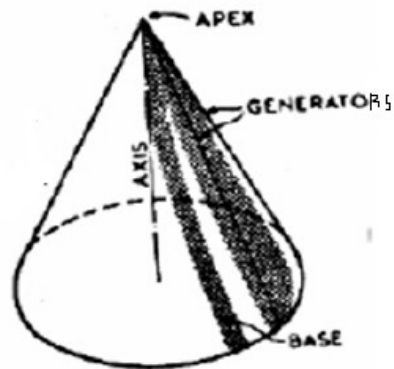
a) Cylinder

A right circular cylinder is a solid generated by the revolution of a rectangle about one of its sides, which remains fixed. It has two equal circular bases. The line joining the centers of the bases is the axis. It is perpendicular to the bases.



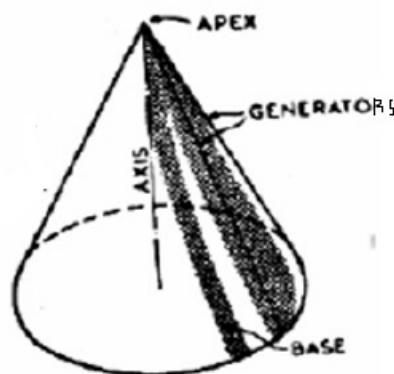
b. Cone :

A right circular cone is a solid generated by the revolution of right-angled triangles about one of its perpendicular sides, which is fixed.



Cone

It has one circular base. Its axis joins the apex with the centre of the base to which it is perpendicular. Straight lines drawn from the apex to the circumference of the base-circle are all equal and are called generators of the cone.



Cone

c. Sphere :

A sphere is a solid generated by the revolution of a semi-circle about its diameter as the axis. The mid-point of the diameter is the centre of the sphere. All points on the surface of the sphere are equidistant from its centre.

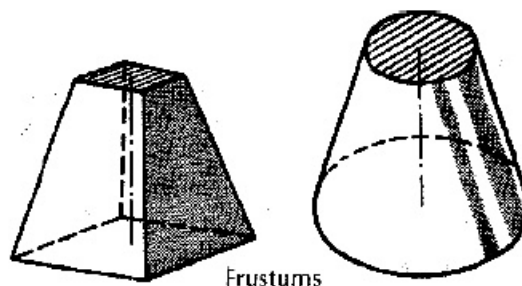


Sphere

d. **Frustum:** When a pyramid or a cone is cut by a plane parallel to its base, thus removing the top portion, the remaining portion is called its frustum.

e. **Truncated:** When a solid is cut by a plane inclined to base it is said to be truncated.

Unless and otherwise stated, the given solid should be understood as right and regular.



Frustums

Projections of Solids in Simple Positions

1. A solid in simple position may have its axis perpendicular to one reference plane or parallel to both.

Date: _____

2. When the axis is perpendicular to one reference plane, it is parallel to the other. Also, when the axis of a solid is perpendicular to a plane, its base will be parallel to that plane.
3. We have already seen that when a plane is parallel to a reference plane, its projection on that plane shows its true shape and size.
4. Therefore, the projection of a solid on the plane to which its axis is perpendicular will show the true shape and size of its base.
5. Hence, when the axis is perpendicular to the ground, i.e. to the H.P., the top view should be drawn first and the front view projected from it.
6. When the axis is perpendicular to the V.P., beginning should be made with the front view. The top view should then be projected from it.
7. When the axis is parallel to both the H.P. and the V.P., neither the top view nor the front view will show the actual shape of the base. In this case, the projection of the solid on an auxiliary plane perpendicular to both the planes, viz. the side view must be both the planes, viz. the side view must be drawn first. The front view and the top view are then projected from the side view. The projections in such cases may also be drawn in two stages.

Experiment No:10

PROJECTION OF SOLIDS-I

1. Draw the projections of a pentagonal pyramid, base 30 mm edge and axis 50 mm long, having its base on the H.P. and an edge of the base parallel to the V.P. Also draw its side view.

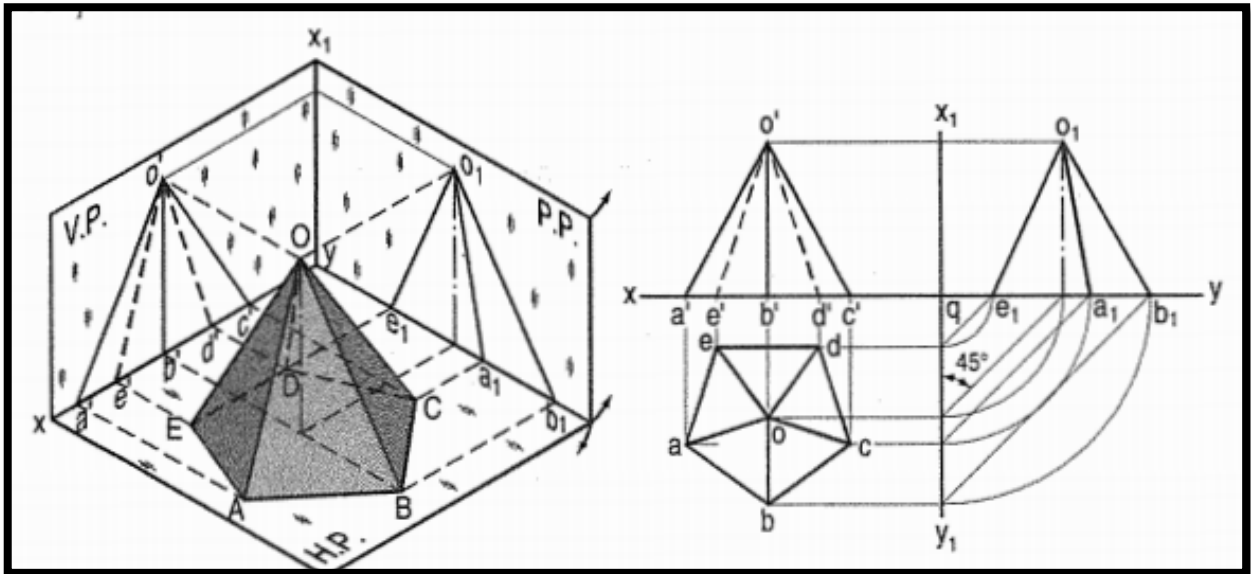


Figure:1

Commands:

1. Units
2. Limits
3. Polygon
4. Line
5. Dtext
6. Dimlin
7. Point
8. Ptype
9. Copy
10. Extend
11. Trim
12. Erase

Procedure:

1. Assume the side DE which is nearer the V.P., to be parallel to the V.P.
2. In the top view, draw a regular pentagon abcde with ed parallel to and nearer xy. Locate its centre o and join it with the corners to indicate the slant edges.

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3. Through o , project the axis in the front view and mark the apex o' , 50 mm above xy . Project all the corners of the base on xy . Draw lines $o'a'$, $o'b'$ and $o'c'$ to show the visible edges. Show $o'd'$ and $o'e'$ for the hidden edges as dashed lines.
4. For the side view looking from the left, draw a new reference line x_1y_1 perpendicular to xy and to the right of the front view. Project the side view on it, horizontally from the front view as shown. The respective distances of all the points in the side view from x_1y_1 , should be equal to their distances in the top view from xy . This is done systematically
5. From each point in the top view, draw horizontal lines upto x_1y_1 . Then draw lines inclined at 45° to x_1y_1 (or xy) as shown. Or, with q , the point of intersection between xy and x_1y_1 as centre, draw quarter circles.
6. Project up all the points to intersect the corresponding horizontal lines from the front view and complete the side view. Lines o_1d_1 and o_1c_1 coincide with o_1e_1 and o_1a_1 respectively.

2. Draw the projections of
- (i) a cylinder, base 40 mm diameter and axis 50 mm long, and
 - (ii) a cone, base 40 mm diameter and axis 50 mm long, resting on the H.P. on their respective bases.

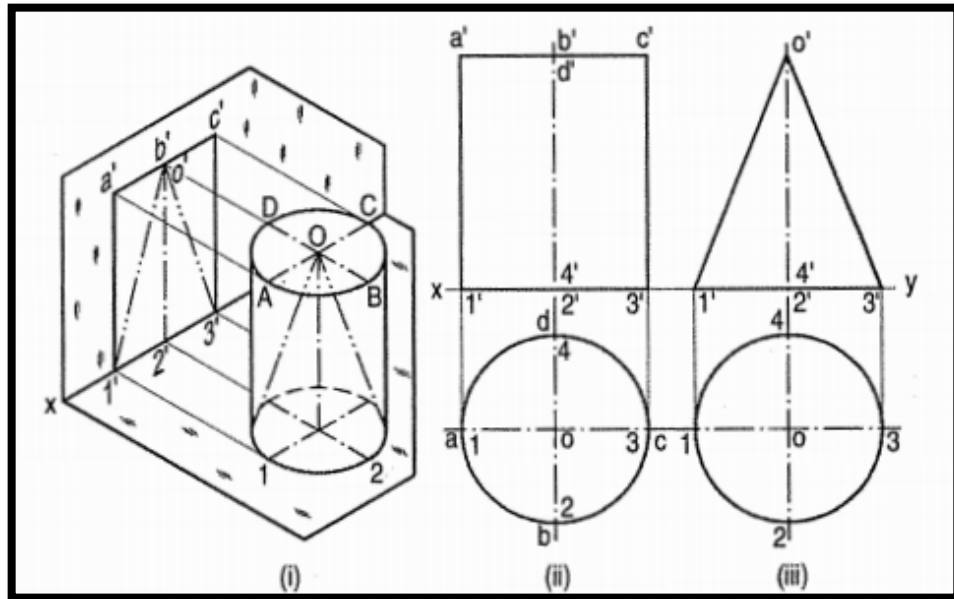


Figure:2

Commands:

1. Units
2. Limits
3. Polygon
4. Line
5. Dtext
6. Dimlin
7. Point
8. Ptype
9. Copy
10. Extend
11. Trim
12. Erase

Procedure:

1. Draw a circle of 40 mm diameter in the top view and project the front view which will be a rectangle [fig.(ii)]
2. Draw the top view [fig.(iii)]. Through the centre o, project the apex o', 50 mm above xy.
3. Complete the triangle in the front view as shown.

3. A cube of 50 mm long edges is resting on the H.P. with its vertical faces equally inclined to the V.P. Draw its projections.

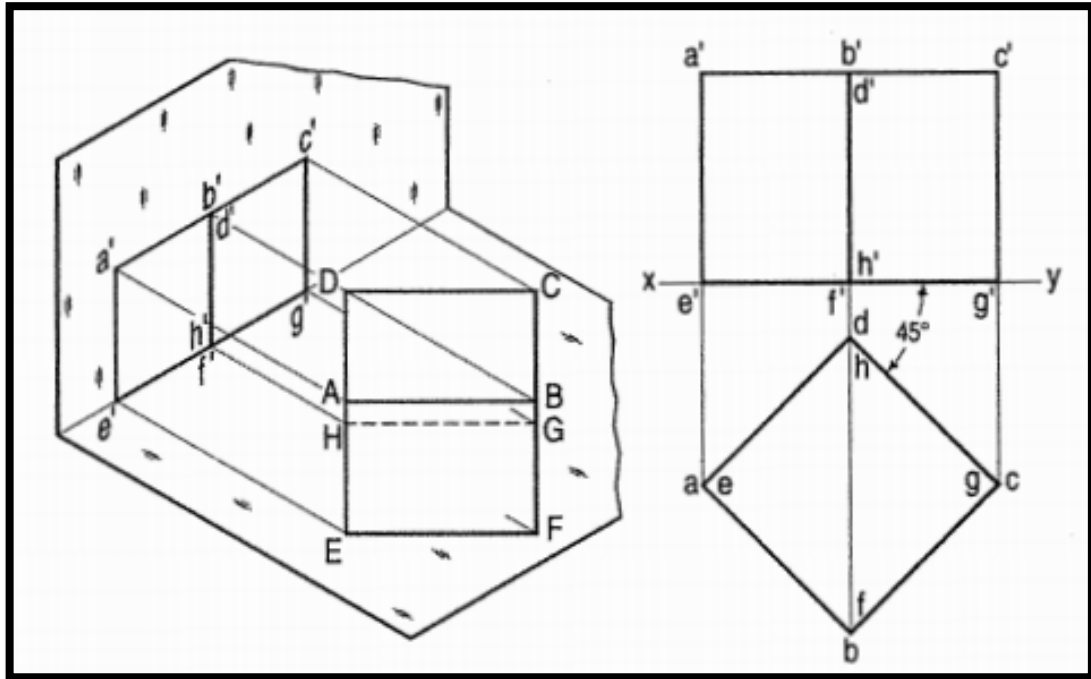


Figure:3

Command:

1. Units
2. Limits
3. Line
4. Extend
5. Copy
6. Dtext
7. Dimlin

Procedure

1. Begin with the top view.
2. Draw a square a, b, c, d with a side making 45° angle with xy.
3. Project up the front view. The line d' h' will coincide with b' f'.

