GOVT. TOOL ROOM AND TRAINING CENTRE
KARNATAKA

REFERENCE NOTES

ENGINEERING DRAWING 1

SUBJECT CODE: DTDM-IS-104

FOR
: DIPLOMA IN TOOL AND DIE MAKING

SL .NO	UNIT NAME
1	INTRODUCTION
2	DRAWING TOOLS AND DRAWING SHEETS
3	LETTERING,NUMERALS
4	PROJECTIONS: OTHOGRAPHIC PROJECTIONS PROJECTIONS (3D)
5	DIMENSIONING & SCALES

UNIT 1: INTRODUCTION

INTRODUCTION TO ENGINEERING DRAWING

The day we were born we never knew what this world was about. We saw things around us and started visualizing. As days passed we started listening to our parents' voice and seeing their action and slowly started to understand what their action and voice meant. Once we understood we started interpretation. As months passed we learnt to raise our voice and started speaking a few words along with conveying what we really meant though action. Later words started to flow like anything (joining words) "just like accelerator being pressed gradually" and landed up in speaking sentence. Parents started guiding us and accordingly corrected our grammatical mistakes and we got the fluency. Later we started to communicate.

"THIS WAS HOW WE LEARNT A LANGAUGE (MOTHER TONGUE)".

Put your sincere effort to learn this interesting language so called Engineering drawing which can be learnt easily, just as your mother tongue.

What is Engineering Drawing?

Engineering drawing can be defined as a language which is needed to communicate technically. This language is learnt the same way as the former which was accomplished only with the eagerness to learn. Hope you keep the same eagerness to learn this language. This LANGAUGE is a written language (cannot be spoken) necessary for communication to get the work done (produce a component) in Technical field which is created by a Designer and executed by the operator / Technician. To accomplish the

former this language has to be learnt by all those who are in the technical field (civil, Mechanical Architecture etc). Our field of TOOL AND DIE MAKING or PRECISION MANUFACTURING comes under Mechanical Engineering.

Why it is necessary?

Is it possible to explain everything to each and everyone who construct the house without a drawing? You may forget how was your plan to construct it that is why we need to learn this language. When our idea to construct the house is in the form of a written document we never have to remember either, nor there is a chance that we get deviated from it, rather will stick on with it. Engineering drawing is a written language, so called the language of engineers which has to be learnt to read and write (draw) and if necessary to communicate the same.

It's a very easy and interesting language. It gives you a immense joy when you have learnt it. It's a sort of solving a puzzle sometime.

What is needed to learn this language?

- Interest
- Concentration
- Visualization
- Involvement

Among these the only thing we need to learn is visualization the rest we already posses. Visualization is a kind of skill which is based on wisdom. Eg: When you watch a movie / major incident you still can recall what you have seen. Engineering drawing needs the same visualizing technique practiced step by step from one level to another but not in a hurry.

The upcoming exercises WILL BE DEALT IN LEVELS. Go to the next LEVEL only when you have understood the concept fully just as you play mobile games. KEEP AN

EYE ON THE GRAPH to measure your achievement. If found lacking kick start putting more effort and more time right from level 1.Try your level best to reach the LAST LEVEL within the stipulated time. Do not attempt to copy from others at any stage for the sake of submission, rather take the help from others to understand the concept. If the former is attempted then it becomes a practice and you lose imaginative thinking skill which leads to your downfall.

UNIT 2: DRAWING TOOLS, LETTERING & LINES

DRAWING TOOLS, LETTERING & LINES

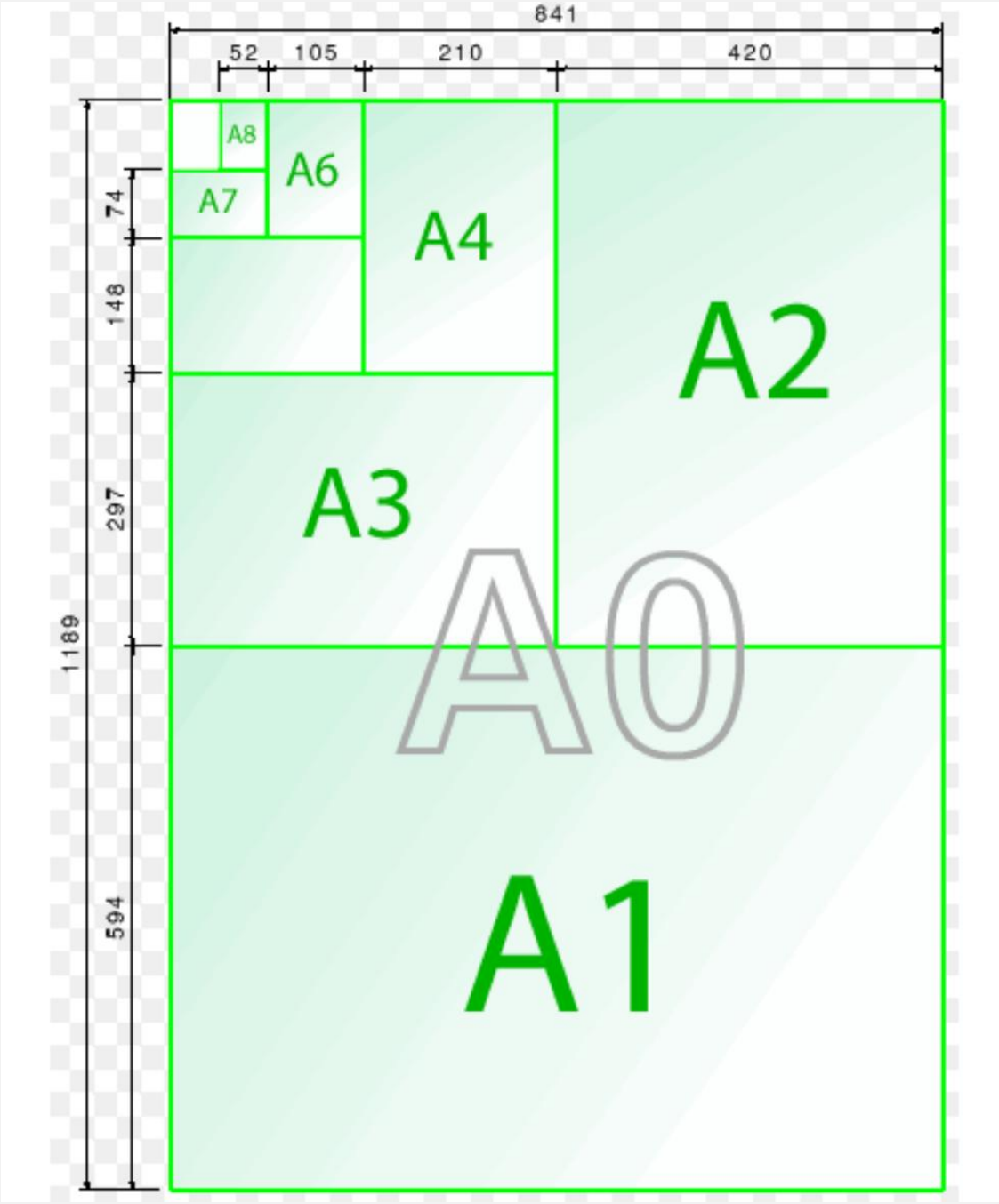
SL	DESCRIPTION	REMARKS	SL	DESCRIPTION	REMARKS
1	CLUTCH PENCIL	0.5mm 2B LEAD	5	PRO CIRCLE	TO DRAW CIRCLES
2	ERASER		6	COMPASS	TO DRAW CIRCLES
3	SCALE	12 INCH	7	CLIPS	TO HOLD SHEETS
4	MINIDRAFTER	DRAW STRAIGHT AND ANGULAR LINES			

SHEET SIZE, LAYOUT AND FOLDING

SHEET SIZE

Sheets are available in different sizes from A0 to A5 sizes. They come in two varieties trimmed and untrimmed sizes (refer table) as per the bureau of Indian standards (B.I.S)

SHEET DESIGNATION	TRIMMED SIZE IN (mm)	UNTRIMMED SIZE IN (mm)
A0	814 X 1189	880 X 1230
A1	594 X 841	625 X 880
A2	420 X 594	450 X 625
A3	297 X 420	330 X 450
A4	210 X 297	240 X 330
A5	147 X 210	165 X 240



EASY WAY TO REMEMBER THE SHEET SIZE:

Just remember A5 =147 X 210.

Now A4 sheet size =The **Max size of A5** becomes **Min size of A4** and **Min size of A5** gets doubled to become the **Max size of A4.** The same is repeated for the rest of the sheet sizes **but the max size of A1 and A0 is just 1mm more after its doubled.**

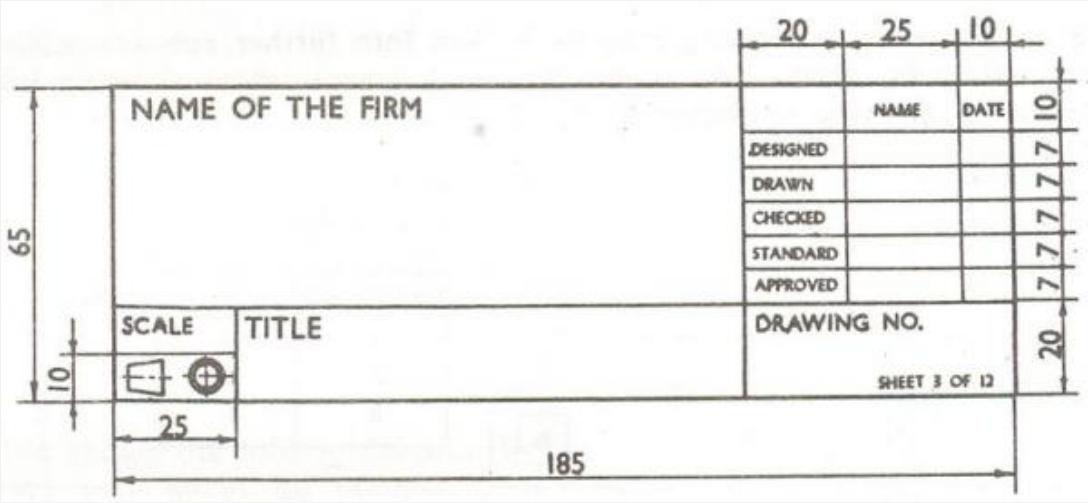
LAYOUT

Border lines: More space is left on the left hand side of the sheet for filing purpose

TITLE BLOCK

The title block gives the following details:

1. Name of the company
2. Title of the drawing
3. Scale
4. Symbol for the method of projection
5. Drawing number
6. Person drawn and checked with date
7. Sheet number & total number of sheets related with the component The title block is drawn on the right hand bottom corner of the drawing sheet and the recommended size as per B.I.S is 185mm X 65mm



BILL OF MATERIAL

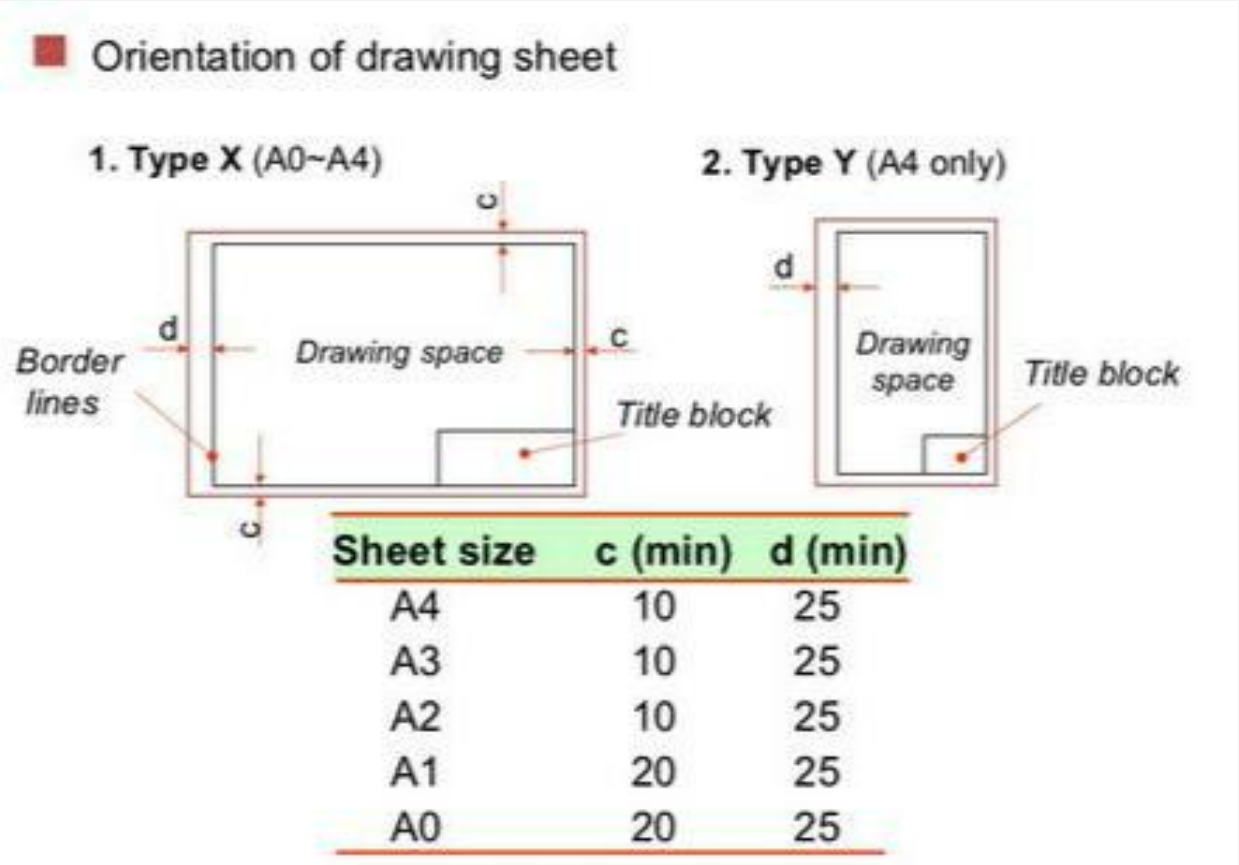
This is done when an assembly drawing is drawn. The bill of material contains