Assignment:

1. Draw the projections of a hexagonal pyramid, base 30 mm side and axis 60 mm long, having its base on the H.P. and one of the edges of the base inclined at 45° to the V.P.
2. A triangular prism base 40 mm side and height 65 mm is resting on the H.P. on one of its rectangular faces with the axis parallel to the V.P. Draw its projections.
3. A square pyramid, base 40 mm side and axis 65 mm long, has its base in the V.P. One edge of the base is inclined at 30° to the H.P. and a corner contained by that edge is on the H.P. Draw its projections.

Experiment No:11

PROJECTION OF SOLIDS-II

1. Draw the of a pentagonal prism, base 25 mm side and axis 50 mm long, resting on one of its rectangular faces on the H.P. with the axis inclined at 45° to the V.P.

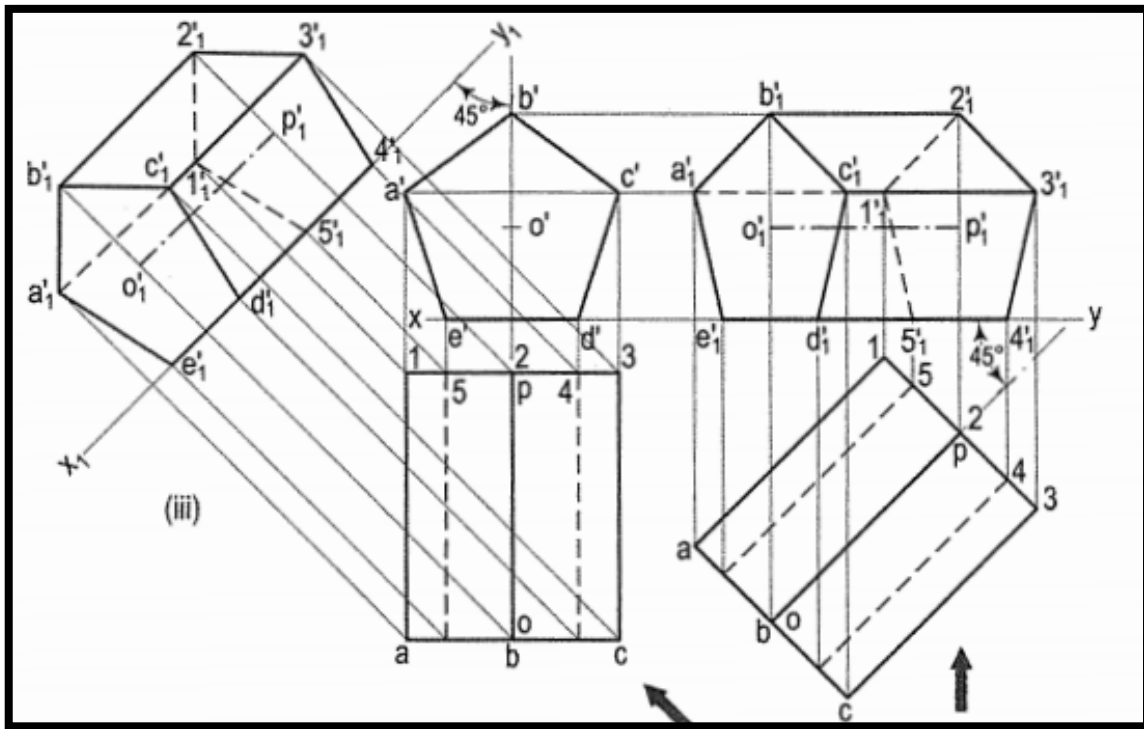


Figure:1

Command:

1. Units
2. Limits
3. Line
4. Dtext
5. Polygon
6. Point
7. Ptype
8. Copy
9. Rotate
10. Erase
11. Dimlin/dimalign/dimang

Procedure:

1. In the simple position, assume the prism to be on one of its faces on the ground with the axis perpendicular to the V.P.

Date: _____

2. Draw the pentagon in the front view with one side in xy and project the top view.
3. The shape and size of the figure in the top view will not change, so long as the prism has its face on the H.P. The respective distances of all the corners in the front view from xy will also remain constant.
4. Alter the position of the top view, i.e. reproduce it so that the axis is inclined at 45° to xy .
5. Project all the points upwards from this top view and horizontally from the first front view, e.g. a vertical from a intersecting a horizontal from a' at a point a'_1 .
6. Complete the pentagon $a'_1b'_1c'_1d'_1e'_1$ for the fully visible end of the prism.
7. Next, draw the lines for the longer edges and finally, draw the lines for the edges of the other end. Note carefully that the lines $a'_11'_1$, $1'_12'_1$ and $1'_15'_1$ are dashed lines. $e'_15'_1$ is also hidden but it coincides with other visible lines.

2. A hexagonal pyramid, base 25 mm side and axis 50 mm long, has an edge of its base on the ground. Its axis is inclined at 30° to the ground and parallels to the V.P. Draw its projections.

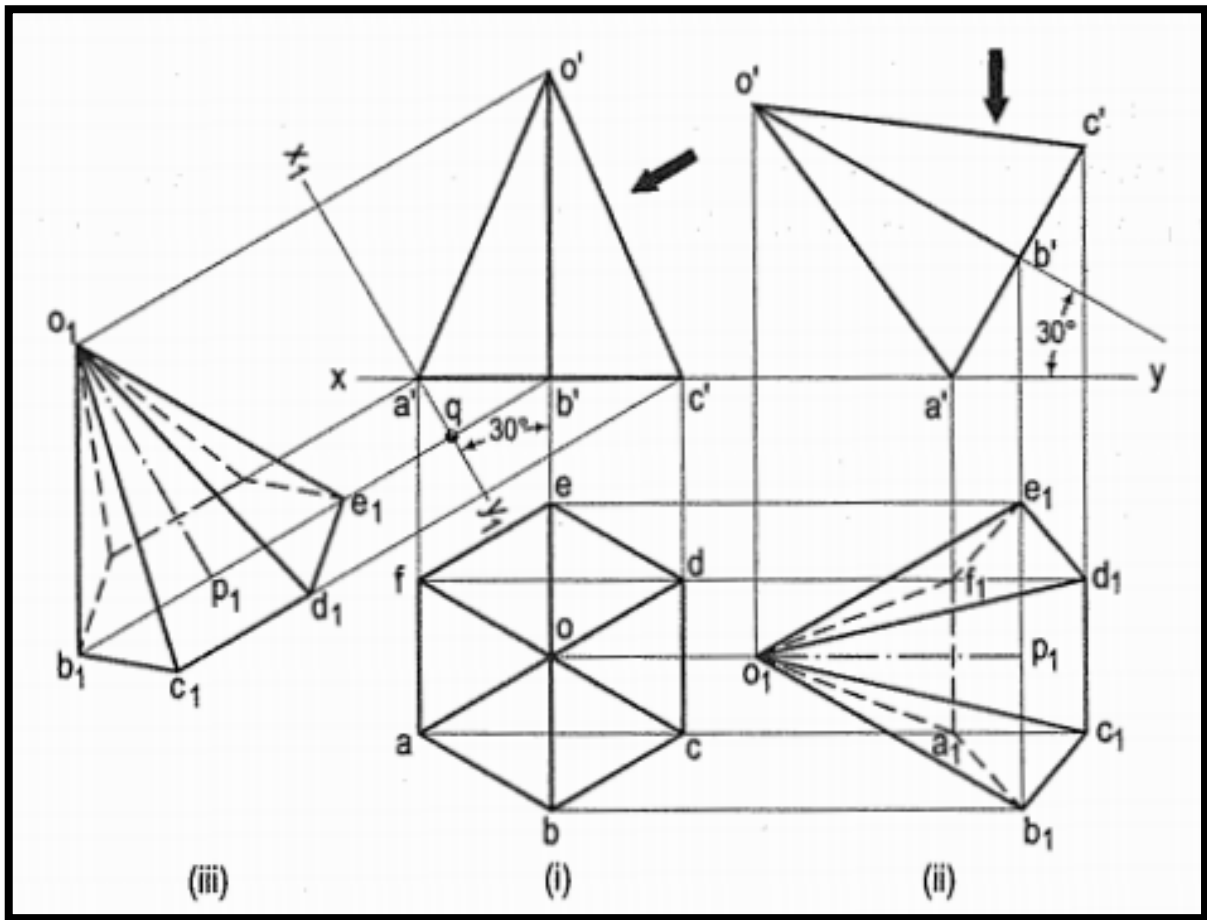


Figure:2

Command:

1. Units
2. Limits
3. Line
4. Dtext
5. Polygon
6. Point
7. Ptype
8. Copy
9. Rotate
10. Erase
11. Dimlin/dimalign/dimang

Procedure:

1. In the initial position assume the axis to be perpendicular to the H.P.

2. Draw the projections with the base in xy and its one edge perpendicular to the V.P.[fig. (i)].
3. If the pyramid is now tilted about the edge AF (or CD) the axis will become inclined to the H.P. but will remain parallel to the V.P. The distances of all the corners from the V.P. will remain constant.
4. The front view will not be affected except in its position in relation to xy . The new top view will have its corners at same distances from xy , as before.
5. Reproduce the front view so that the axis makes 30° angle with xy and the point a' remains in xy .
6. Project all the points vertically from this front view and horizontally from the first top view. Complete the new top view by drawing (a) lines joining the apex o_1 with the corners of the base and (b) lines for the edges of the base.
7. The base will be partly hidden as shown by dashed line a_1b_1 , e_1 and f_1a_1 .
8. Similarly, o_1 and o_1a_1 are also dashed lines.

Assignment:

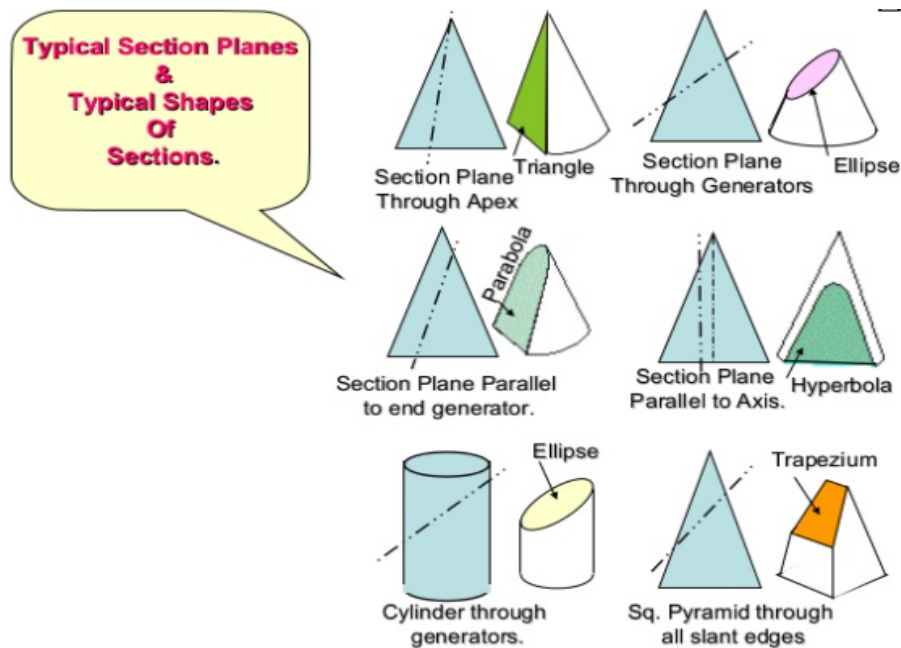
1. Draw the projections of a cylinder 75 mm diameter and 100 mm long, lying on the ground with its axis inclined at 30° to the V.P. and parallel to the ground.
2. Draw the projections of a cone, base 75 mm diameter and axis 100 mm long, lying on the H.P. on one of its generators with axis parallel to the V.P.
3. A pentagonal pyramid, base 25 mm side and axis 50 mm long has one of its triangular faces in the V.P. and the edge of the base contained by that face makes an angle of 30° with the H.P. Draw its projections.

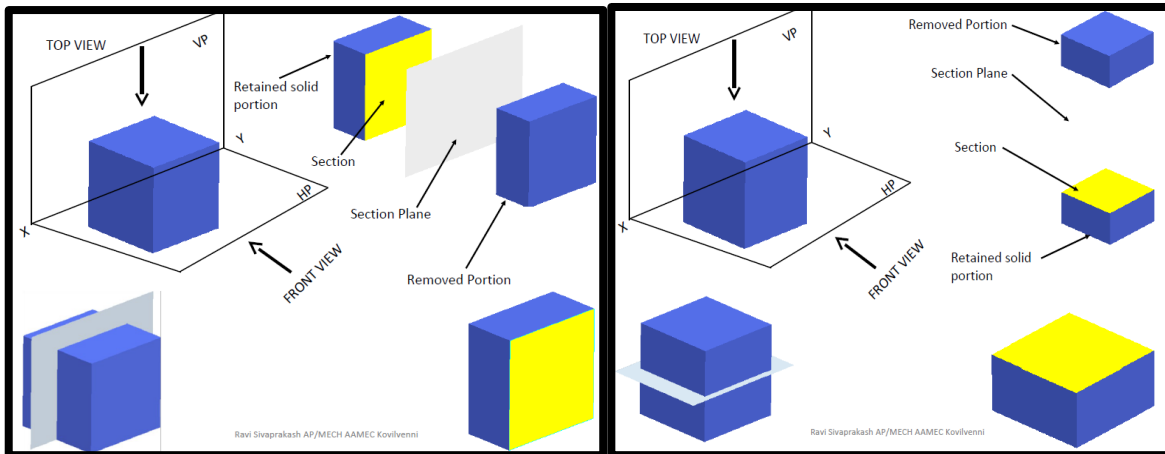
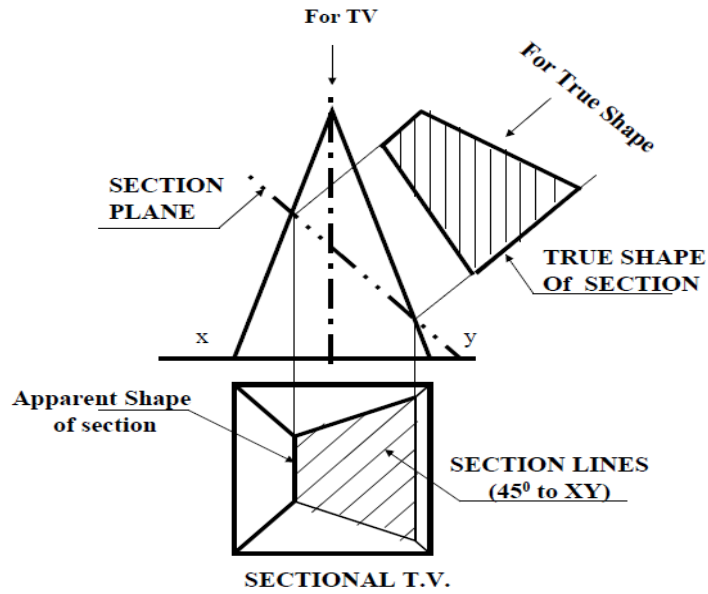
Viva questions:

1. What is the difference between frustum of solid and truncated solid?
2. What do you mean by right solid?
3. What is the difference between prism and pyramid?
4. What is difference between line, plane and solid?
5. What is difference between prism and pyramid?
6. What do you mean by right & regular prism, pyramid, cone & cylinder?
7. What is difference between cone & cylinder?

PROJECTION OF SECTION OF SOLIDS

1. **Cutting plane or section plane:** The imaginary plane which is assumed to cut the object as required is called a cutting plane or section plane.
2. **Section:** The surface produced when a section plane cuts a solid is termed a section.
3. **Sectional view:** The drawing showing that part of the object which is between the plane of projection and the section plane is called a sectional view.
4. **True Shape of Section:** If a solid is sectioned by a section plane and it is projected to a plane parallel to it, the shape of the section obtained will be exactly the section exposed by the section plane. This shape is called True Shape of Section.
5. **Apparent Shape of Section:** If the section plane is inclined to the plane of projection, the shape obtained will not be the true shape. Such a shape is called Apparent Shape of Section.





SECTIONS OF DIFFERENT SOLIDS:

1. Sections of prisms
2. Sections of pyramids
3. Sections of cylinders
4. Sections of cones
5. Sections of spheres.

TYPES OF SECTION PLANES

1. Section Plane Perpendicular to HP and parallel to VP.
2. Section Plane Perpendicular to VP and parallel to HP.
3. Section Plane Perpendicular to VP and Inclined to HP.
4. Section Plane Perpendicular to HP and Inclined to VP.
5. Section Plane Perpendicular to both HP and VP.

Experiment No:12

SECTION OF SOLIDS-I

SECTIONS OF PRISMS

1. A cube of 35 mm long edges is resting on the H.P. on one of its faces with a vertical face inclined at 30° to the V.P. It is cut by a section plane parallel to the V.P. and 9 mm away from the axis and further away from the V.P. Draw its sectional front view and the top view.

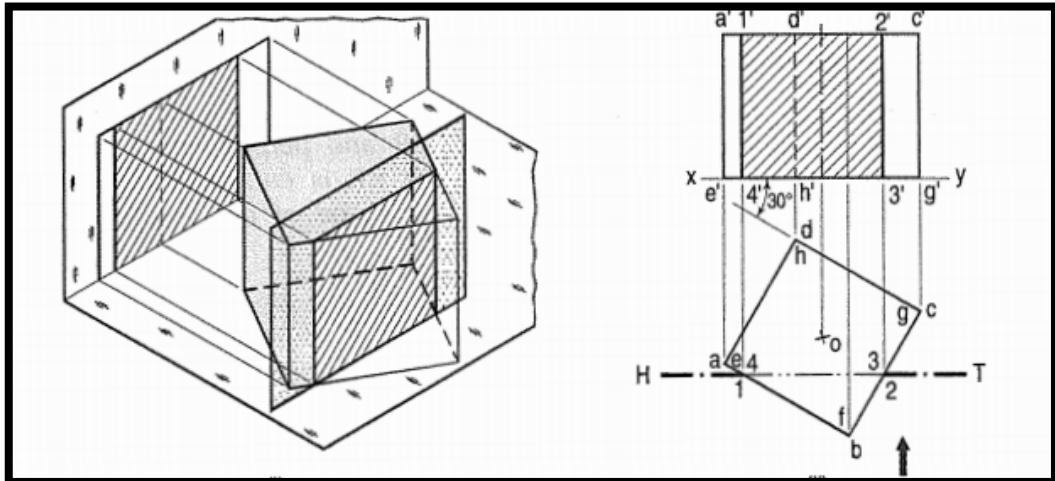


Figure:1

Commands:

1. Units
2. Limits
3. Line
4. Dtext
5. Rotate
6. Copy
7. Extend
8. Hatch

Procedure:

1. Draw a line H.T. in the top view (to represent the section plane) parallel to xy and 9 mm from o.
2. Name the points at which the edges are cut, viz. ab at 1, be at 2, gf at 3 and fe at 4.
3. Project these points on the corresponding edges in the front view and join them in proper order.
4. As the section plane is parallel to the V.P., figure 1' 2' 3' 4' in the front view, shows the true shape of the section.
5. Show the views by dark but thin lines, leaving the lines for the cut-portion fainter.
6. Draw section lines in the rectangle for the section.

SECTIONS OF PYRAMIDS

1. A pentagonal pyramid, base 30 mm side and axis 65 mm long has its base horizontal and an edge of the base parallel to the V.P. A horizontal section plane cuts it at a distance of 25 mm above the base. Draw its front view and sectional top view.

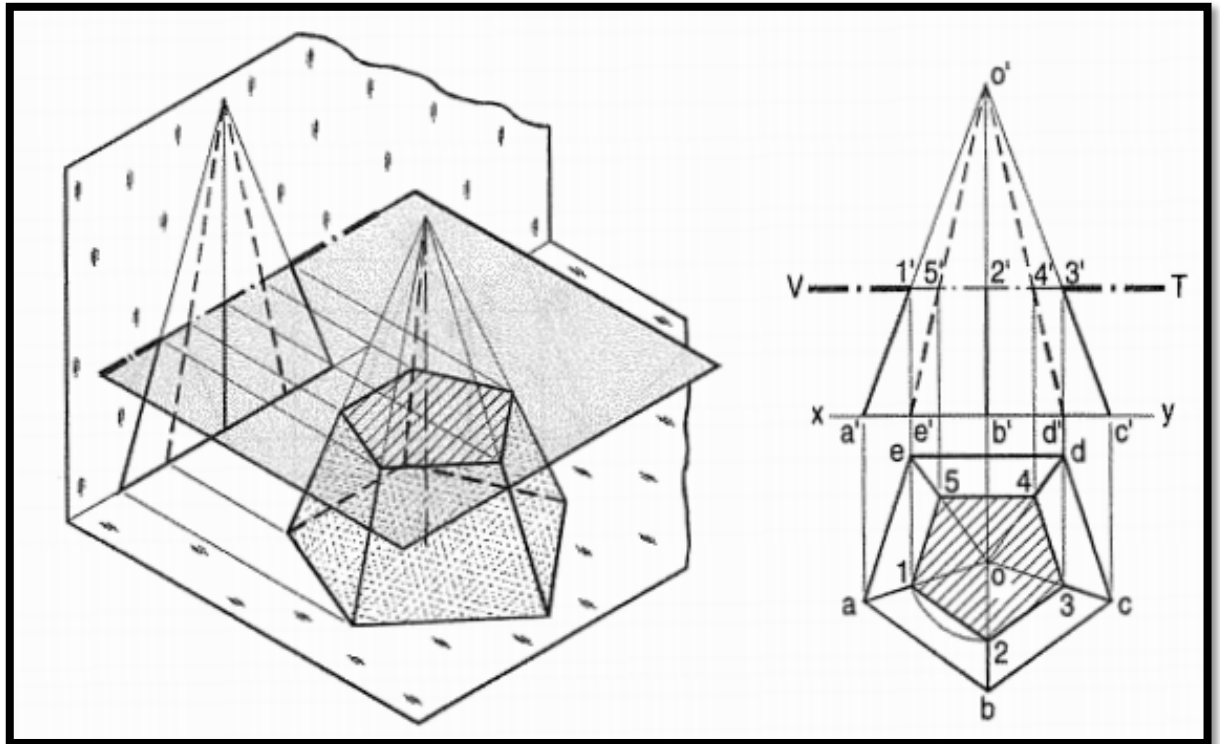


Figure:2

Commands:

1. Units
2. Limits
3. Line
4. Polygon
5. Dtext
6. Rotate
7. Copy
8. Extend
9. Hatch

Procedure:

1. Draw the projections of the pyramid in the required position and show a line V.T. for the section plane, parallel to and 25 mm above the base. All the five slant edges are cut.
2. Project the points at which they are cut, on the corresponding edges in the top view. The point 2' cannot be projected directly as the line ob is perpendicular to xy. But it is quite evident from the projections of other points that the lines of the section in the top view, viz. 3-4, 4-5 and 5-1 are parallel to the edges of the base in their respective faces and that the points 1, 3, 4 and 5 are equidistant from o.
3. Hence, line 1-2 also will be parallel to ab and o2 will be equal to o1, o3 etc. Therefore, with o as centre and radius o1, draw an arc cutting ob at a point 2 which

Date: _____

will be the projection of 2'. Complete the sectional top view in which the true shape of the section, viz. the pentagon 1, 2, 3, 4 and 5 is also seen.