1. Part number
2. Description (name of the part)

3. Quantity required
4. Raw material size and finished size
5. Additional treatment in the remarks column.

1	Top plate	01No	25x150x250	20x145x245	----------
SL NO	**DESCRIPTION**	**QTY**	**RAW MATERIAL SIZE**	**FINISHED SIZE**	**REMARKS**

BORDER LINES FOR VARIOUS SHEET SIZES



Sheet size	c (min)	d (min)
A4	10	25
A3	10	25
A2	10	25
A1	20	25
A0	20	25

SHEET FOLDING

There are two methods of folding the sheets of various sizes. Method 1 is followed when sheets are to be filed in a file. This method helps to unfold and view the drawing and refold without removing from the file. Method 2 is adopted when the drawings are preserved in cabinets.

SHEET SIZE	HORIZONTAL DIMENSION FROM LEFT (IN mm)	VERTICAL DIMENSION FROM BOTTOM (IN mm)	NO OF FOLDS	SHEET SIZE	HORIZONTAL DIMENSION FROM LEFT (IN mm)	VERTICAL DIMENSION FROM BOTTOM (IN mm)	NO OF FOLDS
A0	130 – 109 -190 (5 FOLDS)	297 (2 FOLDS) - 247	9	A0	139 – 210 (5 FOLDS)	297 – 297 - 247	7
A1	146 – 125 – 190 (3 FOLDS)	297 – 297	6	A1	211 – 210 (3 FOLDS)	297 – 297	4
A2	116 - 96 (3 FOLDS) - 190	297	1	A2	174 - 210 (2 FOLDS)	297 – 123	3
A3	125 – 105 - 190	297	1	A3	210 – 210	297	1

PRACTICE SHEET FOLDING OF ALL SIZE MINIMUM 3 TIMES

Folding large format technical drawings

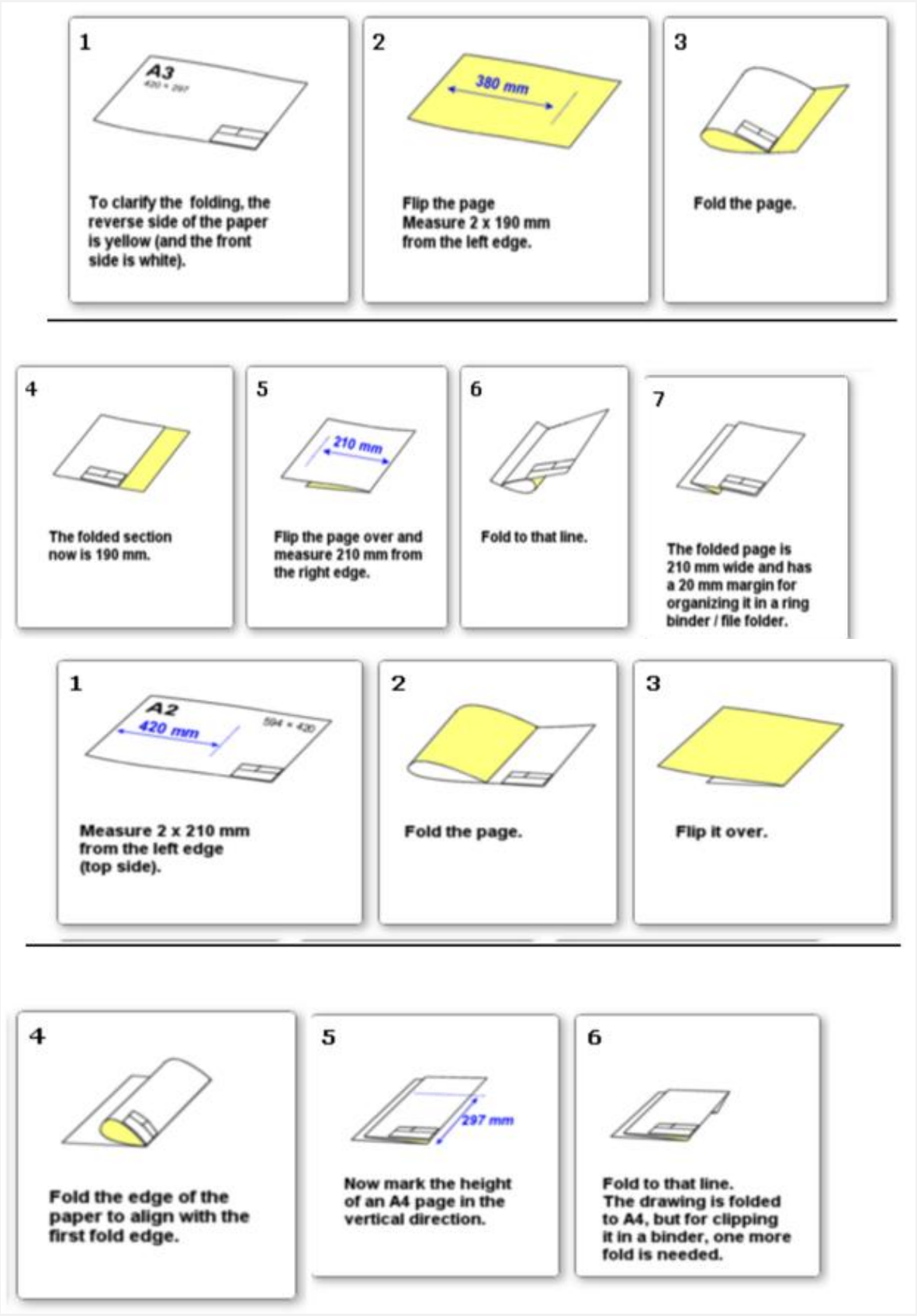
There are basically two ways to handle large format drawings: roll them or fold them. Folding has a number of advantages:

- a folded drawing is easier to archive and takes less space
- a set of folded drawings is conveniently organized in a ring binder or file folder, easy to slip in a briefcase to bring along to meetings
- a set of folded drawings in a binder/ folder can be paged through without unfolding, because the title block is always visible in the lower right corner
- once you have flipped through the drawings and found the one you wish to view (or present), a folded drawing is easily unfolded to its full size without first needing to remove it from the binder/ folder
- a folded drawing, put in an envelope, is cheaper to sent (by post) than a rolled-up drawing in a cardboard tube

There is a catch: you need to fold the drawings correctly. The folding procedure that I present here conforms to the DIN 824 standard, based an "A" paper sizes. Each page folds to A4. I present only how to fold A3, A2 and A1 (we currently do not use larger paper sizes in our company, so I have no experience with them).

DIN 824 only specifies dimensions, of which there are quite a few. The advantage of my stepwise procedure is that you only need to remember three dimensions: the size of A4 format, being 210 x 297 mm, and the width of many folded sections, which is 190 mm. These values are not very critical, if you remember A4 as 21 by 30 cm, that will be fine. In the drawings, you often see the doubled values: I measure 380 mm to create a folded section of 190 mm, but I think it is self-explanitory.

Real paper for technical drawings is typically white on both sides, but to better present the folding, I pretend to use paper that is white on top and yellow on the bottom side.


1
A3
420 × 297
To clarify the folding, the reverse side of the paper is yellow (and the front side is white).
2
380 mm
Flip the page
Measure 2 x 190 mm from the left edge.
3
Fold the page.
4
The folded section now is 190 mm.
5
210 mm
Flip the page over and measure 210 mm from the right edge.
6
Fold to that line.
7
The folded page is 210 mm wide and has a 20 mm margin for organizing it in a ring binder / file folder.
1
A2
420 mm
594 × 420
Measure 2 x 210 mm from the left edge (top side).
2
Fold the page.
3
Flip it over.
4
Fold the edge of the paper to align with the first fold edge.
5
297 mm
Now mark the height of an A4 page in the vertical direction.
6
Fold to that line.
The drawing is folded to A4, but for clipping it in a binder, one more fold is needed.

7

Undo the last fold, flip the page over.

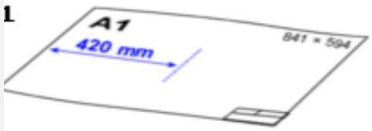
8

Fold the corner of the page, starting from the horizontal fold line, and with an angle of ± 20°.

9

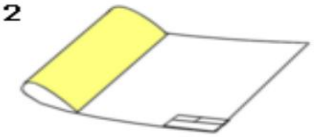
Redo the horizontal fold. When you put the folded drawing in a ring binder, you can unfold it while keeping it in the binder.

1

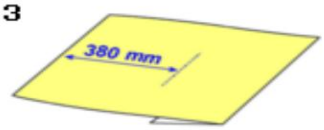


The first fold for A1 is exactly like how you start folding A2.

2

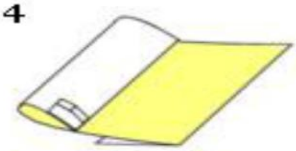


3

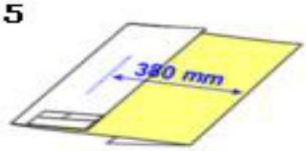


Flip it over, then make the fold as how you would start folding the A3 format.

4

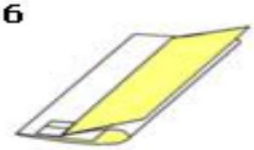


5



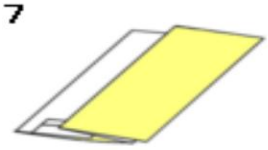
The next fold is for a 190 mm section from the right edge.

6



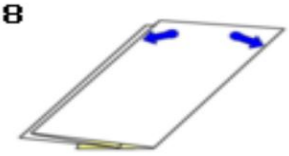
Ignore that you are folding over the title box, this is corrected in the next fold.

7



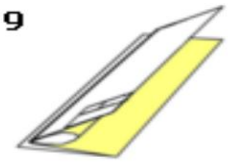
The intermediate result after three folds.

8

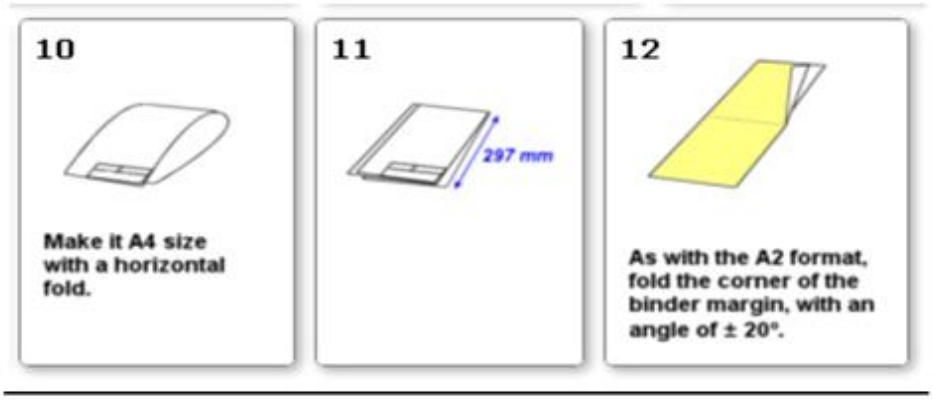


Flip the page over. Take the folded edge at the right and the folded edge at the left.