4. Hence, when a pyramid is cut by a plane parallel to its base, the true shape of the section will be a figure, similar to the base; the sides of the section will be parallel to the edges of the base in the respective faces and the corners of the section will be equidistant from the axis.

Experiment No:13

SECTION OF SOLIDS-II

1. A triangular pyramid, having base 40 mm side and axis 50 mm long, is lying on the H.P. on one of its faces, with the axis parallel to the V.P. A section parallel to the V.P. cuts the pyramid at a distance of 6 mm from the axis. Draw its sectional front view and the top view.

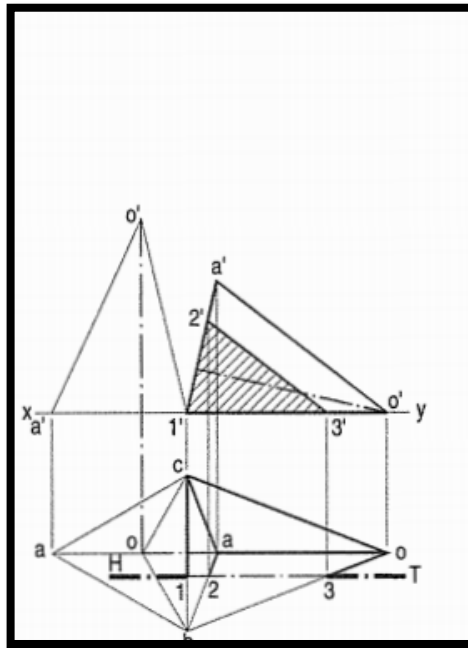


Figure:1

Commands:

1. Units
2. Limits
3. Line
4. Dtext
5. Rotate
6. Copy
7. Extend
8. Hatch

Procedure:

1. Draw the projections of the pyramid in the required position and show a line H.T. (for the cutting plane) in the top view parallel to xy and 6 mm from the axis.
2. Project points 1, 2 and 3 (at which the edges are cut) on corresponding edges in the front view and join them. Figure 1' 2' 3' shows the true shape of the section.

SECTIONS OF CYLINDERS

1. A cylinder of 40 mm diameter, 60 mm height and having its axis vertical, is cut by a section plane, perpendicular to the V.P., inclined at 45° to the H.P. and intersecting the axis 32 mm above the base. Draw its front view, sectional top view, sectional side view and true shape of the section.

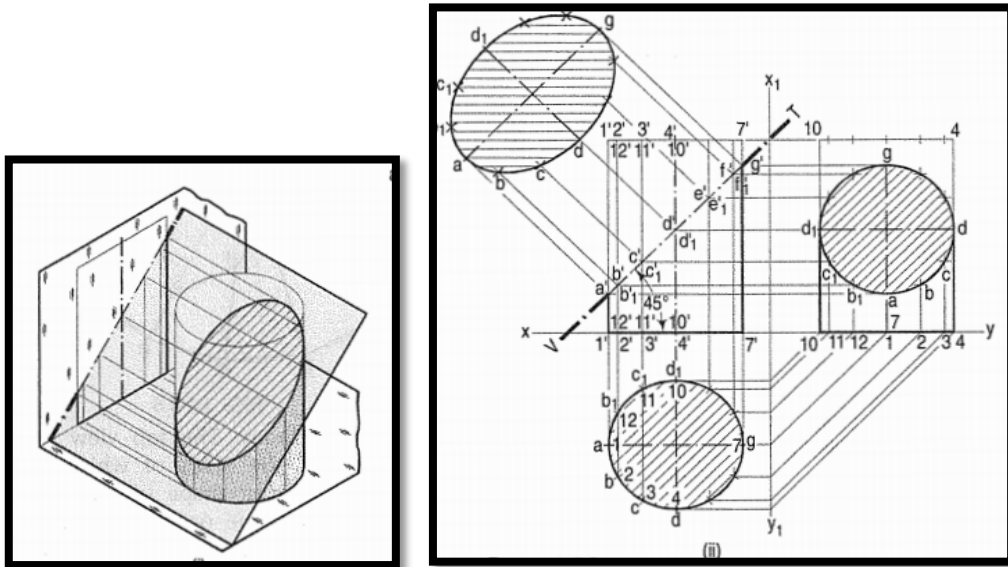


Figure:2

Commands:

1. Units
2. Limits
3. Line
4. Circle
5. Dtext
6. Rotate
7. Copy
8. Extend
9. Hatch
10. Polar array

Procedure:

1. As the cylinder has no edges, a number of lines representing the generators may be assumed on its curved surface by dividing the base-circle into, say 12 equal parts.
2. Name the points at which these lines are cut by the V.T. In the top view, these points lie on the circle and hence, the same circle is the top view of the section. The width of the section at any point, say c' , will be equal to the length of the chord cc_1 in the top view.
3. The true shape of the section may be drawn around the centre line ag drawn parallel to V.T. as shown. It is an ellipse the major axis of which is equal to the length of the section plane viz. $a'g'$, and the minor axis equal to the diameter of the cylinder viz. dd_1 .
4. Project the sectional side view as shown. The section will be seen as a circle because the section plane makes 45° angle with xy .

SECTIONS OF CONES

1. 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 point 35 mm from the apex. Draw its front view, sectional top view, sectional side view and true shape of the section.

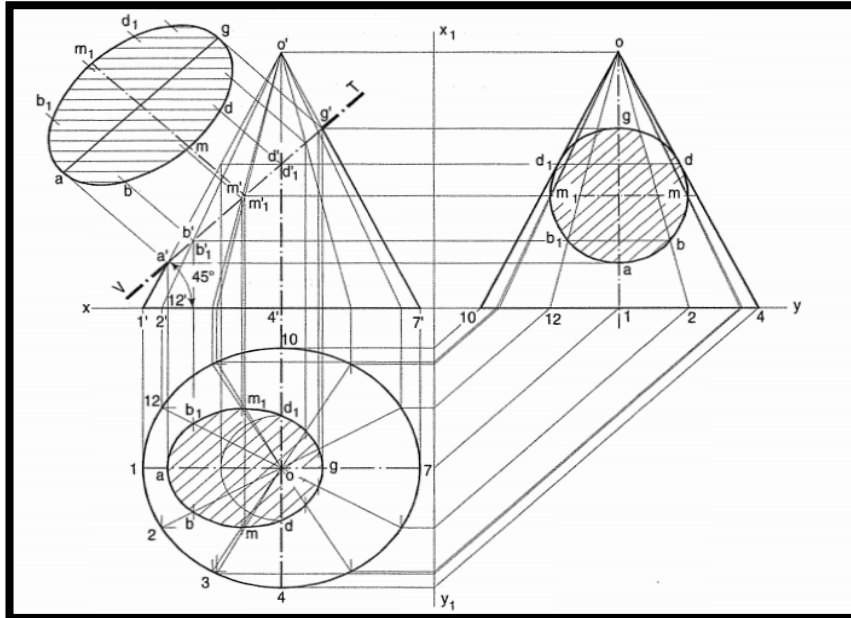


Figure:3

Commands:

1. Units
2. Limits
3. Line
4. Circle
5. Dtext
6. Rotate
7. Copy
8. Extend
9. Hatch
10. Polar array

Procedure:

1. Divide the base-circle into a number of equal parts, say 12. Draw lines (i.e. generators) joining these points with o. Project these points on the line representing the base in the front view.
2. Draw lines $o' 2'$, $o' 3'$ etc. cutting the line for the section at points b' , c' etc. Project these points on the corresponding lines in the top view. For example, point b' on $o' 2'$, also represents point b_1 on $o'-12'$ which coincides with $o'-12'$. Therefore, project b' to b on o_2 and to b_1 on $o'-12'$. b and b_1 are the points on the section (in the top view). FIG. (i)
3. Similarly, obtain other points. Point d' cannot be projected directly. Hence, the same method as in case of pyramids should be employed to determine the positions d and

d_1 , as shown. In addition to these, two more points for the maximum width of the section at its centre should also be obtained.

4. Mark m' , the mid-point of the section and obtain the points m and m_1 .
5. Draw a smooth curve through these points.
6. The true shape of the section may be obtained on the V.T. as a new reference line or symmetrically around the centre line ag , drawn parallel to the V.T. as shown. It is an ellipse whose major axis is equal to the length of the section and minor axis equal to the width of the section at its centre.

Assignments:

1. A triangular prism, base 30 mm side and axis 50 mm long, is lying on the H.P. on one of its rectangular faces with its axis inclined at 30° to the V.P. It is cut by a horizontal section plane, at a distance of 12 mm above the ground. Draw its front view and sectional top view.
2. A pentagonal pyramid, base 30 mm side and axis 65 mm long has its base horizontal and an edge of the base parallel to the V.P. A horizontal section plane cuts it at a distance of 25 mm above the base. Draw its front view and sectional top view.
3. A hollow cylinder; 50 mm outside diameter axis 70 mm long and thickness 8 mm has its axis parallel to the V.P. and inclined at 30° to the vertical. It is cut in two equal halves by a horizontal section plane. Draw its sectional top view.
4. A cone, diameter of base 50 mm and axis 50 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 75° to the H.P. and passing through the apex. Draw its front view, sectional top view and true shape of the section.
5. The projections of a hemisphere 50 mm diameter, placed centrally on the top of a frustum of a hexagonal pyramid, base 32 mm side, top 20 mm side and axis 50 mm long are given. Draw the sectional front view when the vertical section plane H.T. inclined at 45° to the V.P. and 10 mm from the axis, cuts them. Also draw the true shapes of the sections of both the solids.

Viva questions:

1. How cutting planes are represented?
2. What is the significance of section of solid?
3. Define cutting plane?
4. What are the types of section of planes?
5. Define Frustum?
6. Define truncated?
7. Difference between Frustum and truncated?

DEVELOPMENT OF SURFACES

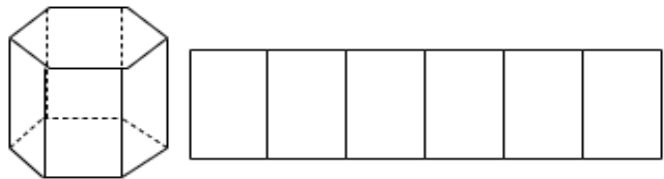
Development is a graphical method of **obtaining the area of the surfaces** of a solid. When a solid is opened out and its complete surface is laid on a plane, the surface of the solid is said to be developed. The figure thus obtained is called a **development of the surfaces of the solid or simply development**. Development of the solid, when folded or rolled, gives the solid.

Examples

Prism – Made up of same number of rectangles as sides of the base

One side: Height of the prism

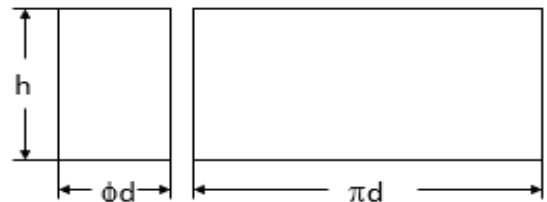
Other side: Side of the base



Cylinder – Rectangle

One side: Circumference of the base

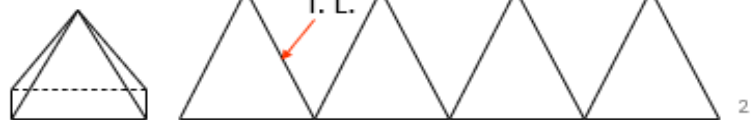
Other side: Height of the cylinder



Pyramid – Number of triangles in contact

The base may be included

if present

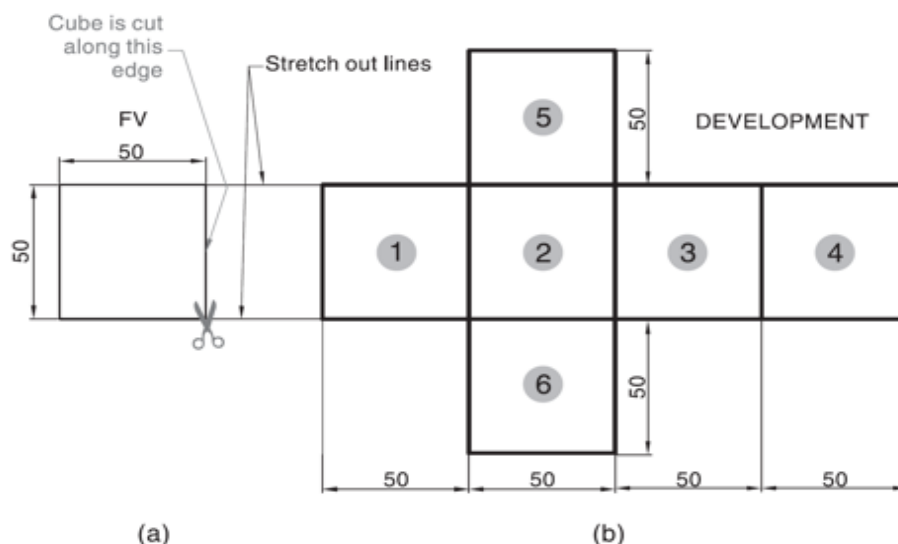


Methods used to develop surfaces

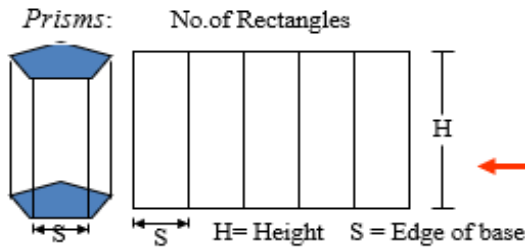
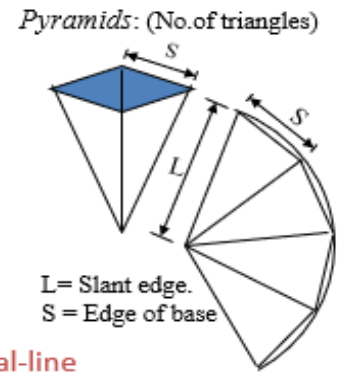
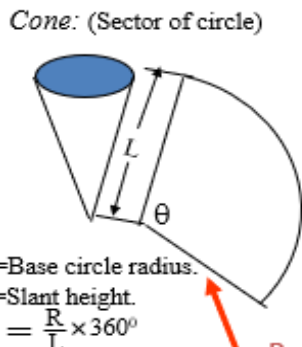
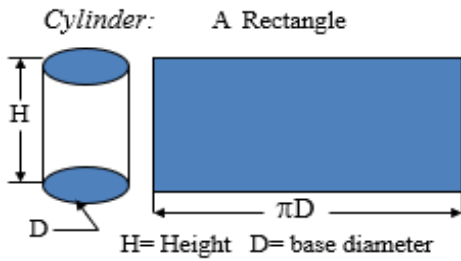
1. **Parallel-line development:** Used for prisms, cylinders etc. in which **parallel lines are drawn along the surface** and transferred to the development.
2. **Radial-line development:** Used for pyramids, cones etc. in which the **true length of the slant edge** or generator is used as **radius**.
3. **Triangulation development:** Complex shapes are **divided into a number of triangles** and transferred into the development (usually used for transition pieces).
4. **Approximate method:** Surface is divided into parts and developed. Used for surfaces such as spheres, paraboloids, ellipsoids etc.

Note:- The surface is preferably cut at the location where the **edge will be smallest** such that welding or other joining procedures will be minimal.

Parallel line development: This method is employed to develop the surfaces of **prisms and cylinders**. Two parallel lines (called **stretch-out lines**) are drawn from the two ends of the solids and the lateral faces are located between these lines.

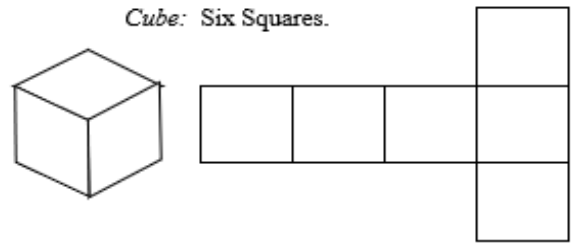
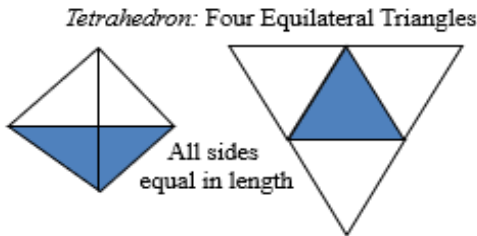


Development of lateral surfaces of different solids.
(Lateral surface is the surface excluding top & base)



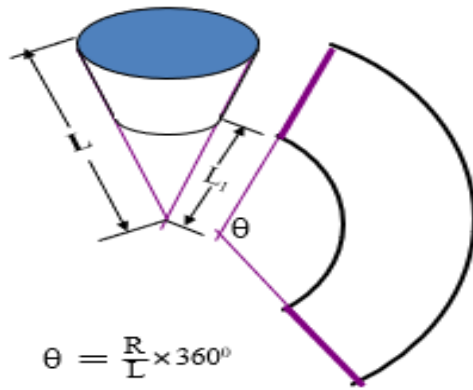
Parallel-line development

Radial-line development



FRUSTUMS

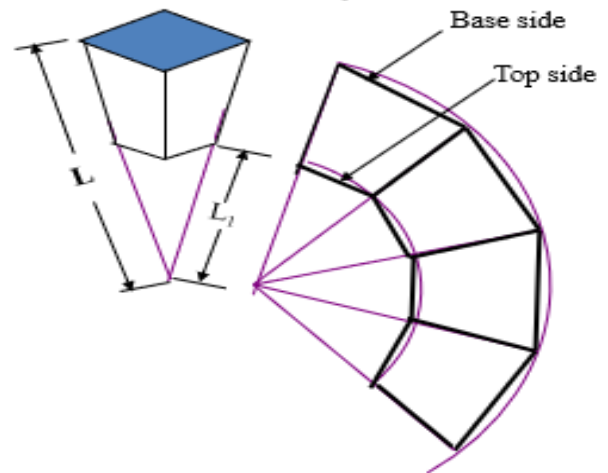
DEVELOPMENT OF FRUSTUM OF CONE



$$\theta = \frac{R}{L} \times 360^\circ$$

R = Base circle radius of cone
 L = Slant height of cone
 L₁ = Slant height of cut part.

DEVELOPMENT OF FRUSTUM OF SQUARE PYRAMID



L = Slant edge of pyramid
 L₁ = Slant edge of cut part.

Experiment No:14
DEVELOPMENT OF SURFACES
(PRISMS AND CYLINDERS)

1. A pentagonal prism of base 20mm side and axis 40mm long rests on H.P on its base with its axis perpendicular to H.P. It is cut by a sectional plane, inclined at 45° to the H.P. and bisects the axis. Draw the development of truncated portion of solids.

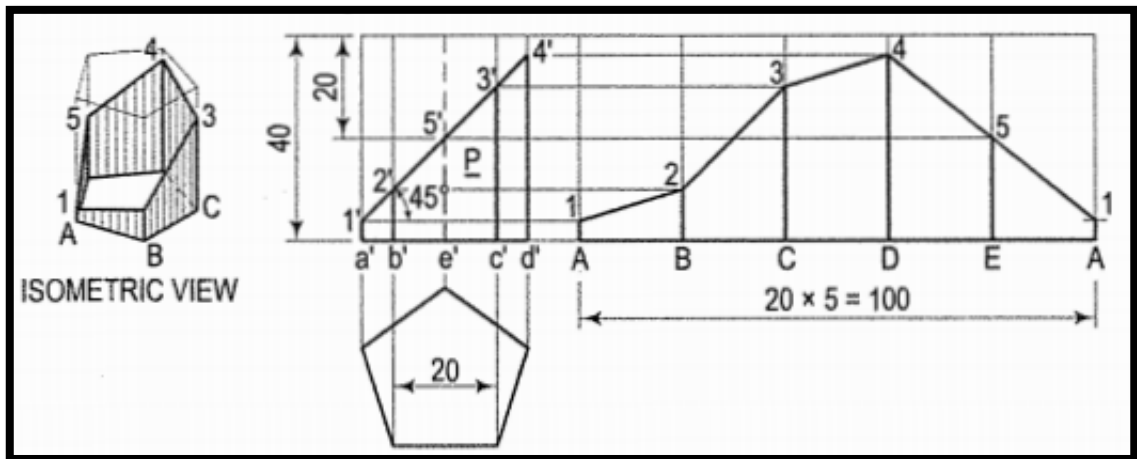


Figure:1

Commands:

1. Units
2. Limits
3. Line
4. Polygon
5. Dtext
6. Rotate
7. Copy
8. Extend
9. Hatch
10. Point
11. Ptype

Procedure:

1. Name the corners of the prism and the points at which the edges are cut.
2. Draw the development assuming the prism to be whole fig.(ii). It is made up of five equal rectangles.
3. Draw horizontal lines through, points $1', 2'$ to cut the lines for the corresponding edges development at points 1, 2 etc.
4. Draw lines joining these points and complete the development as shown.

2. A cylinder of base 45mm diameter and axis 60mm long rests on the HP on its base and its axis is perpendicular to the HP. It is cut by a section plane inclined at some angle to HP such that it cuts the cylinder at 15mm above HP on one side and ends at top of the cylinder at the other end as shown in the figure below. Draw the development of truncated portion of the cylinder by parallel line method.