9



Fold these edges together.



Oversized paper

When handling oversized paper, sometimes called A3+, A2+ and A1+, the easiest way out is to fold them to oversized A4. If that is not acceptable, as a first step, fold away the right or top margin of the drawing, to approximate the width/height of A3, A2 or A1. For A3+ and A1+, you only have to fold the top margin (to approximate the height of A3 and A1 respectively); there is no need to also fold the right margin for A3+ and A1+. Likewise, for A2+ you only fold the *right* margin; you do not need to also fold the top margin.

For example, when folding A2+ with a size of 610 x 430 mm (instead of 594 x 420 mm), fold roughly 15 mm of the right edge of the drawing, so that the new size becomes 595 x 430 mm. Then proceed with the standard way to fold A2.

SUMMERY	At the end of the class the student should have understood the the following : The necessacity of Engineering drawing, Sheet sizes, Layout which includes border lines, Title block, Bill of material, , Title block and the Bill of material and Sheet folding methods
EXERCISES	Make note of Details like sheet size, borderlines, Title block, sheet folding practice etc
AUTHORS OF TEXT BOOKS	ND bhat and Gttc-manuals
TOOLROOM REF	From dwg file:Drg. No. : 11 - 16 – 001 to Drg. No. : 11 - 16 - 003
WEB SITE	http://dlia.ir/Scientific/e_book/Technology/Mechanical_Drawing_Engineering_Graphics/052060.pdf SHEET FOLDING http://www.compuphase.com/electronics/folding.htm
OTHERS	Various size Sheet folding to be demonstrated and practiced
REMARKS	The whole Chapter should not be taught in one class. The teacher can be flexible.

Questions

Objective

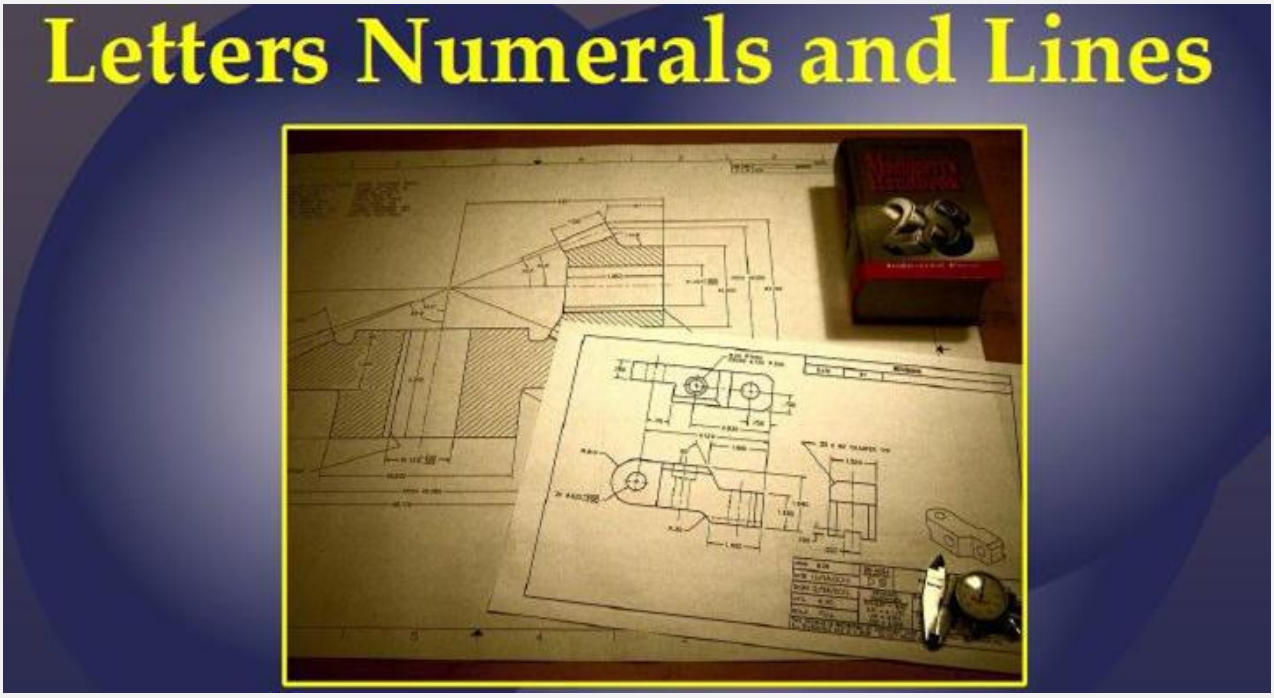
1.Dimensions of border line for A4 sheet is _____
2.The size of A2 sheet is ----------
3.The standard size of the title block is ----------
4. The 2 varieties of sheet available in market are ---------- and ----------
5.The full form of B.I.S is ----------

Subjective

1. What does the bill of material consist of ?
2. State the application of hidden lines and centerlines thick at ends.
3. Write TOOL AND DIE MAKER in inclined letters (both capital and small)

Practice sheet folding AND drawing borderlines.

UNIT 3: LETTERING & NUMERALS



LETTERING & NUMERALS

- Lettering which is called as engineering script is to be practiced and implemented in drawings. It helps in enhancing the appearance and makes it legible for anyone to read.

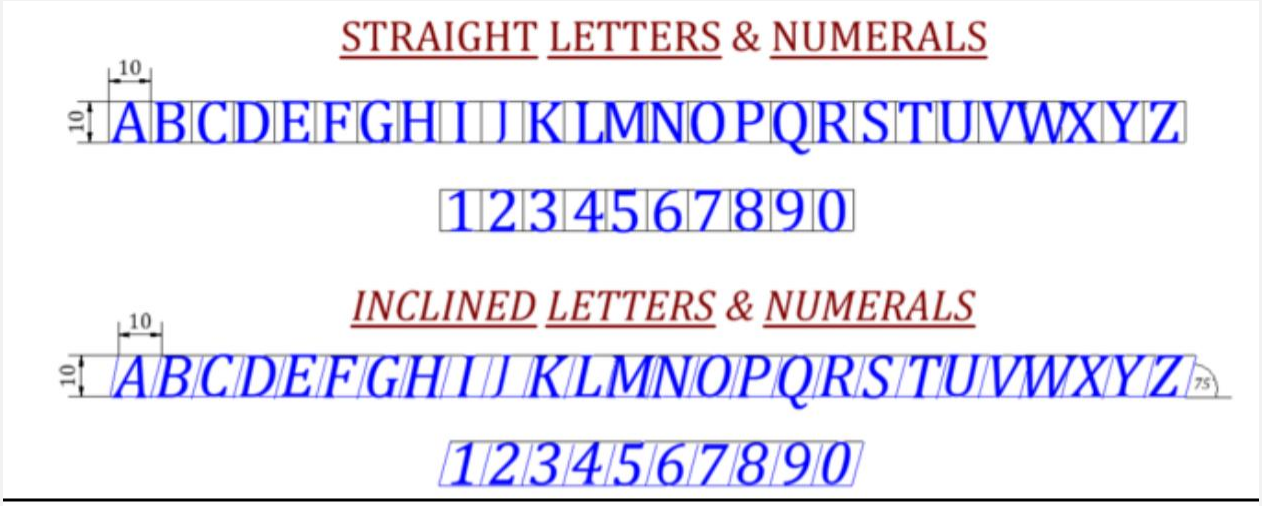
- These letters / numerals are written in two ways. They are VERTICAL and INCLINED. The vertical letters are straight 90 degree to horizontal and inclined letters lean towards the right at 75 degrees to the horizontal.

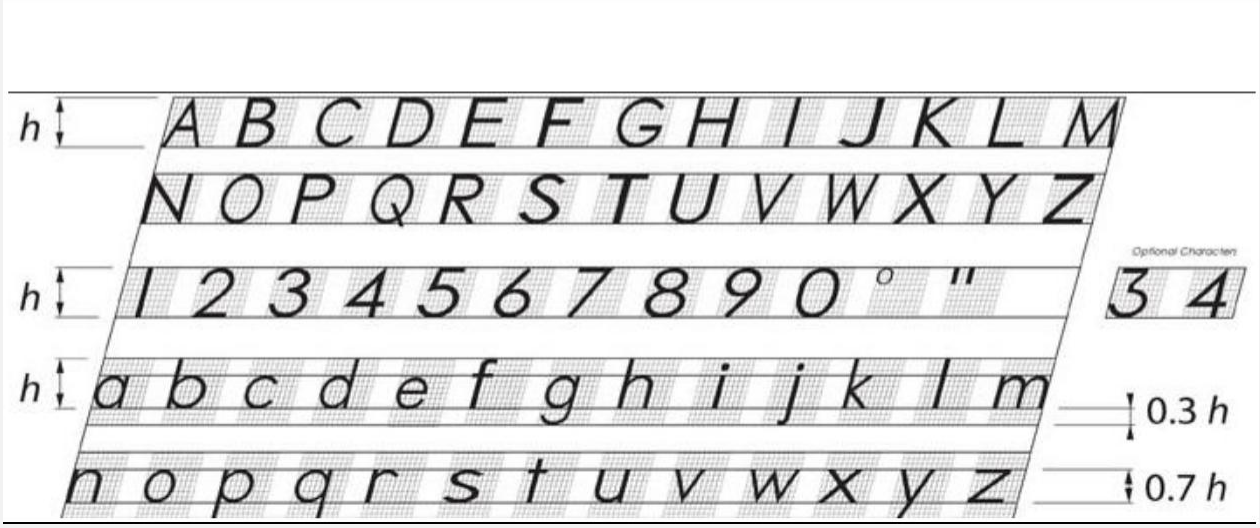
- Letters are written both in capital and small. While writing these letters proportions / ratio have to be maintained i.e. 6:5. Eg: If height of letter is 6mm width should be 5mm & if height of letter is 10 mm then width is around 8mm. The standard height

of the letters /numerals is 2.5, 3.5, 5, 7, 10, 14, 20mm. These sizes are used for different purposes like titles, sub titles (relatively smaller than title).

- Spacing between words should be equal to the letter height. While practicing see that uniformity is maintained both in size of letters and shade. To achieve the latter use H or HB pencil leads.

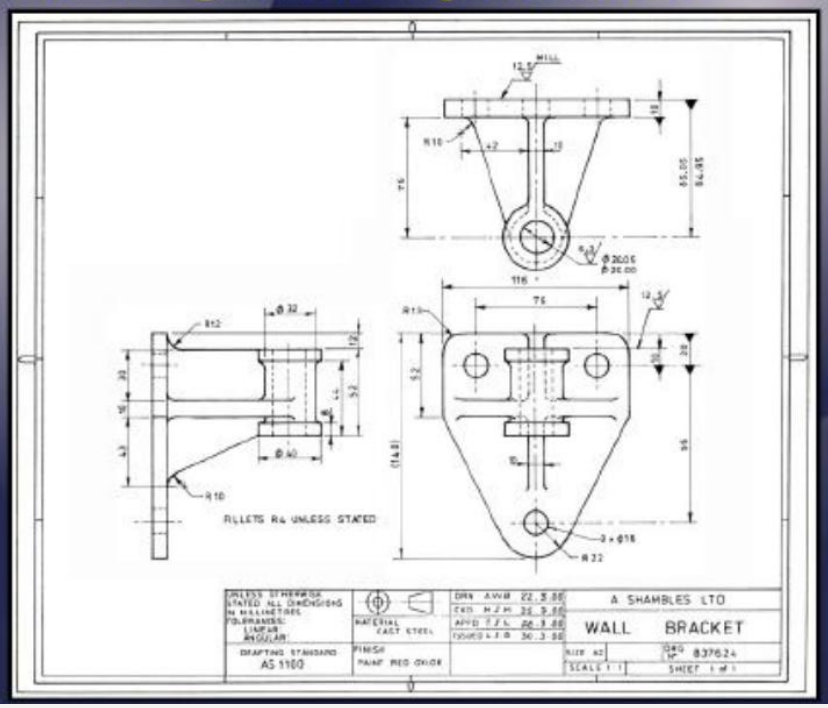
- The shape and standard of letters and numerals can be seen below:





Letters, Numerals and Lines

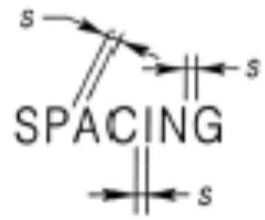
- Upper case letters should be used except for conventional refs. e.g. mm, kg, kPa
- Only one style of character should be used throughout a drawing
- Vertical characters should be used for titles, drawing and reference numbers
- Underlining of letters should be avoided
- All characters on a drawing should be kept clear of lines



Appropriate Letter Height for Sheet Sizes

USAGE (UPPER CASE ONLY)	CHARACTER HEIGHT (h), mm	
	SHEET SIZE	
	A0, B1	A1, A2, A3, A4, B2, B3, B4
Titles and drawing numbers	7	5
Subtitles, headings, view and section designations	5	3.5
General notes, material lists, dimensions	3.5	2.5

CORRECT



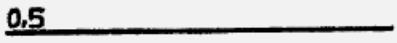
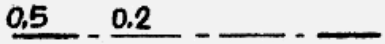
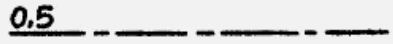
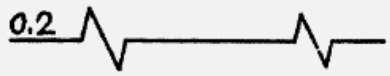
INCORRECT

Different Types of Lines

LINES

- There are various types of lines in Engineering drawing which are mentioned in the table.
- The selection of the line depends on the purpose / application.
- They are drawn in various thicknesses for identification and to avoid confusion.
- When a line is drawn thickness of the line should be uniform. Pencil leads are available in various hardness (LABELED 2B) which can be used for drawing a particular line Eg: Outlines 2H lead is preferable and construction lines H.

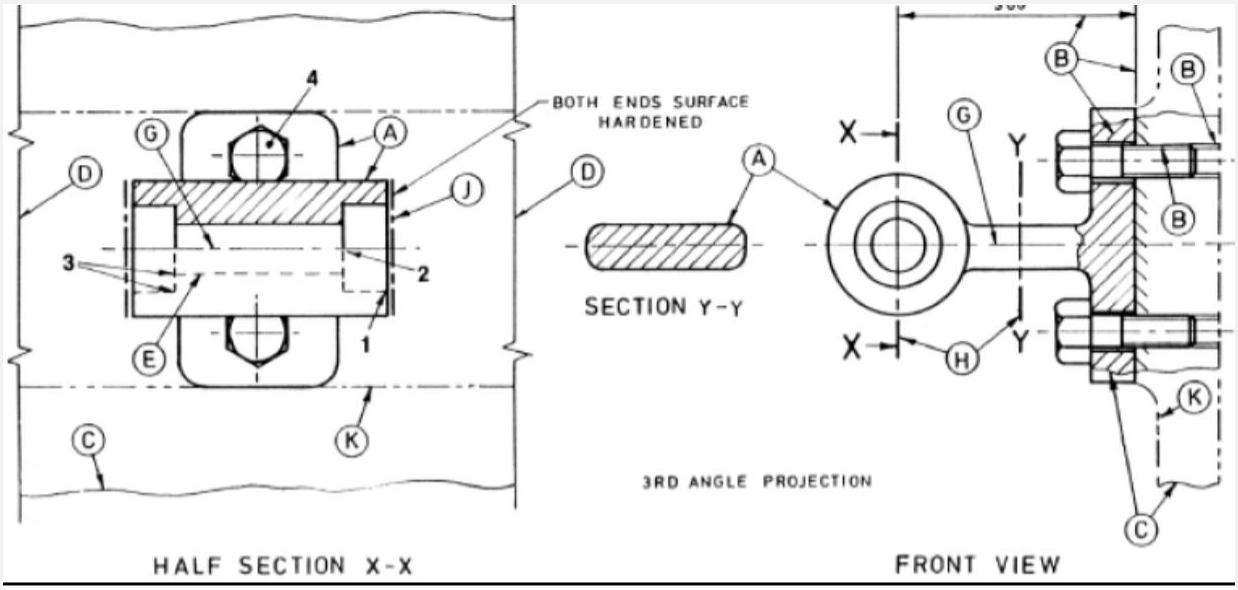
DIFFERENT TYPES OF **LINES ILLUSTRATION** AND THEIR **APPLICATION** IS SHOWN IN THE TABLE BELOW

A	Continuous thick		Visible outlines
B	Continuous thin		Dimension lines, leader lines, extension lines, construction lines, outlines of adjacent parts, hatching and revolved section.
C	Continuous thin - wavy		Irregular boundary lines, short break lines
D	Short dashes medium		Hidden outlines and edges
E	Long chain thin		Centre lines, locus lines, extreme positions of the moveable parts, parts situated in front of the cutting planes and pitch circles
F	Long chain thick at ends and thin elsewhere		Cutting plane lines
G	Long chain thick		To indicate surfaces which are to receive additional treatment
H	Ruled line and short zigzag thin		Long break lines

ADDITIONAL INFORMATION

TYPE	DESCRIPTION	DRAWING EXAMPLE	USAGE
A	continuous thick line		to indicate visible outlines
B	continuous thin line		for fictitious outlines, dimensions, projection, hatching and leader lines; also for the imaginary intersection of surfaces, revolved sections, adjacent parts, fold and tangent bend lines, short centre lines, and for indicating repeated detail
C	continuous thin freehand line		on part sectional boundary lines or to terminate a part view, and for short break lines
D	continuous thin ruled line with intermittent zigzag		to show a break on an adjacent member to which a component is attached; also to indicate a break in a long continuous series of lines on architectural or structural drawings
E	thin dashed line	s = 1 mm minimum q = 2s to 4s	to show outlines of hidden features: • for complete hidden features, the line should begin and end with a dash • dashes should meet at corners • where a hidden line is a continuation of a visible outline, it should commence with a space
F	medium dashed line	(proportions as for E)	in electrotechnology drawing only; for assemblies, boxes and other containers
G	thin chain line	s = 1 mm minimum q = 2s to 4s p = 3q to 10q	to indicate centre lines, pitch lines, path movement, developed views, material for removal and features in front of a cutting plane
H	chain line, thick at the ends and at change of direction but thin elsewhere	(proportions as for G)	to indicate a cutting plane for sectional views
J	thick chain line	(proportions as for G)	to indicate surfaces that must comply with certain requirements such as heat treatment or surface finish
K	thin double-dashed chain line	(proportions as for G)	to indicate adjacent parts, alternative and extreme positions of moving parts, centroidal lines and tooling profiles

DIFFERENT TYPES OF LINES USED IN VIRTUAL DRAWING



Appropriate Line Type and Thickness (mm)

SHEET SIZE	LINE TYPE AND THICKNESS (mm)									
	A	B	C	D	E	F	G	H	J	K
A0, B1	0.7	0.35	0.35	0.35	0.35	0.5	0.35	0.35 0.7	0.7	0.35
A1, A2, A3, A4, B2, B3, B4	0.5	0.25	0.25	0.25	0.25	0.35	0.25	0.25 0.5	0.5	0.25

SUMMERY	At the end of the class the student should have understood the the following : Standards of letter writing, Numerals, Lines and its application
EXERCISES	Make note of Details like letter writing, Numerals, Lines and its application
AUTHORS OF TEXT BOOKS	ND bhat and Gttc-manuals
TOOLROOM REF	From dwg file:Drg. No. : 11 - 16 –004 to Drg. No. : 11 - 16 - 007
WEB SITE	http://dlia.ir/Scientific/e_book/Technology/Mechanical_Drawing_Engineering_Graphics/052060.pdf SHEET FOLDING http://www.compuphase.com/electronics/folding.htm
OTHERS	Various size Sheet folding to be demonstrated and practiced
REMARKS	The whole Chapter should not be taught in one class. The teacher can be flexible.

Questions

Objective

1. Inclined letters lean towards ---------- at ---------- angle.
2. Represent long break line: ----------
3. The thickness of hidden line is ----------
4. The full form of B.I.S is ----------

Subjective

1. What does the bill of material consist of ?
2. State the application of hidden lines and centerlines thick at ends.
3. Write TOOL AND DIE MAKER in inclined letters (both capital and small)

UNIT 4: PROJECTIONS (2D)

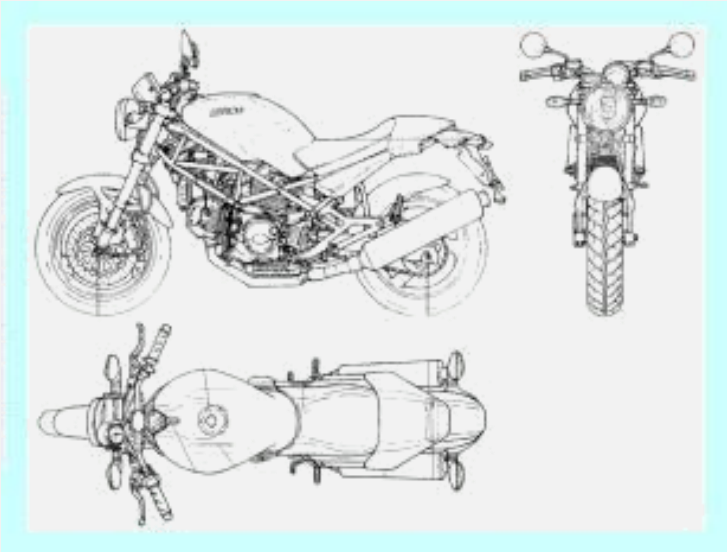
INTRODUCTION TO PROJECTIONS

You might have used Google map in your mobile how does it look? Can you tell which view is that? If you have taught its Top then it's correct. So you call it as Top view. We live in a house. Does it look the same from all the direction? "No" it looks different when you look from the Front, Side and Top. Stand exactly at the center in front of your house and draw the sketch of your house in a sheet of paper. The sketch you draw then is called the Front view.

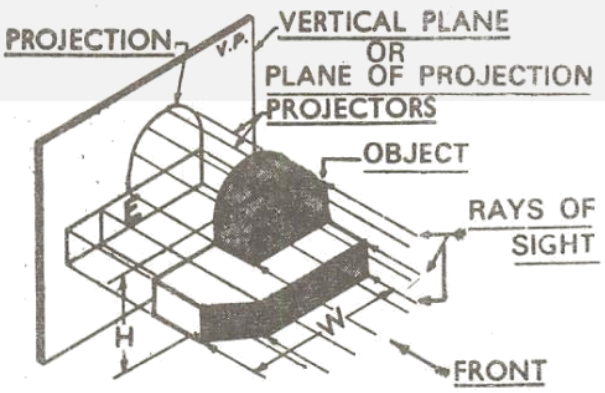
Now move to the left side of your house does this look the same, "NO "it's different e.g. you may find a stair case or something else. This is called Side view do you agree.

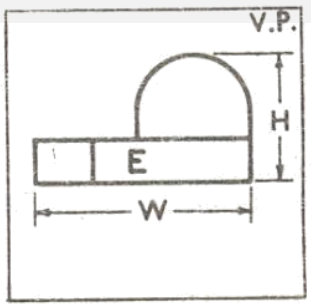
Like this you may need many views to describe the shape, size and Layout of your house. Placing the former (earlier) mentioned views in a systematic manner with the proper measurement and with a proper layout itself is called projection which will be explained in detail under principle of projection.

An example of a motorbike where it describes the views from Top, Front and Side is given for reference.



PRINCIPLE OF PROJECTION:





Refer sketch to understand the below mentioned points)

- If straight lines are drawn from various points on the contour of an object to meet a plane, the object is said to be projected on that plane.
- The figure formed by joining, in correct sequence, the points at which these lines meet the plane is called projection of that object also called view
- The lines from the object to the plane are called projectors
- The plane on which the projectors meet is called the plane of projection.