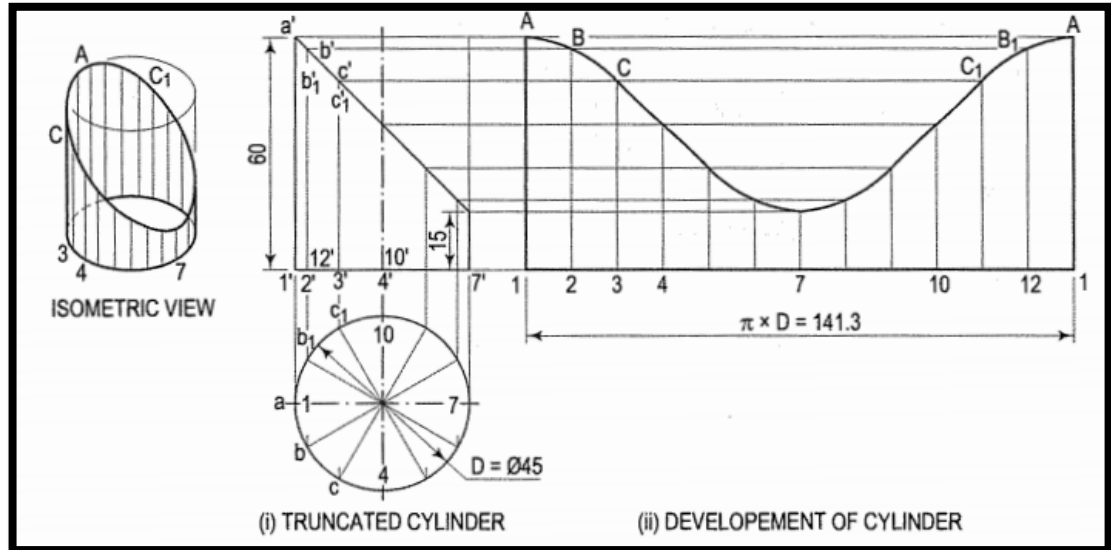


Figure: 2

Commands:

1. Units
2. Limits
3. Line
4. Circle
5. Dtext
6. Copy
7. Extend
8. Hatch
9. Point
10. Ptype
11. Polar array
12. Dimlin/dimang

Procedure:

1. Divide the circle in the top view into twelve equal parts.
2. Project the division points to the front view and draw the generators.
3. Mark points a', b' and b'1, c' and c'1 etc. in which the generators are cut.
4. Draw the development of the lateral surface of the whole cylinder along with the generators [fig.(ii)].
5. The length of the line 1-1 is equal to $n \times D$ (circumference of the circle).
6. This length can also be marked approximately by stepping off with a bow divider, twelve divisions, each equal to the chord-length ab.
7. Draw horizontal lines through points a', b' and b'1 etc. to cut the corresponding generators in points A, B and 81 etc.
8. Draw a smooth curve through the points thus obtained.
9. The figure 1-A-A-1 is the required development.

Experiment No:15

DEVELOPMENT OF SURFACES

(PYRAMIDS & CONES)

1. A Triangular pyramid of base 30mm sides and axis 40mm long rests on HP on its base with an edge of the base perpendicular to VP. It is cut by a section plane inclined at 30° to the HP and bisects the axis. Draw the development of the truncated portion of the pyramid.

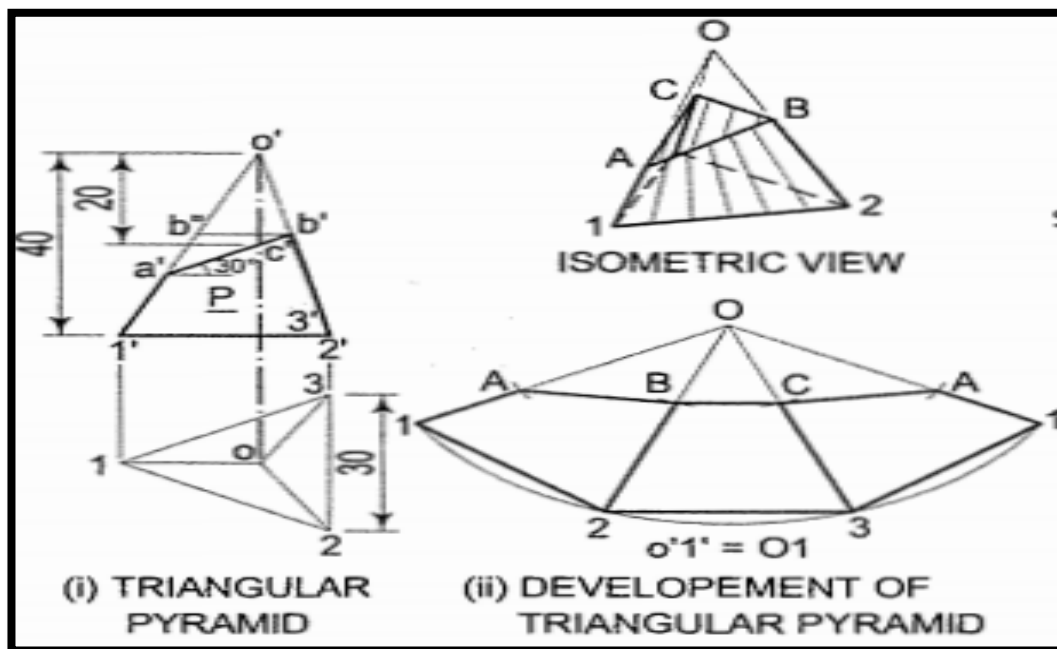


Figure:1

Commands:

1. Units
2. Limits
3. Line
4. Dtext
5. Dimlin/dimalign
6. Arc
7. Extend

Procedure:

1. Draw the development of the lateral surface of the whole pyramid [fig.(ii)]
2. On O1 mark a point A such that $OA = o'a'$. $o'2'$ (with which $o'3'$ coincides) is not the true length of the slant edge.
3. Hence, through b' , draw a line parallel to the base and cutting $o'a'$ at b'' . $o'b''$ is the true length of $o'b'$ as well as $o'c'$. Mark a point B in O2 and C in O3 such that $OB = OC = o'b''$.
4. Draw lines AB, BC and CA and complete the required development as shown. Keep the arc and the lines for the removed

2. A pentagonal pyramid of base 25mm sides and axis 50mm long rests on HP on its base with an edge of its base parallel to VP. It is cut by the section plane inclined at 30° to the HP and starts from the left bottom corner of the base. Draw the development

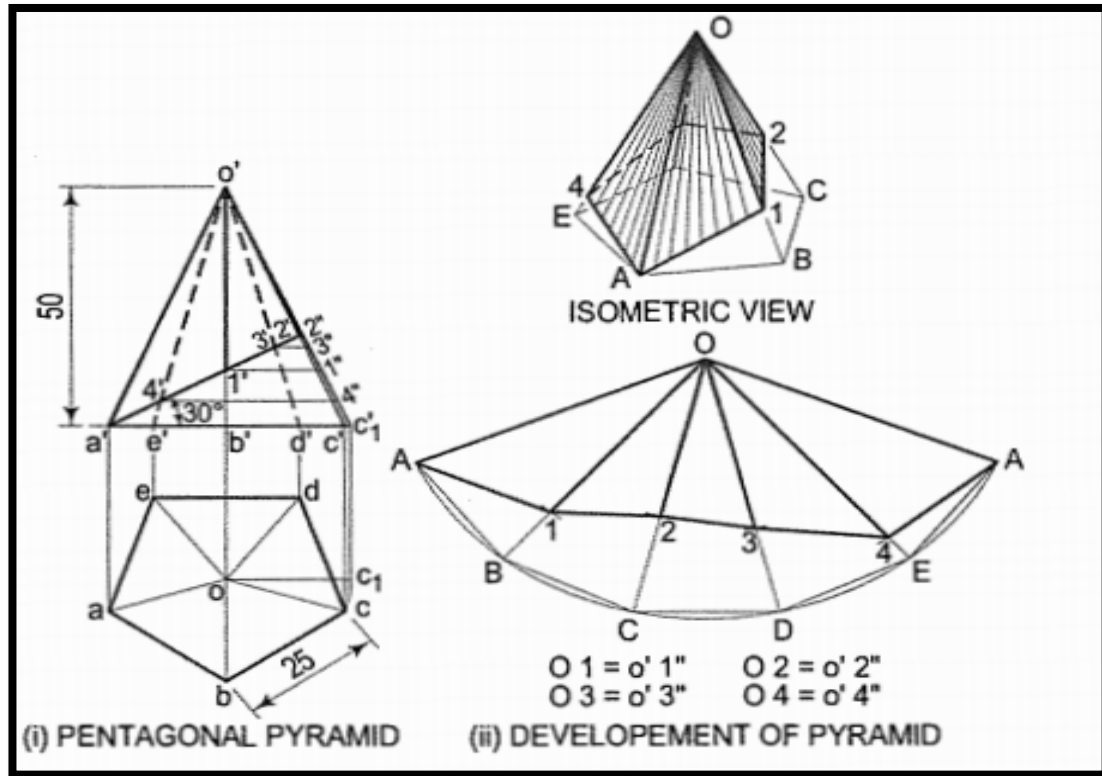


Figure:2

Commands:

1. Units
2. Limits
3. Line
4. Polygon
5. Dtext
6. Dimlin/dimalign
7. Arc
8. Extend

Procedure:

1. None of the lines in the front view shows the true length of the slant edges. Hence, draw the top view and determine the true length $o'c'1$. Through points $1'$, $2'$ etc., draw lines parallel to the base and obtain the true lengths $o'1''$, $o'2''$ etc.
2. Draw the development of lateral surfaces of whole pyramid
3. Mark 1,2,3 etc. on line OB, OC, OD etc. such that that $o1 = o'1''$, $o2 = o'2''$, $o3 = o'3''$ etc.
4. Draw lines joining points A, 1, 2 etc. in correct sequence and complete the required development. Note that the lines for the lower part should be fainter.

3. A cone of base 60mm diameter and axis 70 mm long rests on HP on its base. It is cut by a section plane inclined at 45° to the HP and bisects the axis. Draw the development of surfaces of the truncated portion of the cone.

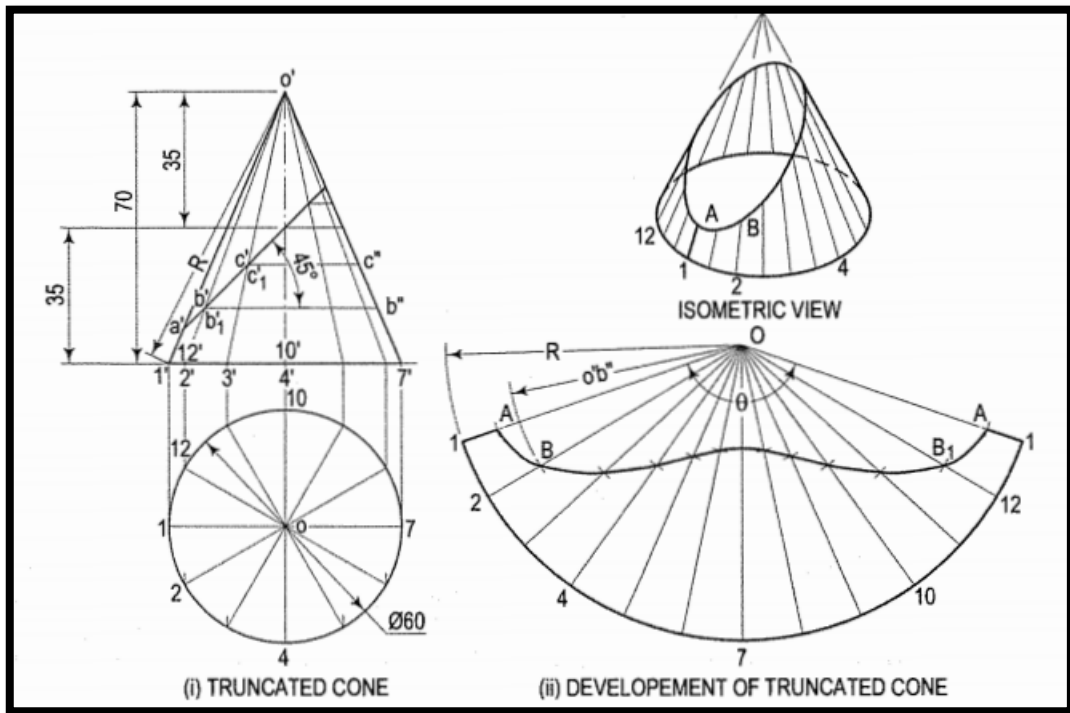


Figure: 3

Commands:

1. Units
2. Limits
3. Line
4. Circle
5. Polar array
6. Dtext
7. Dimlin/dimalign
8. Arc
9. Extend

Procedure:

1. Draw the base-circle in the top view and divide it into twelve equal parts.
2. With any point O as centre and radius equal to o'1' or o'7', draw an arc of the circle [fig.(ii)].
3. The length of this arc should be equal to the circumference of the base circle. This can be determined in two ways.
4. Calculate the subtended angle θ by the formula,

$$\theta = 360 * \frac{\text{radius of the base circle.}}{\text{slant height}}$$
5. Cut-off the arc so that it subtends the angle θ at the centre and divide it into twelve equal parts.