NOTE: START WITH SIMPLE EXERCISES

1. **MISSING LINES**

2. **MISSING VIEWS**

FOR EXERCISES REFER GTTC ENIGINEERING DRAWING FILE AND ENGG DRAWING BY ND BHAT

SUMMERY	At the end of the class the student should have understood the principle of projection and be able to draw the views (Top, Front & Side view)
EXERCISES	MISSING LINES(ND. BHAT) AND MISSING VIEWS (ENGG DRAWING FILE)
AUTHORS OF TEXT BOOKS	ND.BHAT
TOOL ROOM REF	DWG FILE From**Drg. No. : 11 - 16 – 008 to Drg. No. : 11 - 16 - 015**
WEB SITE/link	http://dlia.ir/Scientific/e_book/Technology/Mechanical_Drawing_Engineering_Graphics/052060.pdf
OTHERS	http://www.kuet.ac.bd/webportal/ppmv2/uploads/1386659781Mechanic al%20Engineering%20Drawing%20(ME%201200).pdf
REMARKS	➢ Explain them with example. Eg 1: Draw how the student looks like from front, Shape of his eyes can be shown when you draw his front view. Shape of Ears and Nose when viewed from side (SIDE VIEW). Eg 2 : Rough sketch of tool room as it looks from front and side.Etc ➢ Now start with simple exercise if not able to grasp assist him with models. Do not teach WHAT IS FIRST ANGLE PROJECTION AND THIRD ANGLE PROJECTION now until he completes 6 to 8 exercises using models. **NOTE**: **Follow First angle projection to place the views though its not taught at this stage.**

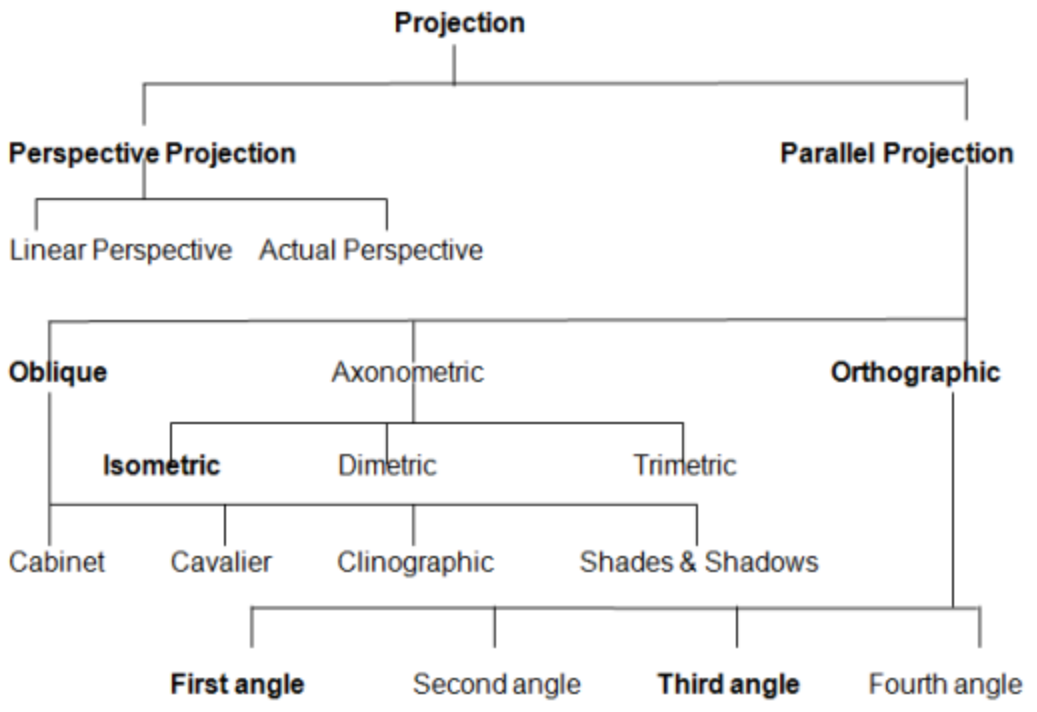
METHODS OF PROJECTION

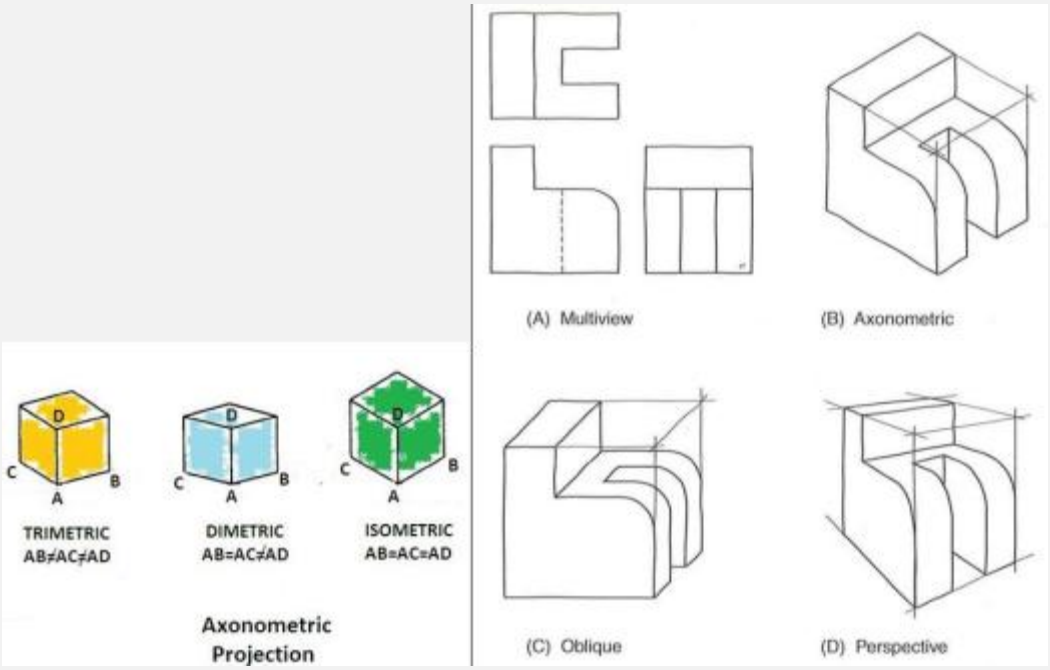
In Engineering drawing following four methods of projection are commonly used they are:

1) **Orthographic Projection**
2) **Isometric Projection**
3) **Oblique Projection**
4) **Perspective Projection**

In the above methods 2,3,4 represent the object by pictorial view as eyes see it which are three dimensional represented by one view only (have you seen a 3D Movie) lets now concentrate on orthographic projection but have only a general knowledge of Isometric.

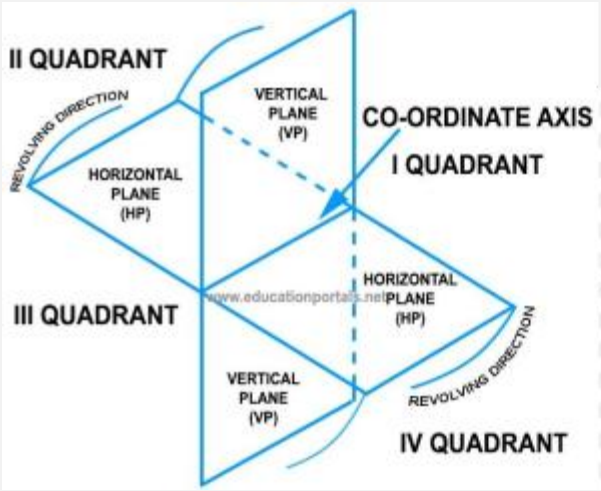
NOTE: Teachers just highlight about isometric it will be dealt in detail after orthographic projection.

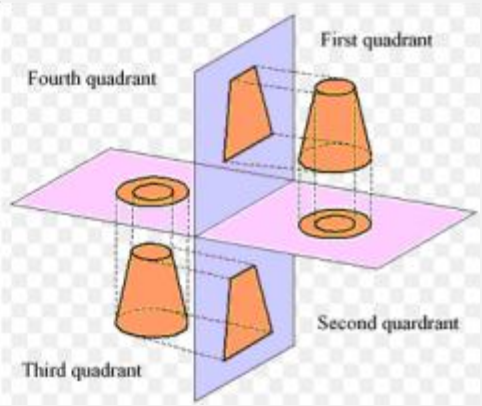




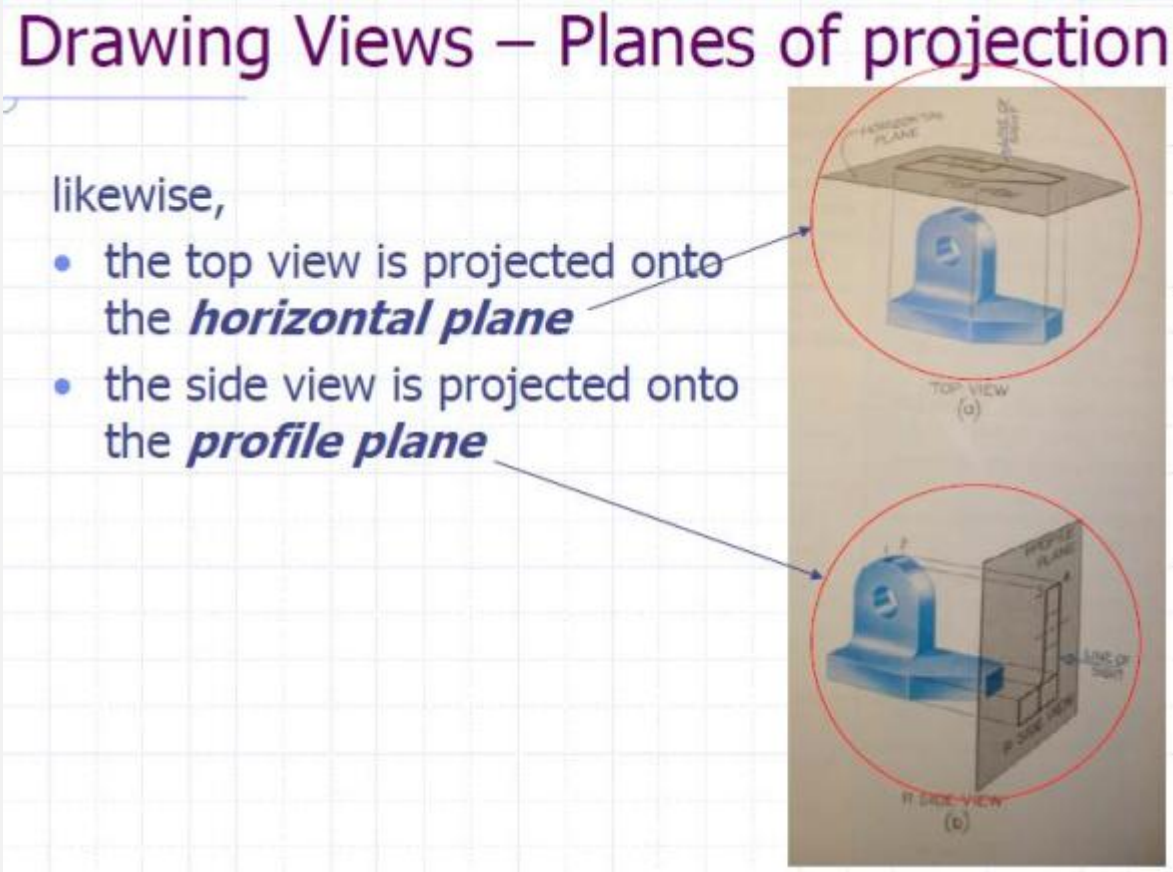
ORTHOGRAPHIC PROJECTION(2D PROJECTION)

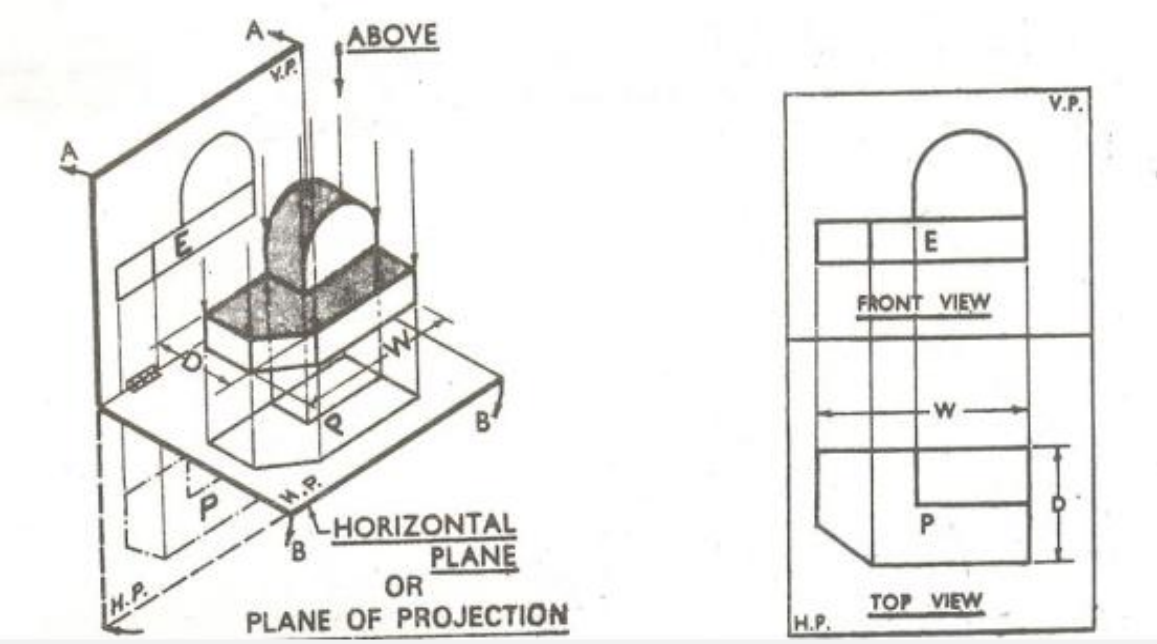
- To understand what orthographic projection is we need to know regarding reference planes or principal plane of projection.
- There are two principal planes HORIZONTAL PLANE and VERTICAL PLANE which meet each other at the center at right angle. These planes are imaginary planes.

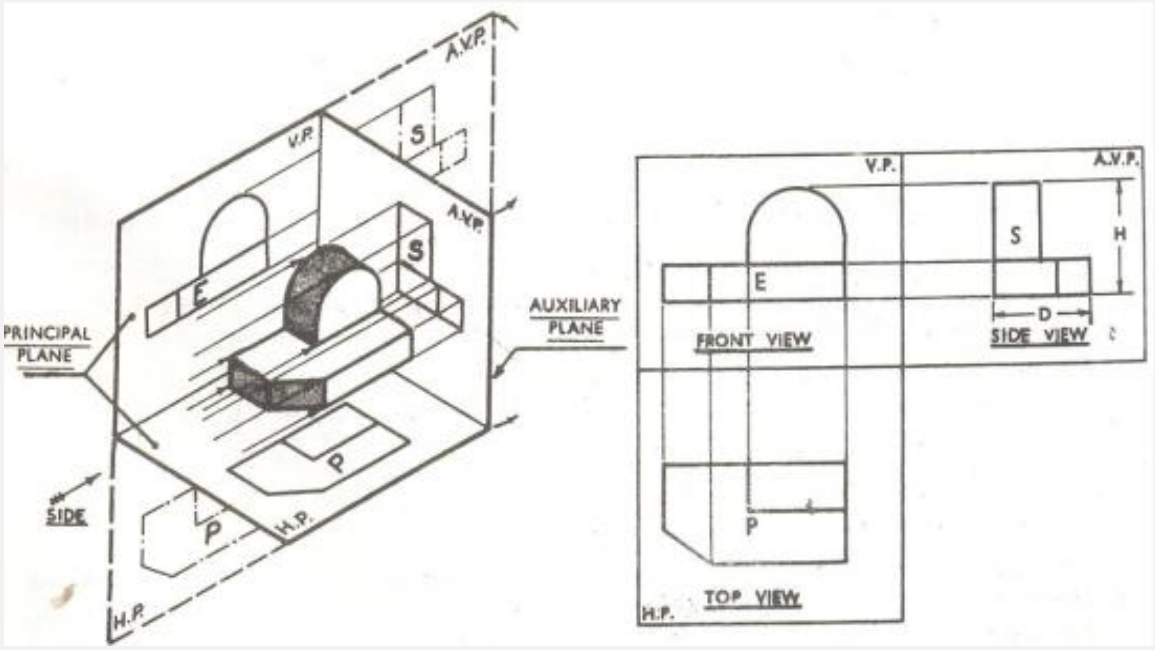




- The projection on the vertical plane is called the **FRONT VIEW** which is also called as **elevation.**
- The projection on the horizontal plane is called the **TOP VIEW** or **Plan view**.
- These two views sometimes are not sufficient to describe an object completely. An Additional VERTICAL PLANE **(Marked A.V.P Auxiliary vertical plane)** which is also imaginary is placed at right angles to the principal planes (H.P & V.P). The projection of this plane is mentioned as **S**. It is the view from the side surface and hence called **SIDE VIEW** or **profile views**.







TYPES OF PROJECTION:

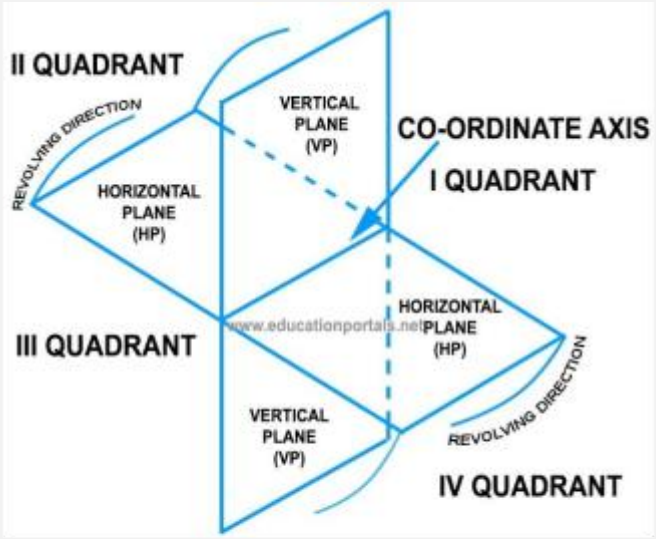
In orthographic views there are two angles of projection.

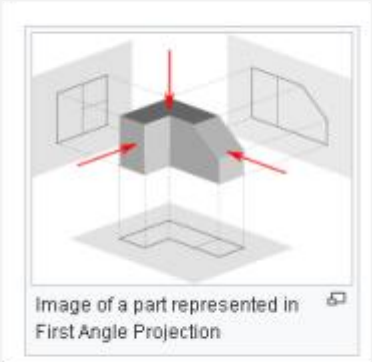
1) First angle projection
2) Third angle projection.

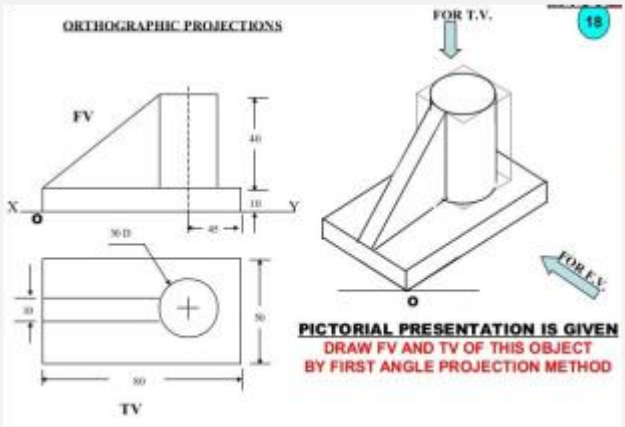
There are **three important elements** of these projections.
They are:

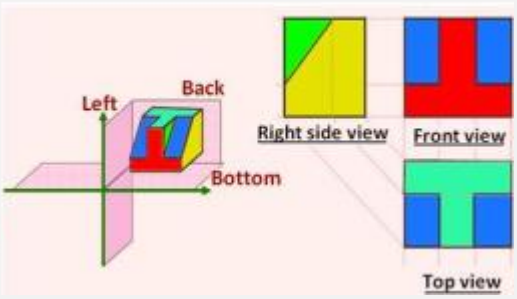
i) An object **ii)** Plane of projection i i i **)** Observer

FIRST ANGLE PROJECTION:





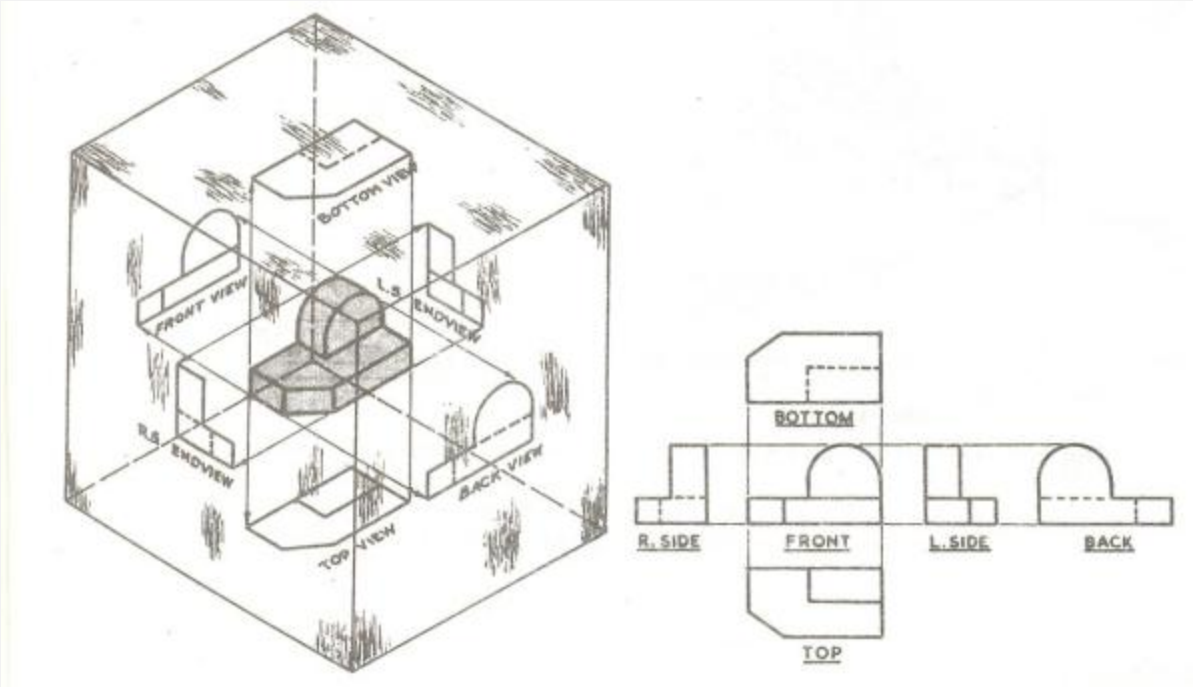


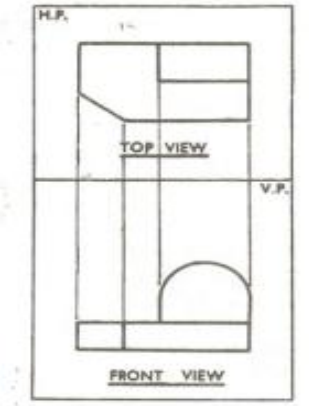


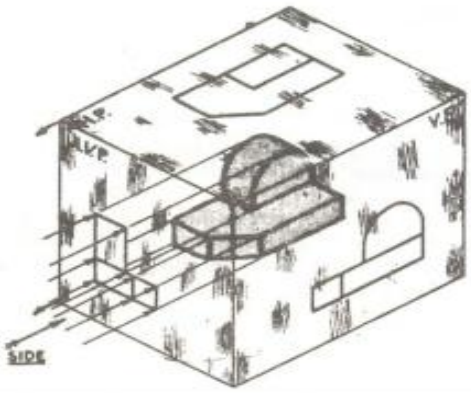
- If the space is divided by the two principal planes of projection and extended beyond the point of meeting there exist 4 quadrants.
- The right side top being 1^{st} quadrant, left side top is 2^{nd} quadrant, bottom left is 3^{rd} quadrant and bottom right is 4^{th} quadrant in other words below 1^{st} quadrant is 4^{th} quadrant and below 2^{nd} lies the 3^{rd} quadrant.
- In first angle projection the object is placed in the 1^{st} quadrant i.e. Assuming that the object is placed in front of the vertical plane and

above the horizontal plane and then projected on these planes.

Now the object lies in between the Observer and the plane of projection. When the views are drawn in their relative position the top view comes below the front view the view of the object as seen from the left side is placed to the right side of the front view and vice versa.(ref sketch).in the same manner bottom and back / rear views are placed.