6. Join the division-points with 0, thus completing the development of the whole cone with twelve generators.
7. The truncated portion of the cone may be deducted from this development by marking the positions of points at which generators are cut and then drawing a curve through them. For example, generators o'2' and o'12' in the front view are cut at points b' and b'1 which coincide with each other. The true length of o' b' may be obtained by drawing a line through b', parallel to the base and cutting o'7' at b". Then o'b" is the true length of o'b'.
8. Mark points B and 81 on generators 02 and 0-12 respectively, such that $OB = OB_1 = o' b'$. Locate all points in the same way and draw a smooth curve through them. The figure enclosed this curve and the arc is the development of the truncated cone.

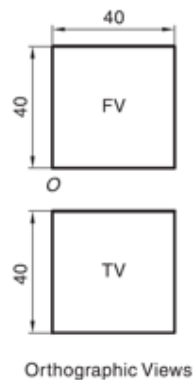
Viva questions:

1. What do you mean by Development of solid?
2. Classify the methods of development of solids?
3. What are the methods for development of sphere?
4. What do you mean by Antidevelopment?
5. What is parallel line method and when it is used?
6. What is radial line method and when it is used?
7. What is triangulation method and when it is used?
8. what are approximate methods and on which solids

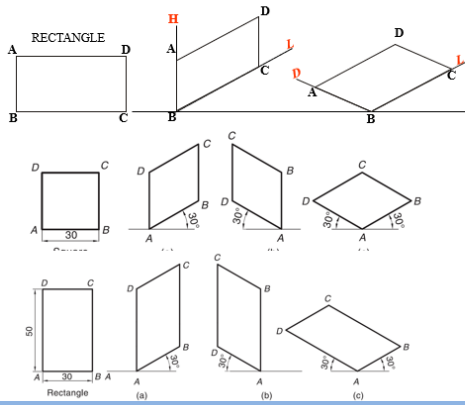
ISOMETRIC PROJECTION

Isometric Projections and Isometric Views

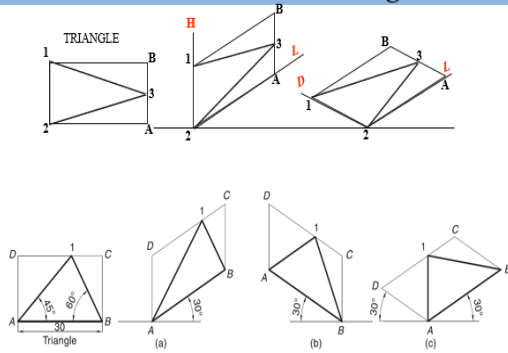
- Isometric projection is often constructed using isometric scale which gives dimensions smaller than the true dimensions.
- However, to obtain isometric lengths from the isometric scale is always a cumbersome task.
- Standard practice is to keep all dimensions as it is. The view thus obtained is called *isometric view* or *isometric drawing*.
- As the isometric view utilizes actual dimensions, the isometric view of the object is seen larger than its isometric projection.



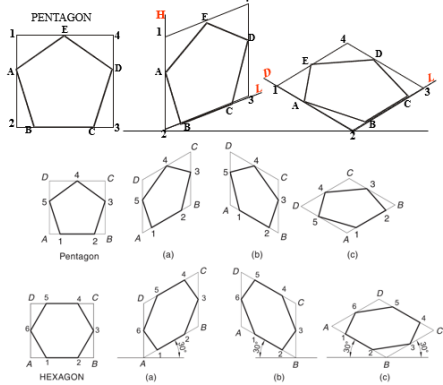
Isometric View: Rectangle/Square



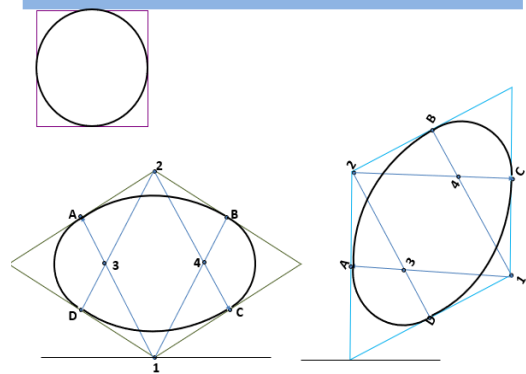
Isometric View: Triangle



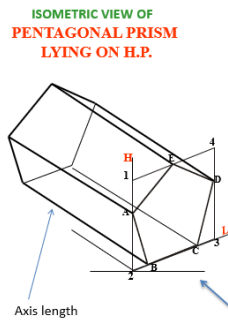
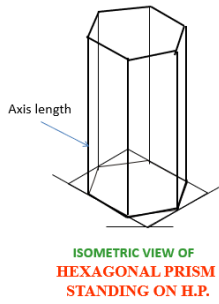
Isometric View: Pentagon/Hexagon



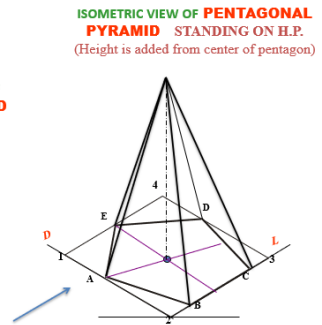
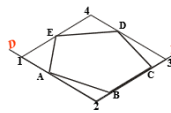
Isometric View: Circle



Isometric View: Prism

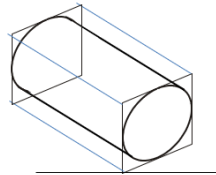


ISOMETRIC VIEW OF BASE OF
PENTAGONAL PYRAMID
STANDING ON H.P.

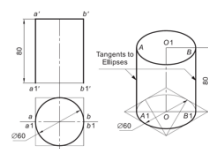
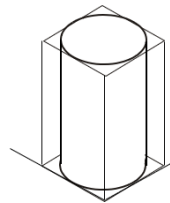


Isometric View: Cylinder

CYLINDER STANDING ON H.P.

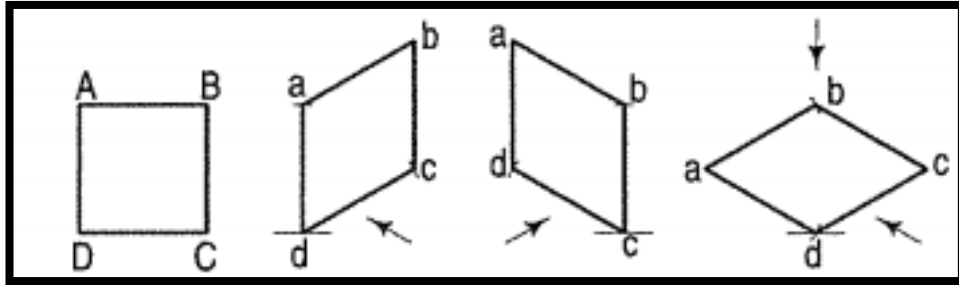


CYLINDER LYING ON H.P.



Experiment No:16
ISOMETRIC PROJECTION
(PLANES & SIMPLE SOLIDS)

1. Draw three isometric view of a square of side 40mm

**Figure:1****Figure:2****Figure:3****Figure:4****Commands:**

1. Units
2. Limits
3. Line
4. Dtext
5. Dimlin/dimalign
6. Copy

Procedure:

1. As the front view is a square, the surface of the square is vertical. In isometric view, vertical lines will be drawn vertical, while horizontal lines will be drawn inclined at 30° to the horizontal.
2. Through any point d, draw a vertical line $da = DA$ [fig.(ii)].
3. Again through d, draw a line $de = DC$ inclined at 30° to the horizontal and at 60° to da.
5. Complete the rhombus abed which is the required isometric view. The view can also be drawn in direction of the other sloping axis as shown.

2. Draw the isometric view of a square prism, side of the base 20 mm long and the axis 40 mm long, when its axis is (i) vertical and (ii) horizontal.

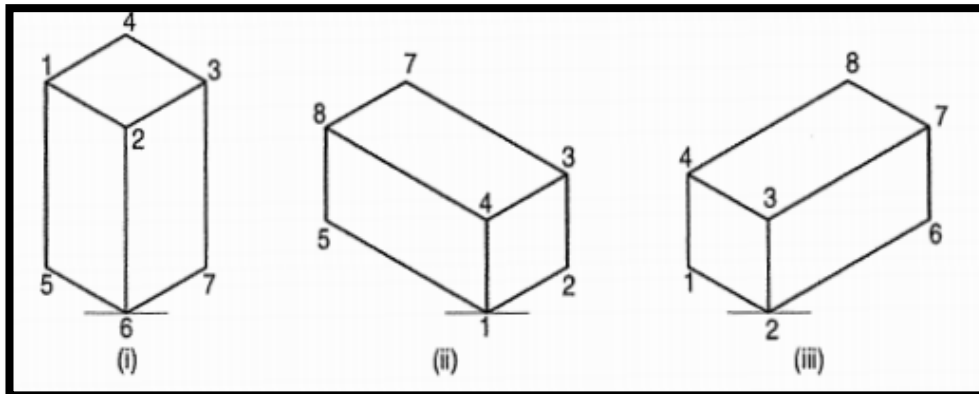


Figure:6

Commands:

1. Units
2. Limits
3. Line
4. Dtext
5. Dimlin/dimalign
6. Copy

Procedure:

1. When the axis is vertical, the ends of the prism will be horizontal. Draw the isometric view (the rhombus 1-2-3-4) of the top end [fig.(i)].
2. Its sides will make 30°-angles with the horizontal.
3. The length of the prism will be drawn in the third direction, i.e. vertical. Hence, from the corners of the rhombus, draw vertical lines 1-5, 2-6 and 3-7 of length equal to the length of the axis. The line 4-8 should not be drawn, as that edge will not be visible.
4. Draw lines 5-6 and 6-7, thus completing the required isometric view. Lines 7-8 and 8-5 also should not be drawn. Beginning may also be made by drawing lines from the point 6 on the horizontal line and then proceeding upwards.
5. When the axis is horizontal, the ends will be vertical. The ends can be drawn in two ways as shown in fig. (ii) and fig. (iii).
6. In each case, the length is shown in the direction of the third isometric axis.