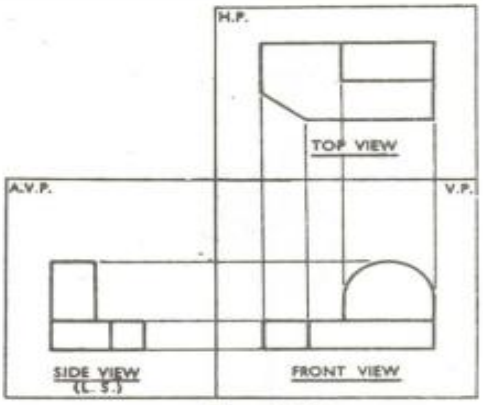


FIG. 1-13

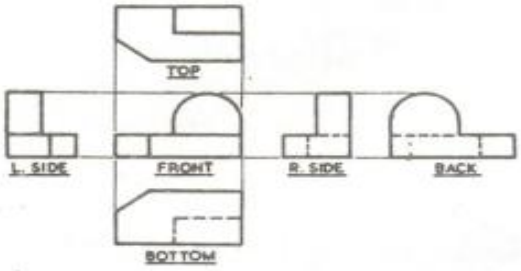


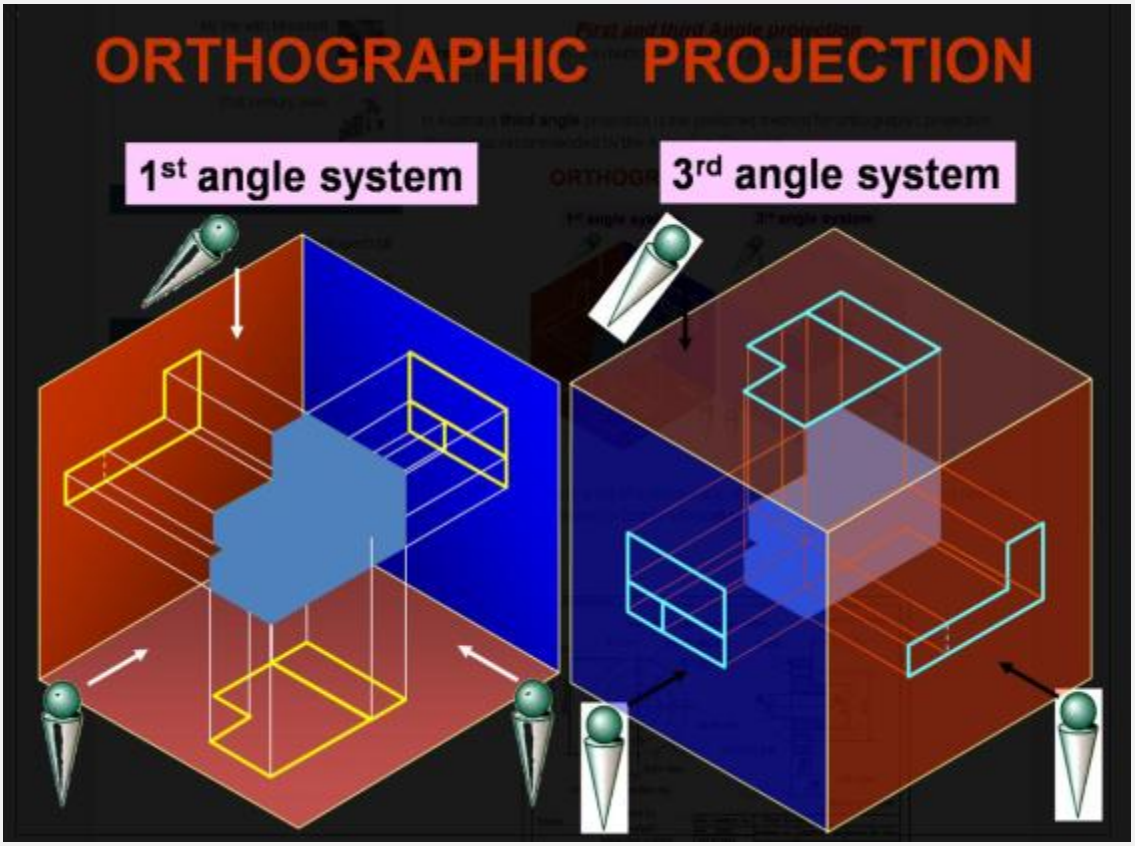
FIG. 1-14

The three views obtained after the planes are rotated and brought in line with the V.P. are shown in fig. 1-13. The left-side view of the object is placed on the left side of the front view. Fig. 1-14 shows all the six views obtained by the method of third-angle projection. Careful study of the views will show that each projection

DIFERENCE BETWEEN FIRST ANGLE PROJECTION AND THIRD ANGLE PROJECTION

SLNO	First angle projection	Third angle projection
1	The object is kept in the first quadrant	The object is kept in the third quadrant
2	The object lies between the observer and the plane of	The plane of projection lies between the observer and the object
3	The plane of projection is assumed to be non - transperant	The plane of projection is assumed to be transperant
4	In this method when the views are drawn in their relative positions the top view comes below the front view. The view of the object as	In this method when the views are drawn in their relative positions the top view comes above the front view. The view of the object as seen from the left side is

	from the left side of front view is drawn on the right side of the front view	drawn on the left side itself and vice versa.
5	Recommended by B.I.S (Bureau of Indian Standard)	Used in countries like USA



NOTE: There is a step in the component don't get confused as angle (GREY COMPONENT)

HOW TO DRAW ORTHOGRAPHIC VIEWS:

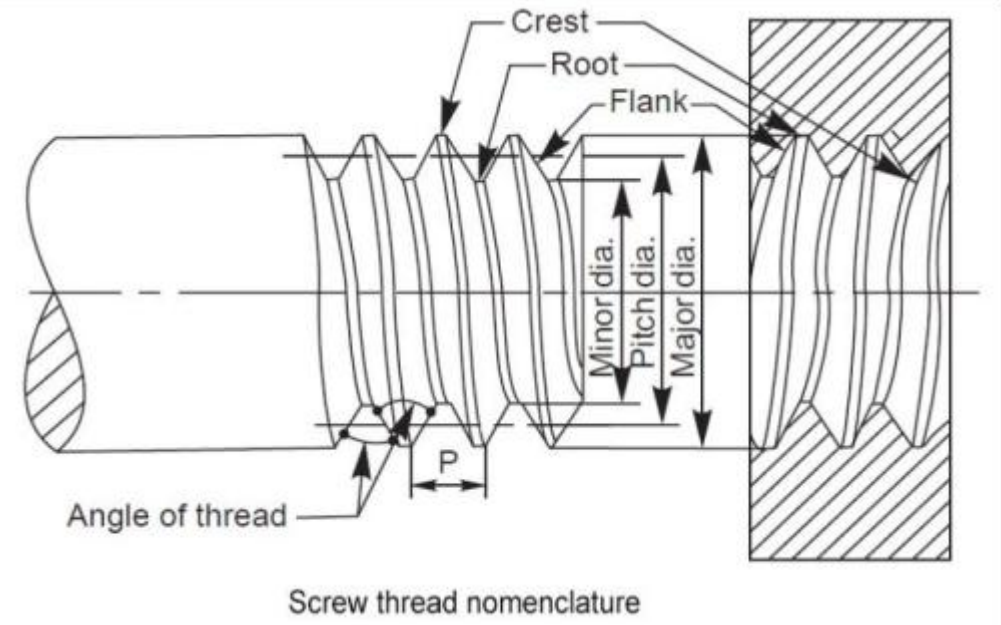
- It is easy to prepare a drawing from an actual object. The object is carefully examined and then placed in a suitable position for the front view. The front view of the object should be selected in such a way that the maximum details of the object are visible so that hidden lines are minimized.
- All the necessary views are then sketched free hand in a sketch book or a pad.
- Measurements of all its details and overall sizes are taken and inserted in the

views.

- Finally a scale-drawing is prepared from these sketches.

REPRESENTATION OF THREADS IN ORTHOGRAPHIC PROJECTION

The true projection of a threaded portion of a part consists of a series of helices and it takes considerable time to draw them. Hence it is the usual practice to follow some conventional methods to represent screw threads. Screw thread nomenclature figure below shows the true projection of a screw thread, whereas the conventional representation of external and internal threads as recommended by BIS is shown in Conventional representation of threads figure below.



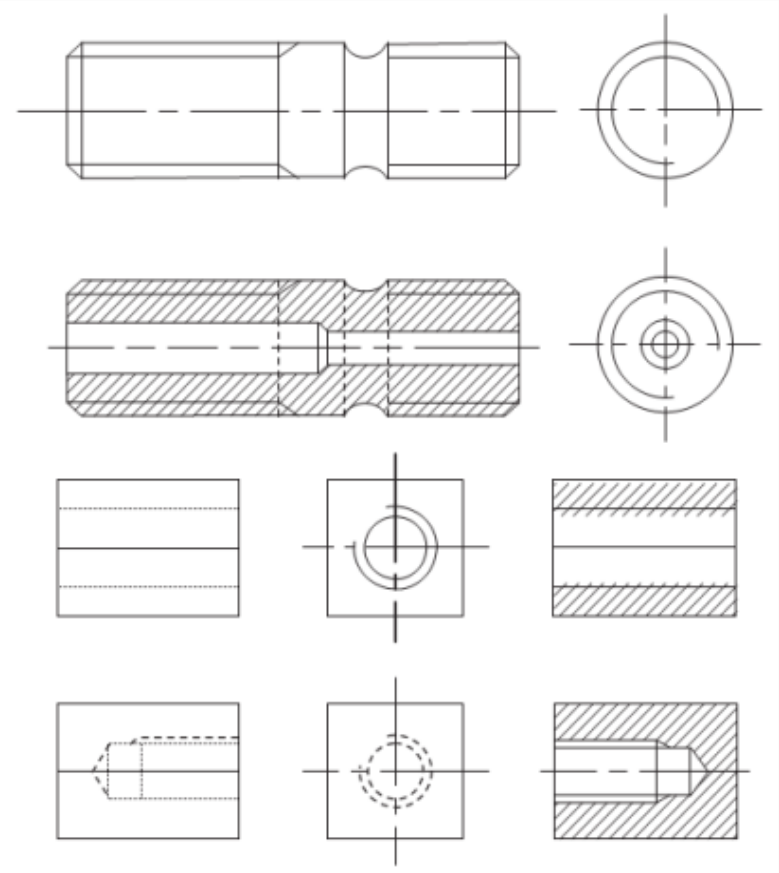
Screw thread nomenclature

It may be noted from Conventional representation of threads figure below, that the crests of threads are indicated by a continuous thick line and the roots, by a continuous thin line. For hidden screw threads, the crests and roots are indicated by dotted lines. For threaded parts in section, hatching should be extended to the line defining the crest of the thread. In the view from side, the threaded roots are represented by a portion of a circle, drawn with a continuous thin line, of length approximately three-quarters of the circumference.

The limit of useful length of screw threads is represented by a continuous thick

line or a dotted line, depending on its visibility. The length upto which the incomplete threads are formed beyond the useful limit, is known as a run-out. It is represented by two inclined lines.

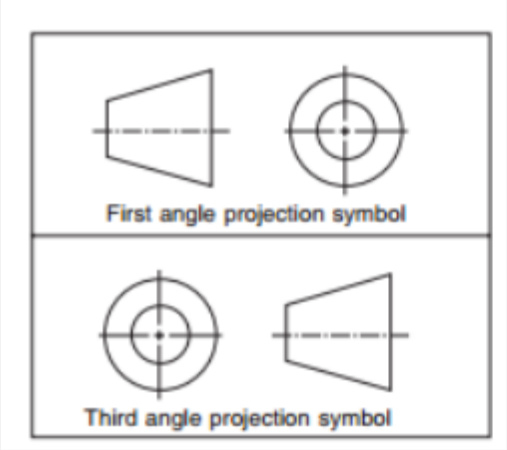
The simplified representation, though it saves time, is not an effective method to convey thread forms. The schematic representation, used for the purpose is shown in Schematic representation of threaded parts–V-threads figure below. In practice, the schematic representation is followed for only visible threads, *i.e.*, for external threads and internal threads in section. From the below figure, it may be observed that the crest diameters, both in external and internal threads, are drawn by thick lines. Further, the crests are represented by thin lines, extending upto the major diameter and the roots by thick lines, extending upto the minor diameter, these lines being drawn inclined with a slope equal to half the pitch.