3. Draw the isometric view of the pentagonal pyramid of base 30mm side and axis 50mm long.

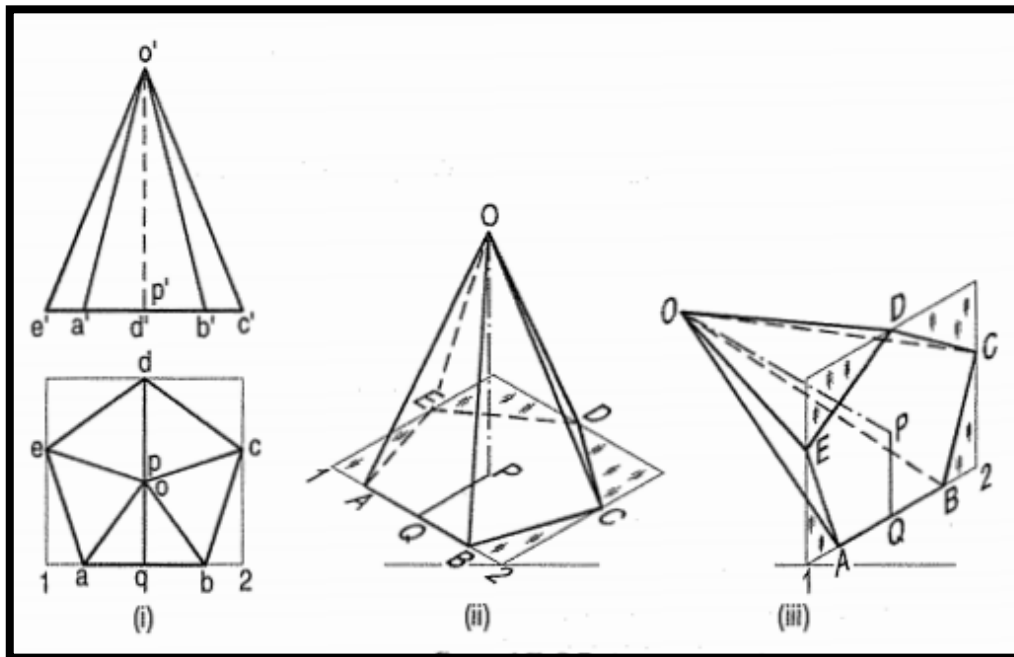


Figure:7

Commands:

1. Units
2. Limits
3. Line
4. Polygon
5. Dtext
6. Dimlin/dimalign
7. Copy

Procedure:

1. Enclose the base (in the top view) in an oblong.
2. Draw an offset oq (i.e. pq) on the line ab.
3. Draw the isometric view of the oblong and locate the corners of the base in fig. (ii)
4. Mark a point Q on the line AB such that $AQ = aq$. From Q, draw a line QP equal to qo and parallel to 2C. At P, draw a vertical OP equal to o'p'.
5. Join O with the corners of the base, thus completing the isometric view of the pyramid.

Assignment:

1. Draw the three isometric view of a Pentagon of a given side 25mm.
2. Draw the three isometric view of a Hexagon of a given side 30mm.
3. Draw the three isometric view of a Rectangle of a given length 100mm & 30mm.
4. Draw the isometric view of a cone, base 40 mm diameter and axis 55 mm long (i) when its axis is vertical and (ii) when its axis is horizontal.

4. Draw the i) Front View ii) Side View iii) Top View of the given diagram

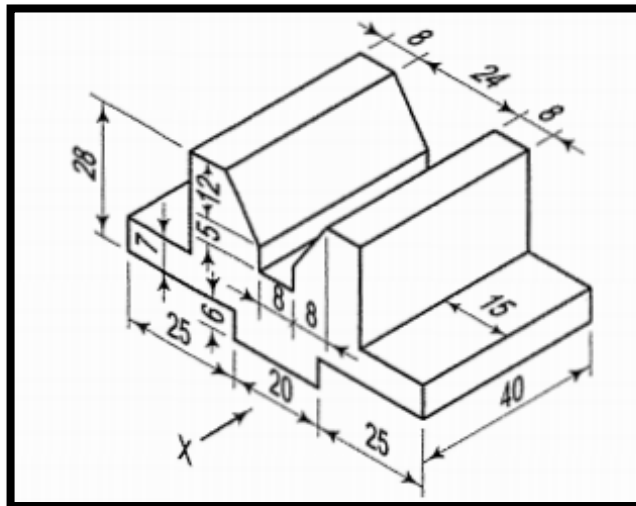


Figure:8

Commands:

1. Units
2. Limits
3. Line
4. Offset
5. Copy
6. Erase
7. Dimlin

Procedure:

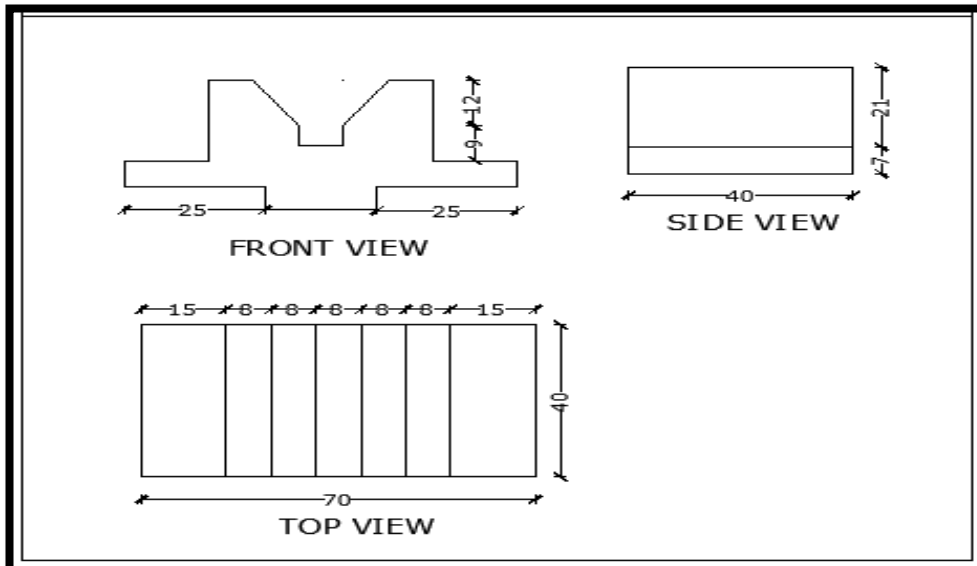


Figure:2

5. Draw the i) Front View ii) Side View iii) Top View of the given diagram

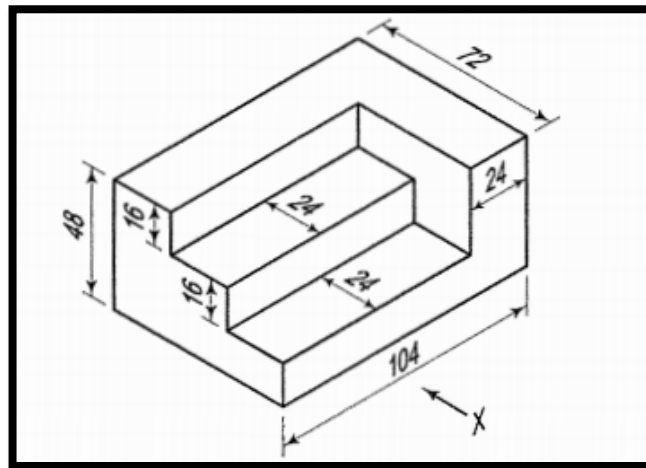


Figure:9

Commands:

1. Units
2. Limits
3. Line
4. Offset
5. Copy
6. Erase
7. Dimlin

Procedure:

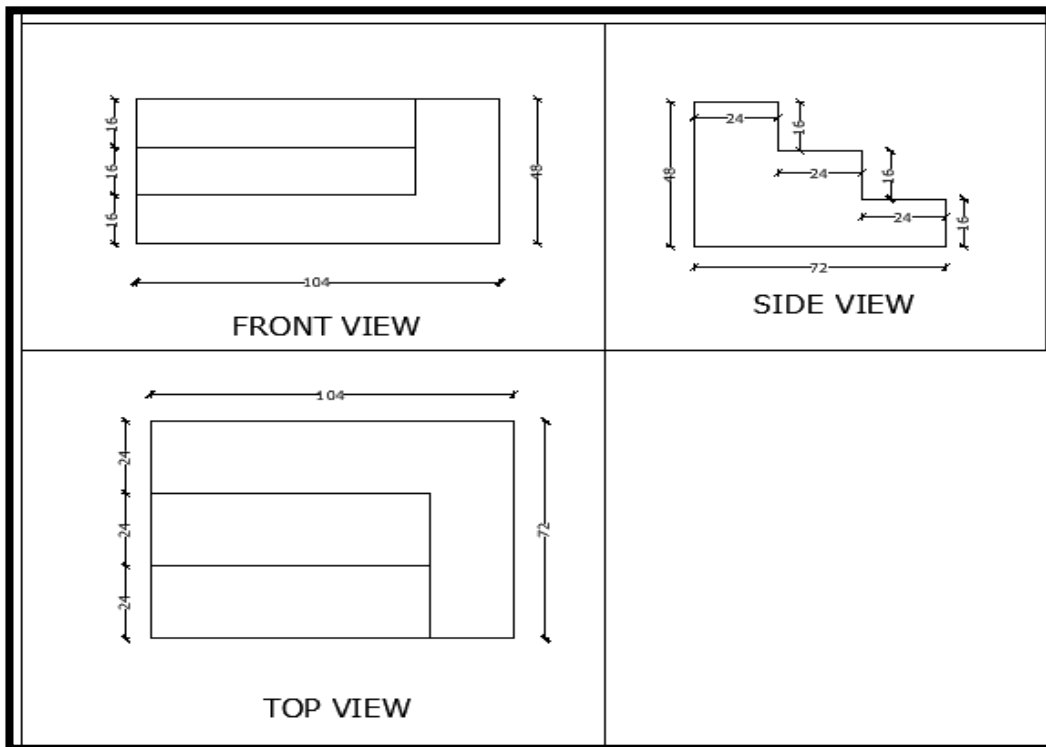
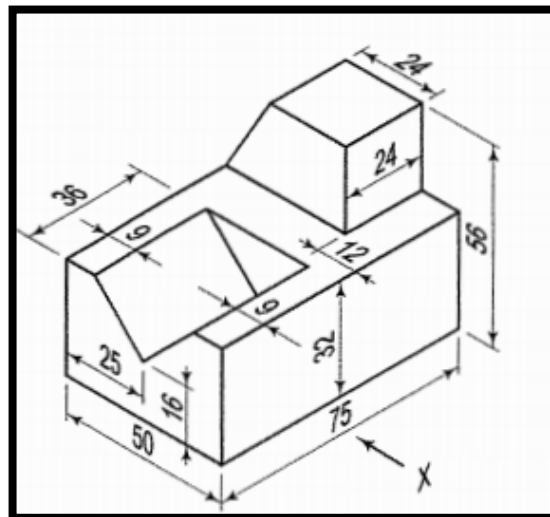
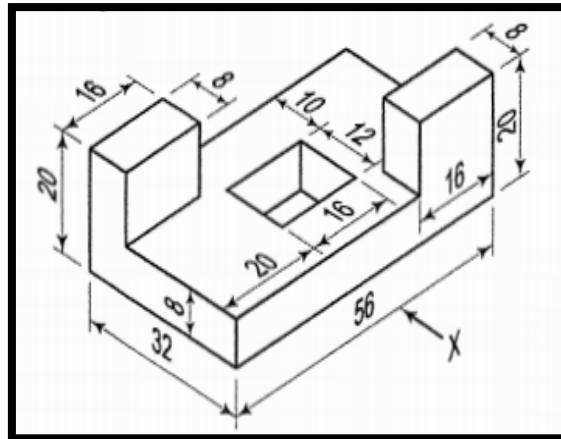
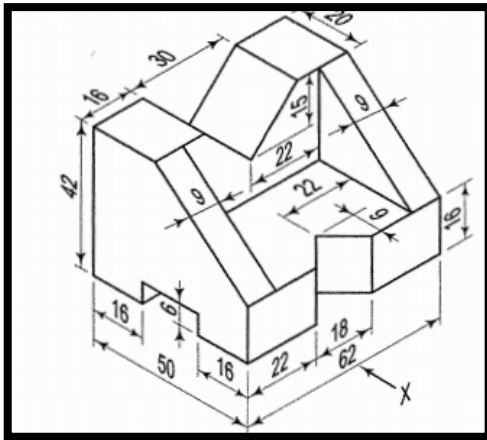


Figure:10

Assignment:

1. Draw the i) Front View ii) Side View iii) Top View of the given below diagrams



VIVA QUESTIONS

1. What is the difference between isometric view and isometric projection?
2. What are the advantages of isometric projections?
3. How will you draw isometric projection of sphere?
4. Define Isometric projection?
5. What are the advantages of isometric drawing over isometric projections?
6. How will you draw orthographic projections of a regular tetrahedron?
7. What do you mean by isometric axes?
8. What do you mean by isometric planes?