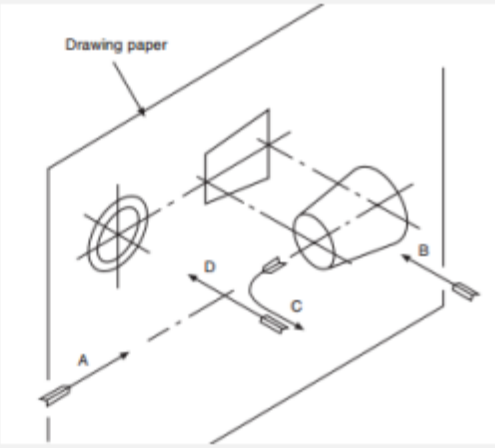


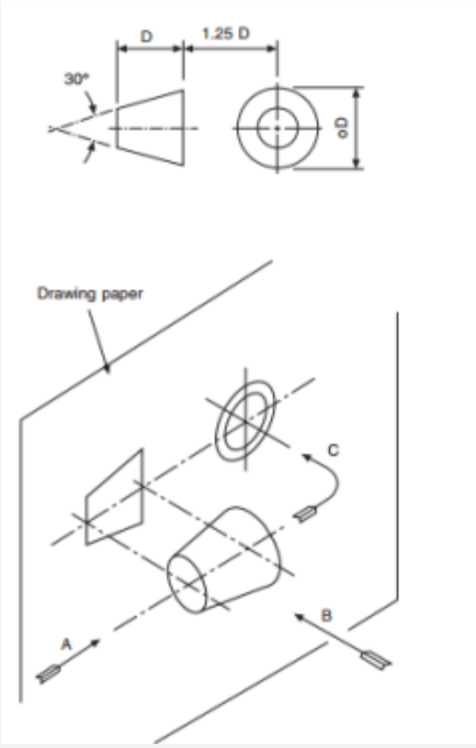
Conventional representation of threads

SYMBOL FOR THE METHODS OF PROJECTION:

For every drawing it is essential to indicate the method of projection adopted. This is done by means of a symbolic figure drawn within the title block as shown in fig. These symbolic figures are actually the projections of a frustum of a cone of convenient dimensions according to the size of the drawing







QUESTIONS

OBJECTIVE

1. ---------- is the symbol that represents 3rd angle projection.
2. In first angle projection the object is placed in the ---------- quadrant.
3. The plane on which the projectors meet is called ----------
4. In first angle projection the R.S.V is drawn on the ---------- side of front view.
5. In third angle projection the plane of projection lies between the observer and the object

SUBJECTIVE

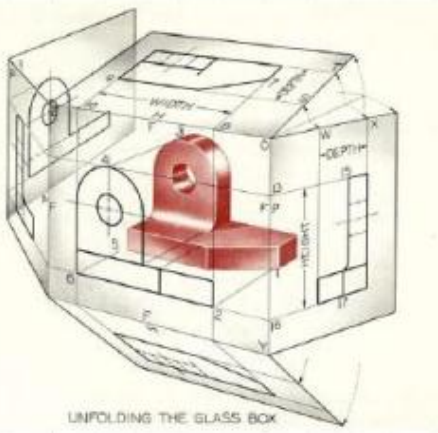
1 . Differentiate between first angle and third angle projection.
2. Show the symbolic representation of first angle and third angle projection?
3. Explain the conventional representation of external and internal threads with sketch.
4. Drawing file exercises.

ADDITIONAL NOTES IF NEEDED TO UNDERSTAND PROJECTIONS

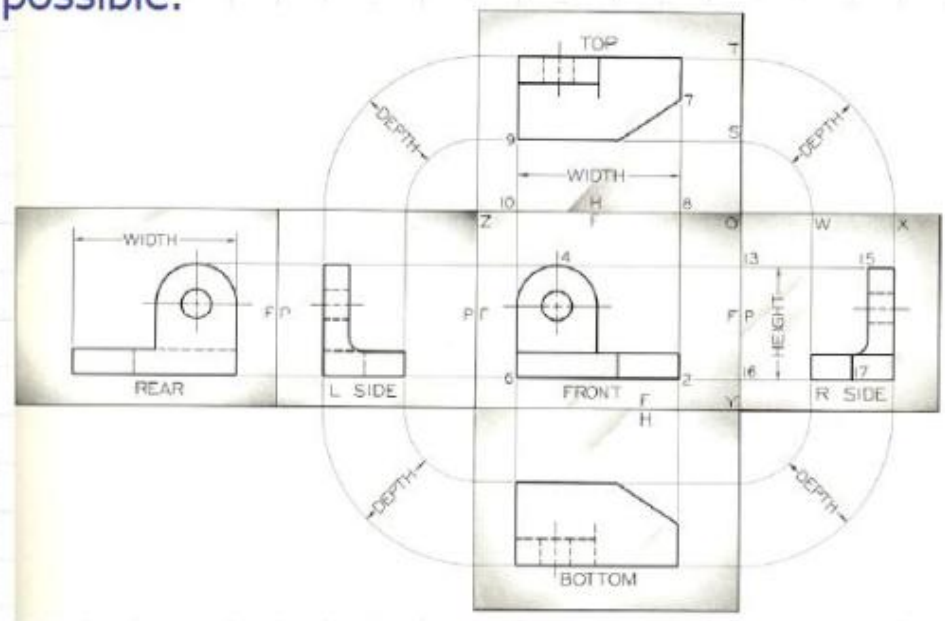
More details to understand the concept of projections. an example of third angle is given (**Multi view projection – The Glass Box**).

Multiview Projection – The Glass Box

- Placing parallel planes to the principal planes forms a *glass box* (always observed from outside the box)
- To show views of a 3D object on a 2D piece of paper, it is necessary to unfold the planes such that they lie in the same plane
- All planes except the rear plane are hinged to the frontal plane, which is hinged to the left-side plane



- By unfolding the box, six views of the object are possible.



Example:

ORTHOGRAPHIC VIEWS OF CYLINDRICAL COMPONENTS REFER:
GTTC Drg. No. :11 - 16 - 022 to 11 - 16 – 026

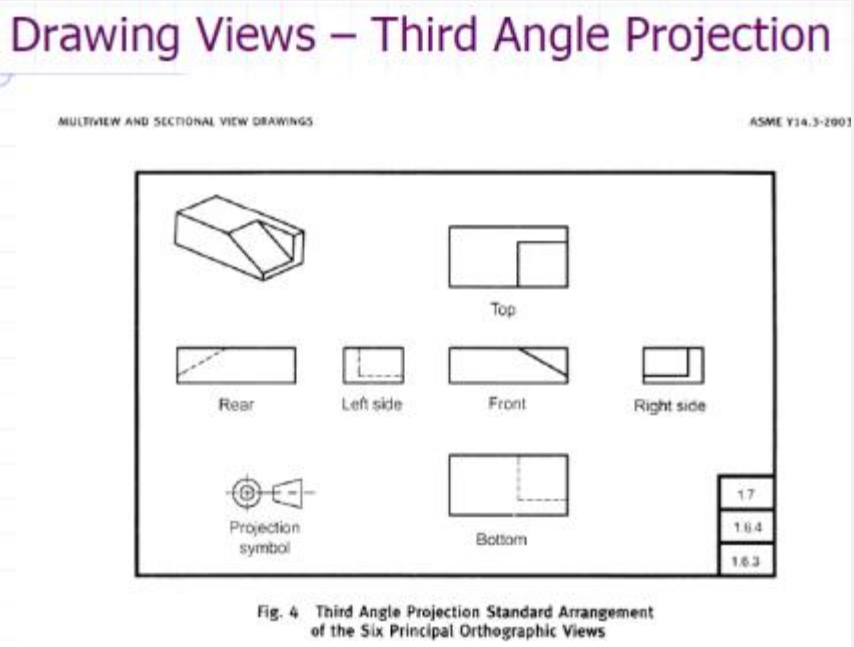


Fig. 4 Third Angle Projection Standard Arrangement of the Six Principal Orthographic Views

SUMMERY	At the end of the class the student should have understood orthographic projection and its types and be able to draw the views in first angle projection. They should also be in a position to distinguish the difference between 1st angle and 3rd angle
EXERCISES	Prepare notes from details
AUTHORS OF TEXT BOOKS	ND BHAT
TOOLROOM REF	DWG FILE **Drg No : 11- 16- 016 to** **Drg N. o. :11- 16- 026** **ORTHOGRAPHIC VIEWS OF CYLINDRICAL COMPONENTS** **REFER: GTTC Drg. No. :11 - 16 - 022 to 11 - 16 - 026**
WEB SITE	http://www.technologystudent.com/prddes1/orthogrp1.html **Attached some informative notes from the site at the end of chapter**
OTHERS	PRACTICE GTTC FILE **Drg. No. : 11 - 16 – 030 DRAW THE THREE VIEWS OF THE COMPONENT AND DIMENSIONING THE SAME TO BE DONE AFTER COMPLETION OF DIMENSIONING CHAPTER.(i.eDrg. No. : 11 - 16 – 030)**
REMARKS	➢ Start with missing lines and the next step with missing views and finally the trainee should be in a position to draw orthographic views from the given isometric views with little or without any assistance. At this stage more concentration to be given on weak students. ➢ **Additional exercises from referance book to be given after complition of exercises in engg dwg file supplied** ➢ ORTOGRAPHIC VIEW EXERCISES**Continued**AFTER COMPLITION OF DIMENSIONING CHAPTER- 4 (**Orthographic views with dimensioning)** **Teachers may use a transparent cubical box to explain methods of orthographic projection**

Multiview Projection – Proper number Views

- It may not, be necessary to show all six views to completely describe the object.
- In fact, the minimum number of views is preferable.
- How many views are necessary to completely describe this plate?
- 1?
- 2?
- 3?
- 4?

ADDITIONAL NOTES FOR REFERENCE

Multiple views and projections [edit]

Main article: Graphical projection

In most cases, a single view is not sufficient to show all necessary features, and several views are used. Types of views include the following:

Orthographic projection [edit]

The orthographic projection shows the object as it looks from the front, right, left, top, bottom, or back, and are typically positioned relative to each other according to the rules of either first-angle or third-angle projection. The origin and vector direction of the projectors (also called projection lines) differs, as explained below.

- In **first-angle projection, the projectors originate as if radiated *from a viewer's eyeballs* and shoot *through* the 3D object to project a 2D image onto the plane *behind* it.** The 3D object is projected into 2D "paper" space as if you were looking at a radiograph of the object: the top view is under the front view, the right view is at the left of the front view. First-angle projection is the ISO standard and is primarily used in Europe.

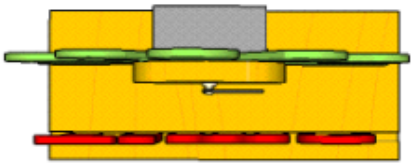
THE DESIGNER AND ORTHOGRAPHIC DRAWING

V. Ryan © 2010

An orthographic drawing, sometimes called a working drawing, is usually the last drawing produced by a designer. It normally has three accurate views of a product, a front view, side view and plan view. Dimensions (measurements) are also drawn on each view, ensuring the manufacturer can make the product to the precise size and the designers requirements. A parts list is also included. This has the precise measurements for every part of the product and includes details such as materials and finish.

A working drawing is required if manufacturing is to take place

PLAN ELEVATION



The working drawing seen below is for a clock. It has been drawn in a system called Third Angle Orthographic Projection, a world standard for this type of presentation.

It should be possible for a designer based in the UK, to draw an working drawing of a product and for it to be manufactured in another country, by using only the orthographic drawing. This is called 'Remote Manufacture'. The orthographic drawing should be accurate and include all the information required for manufacturing. Designers often use this process for the design and manufacture of products.

THE DESIGNER AND ORTHOGRAPHIC DRAWING

V. Ryan © 2010

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FRONT ELEVATION

The working drawing seen below is for a clock. It has been drawn in a system called Third Angle Orthographic Projection, a world standard for this type of presentation.

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THE DESIGNER AND ORTHOGRAPHIC DRAWING

V. Ryan © 2010

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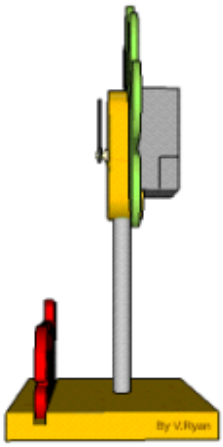
A working drawing is required if manufacturing is to take place

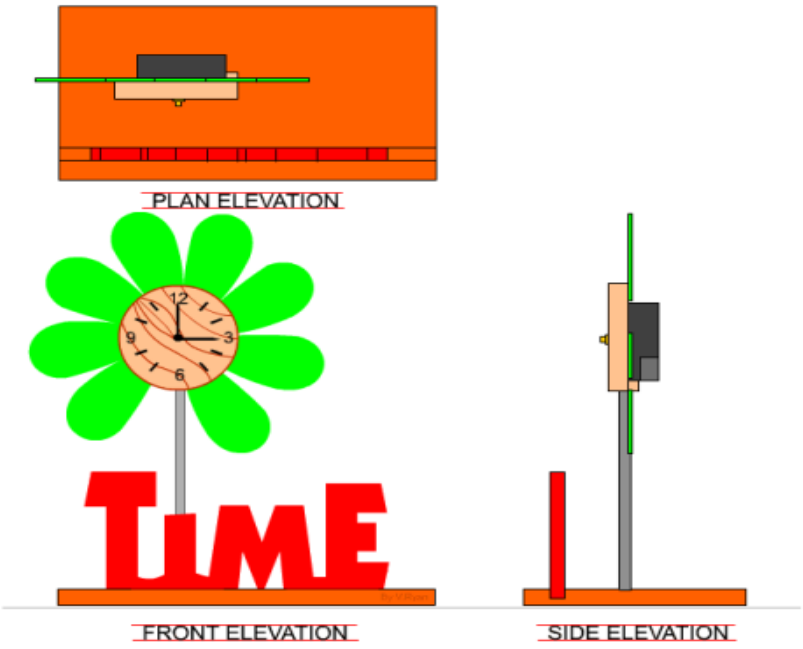
SIDE ELEVATION



The working drawing seen below is for a clock. It has been drawn in a system called Third Angle Orthographic Projection, a world standard for this type of presentation.

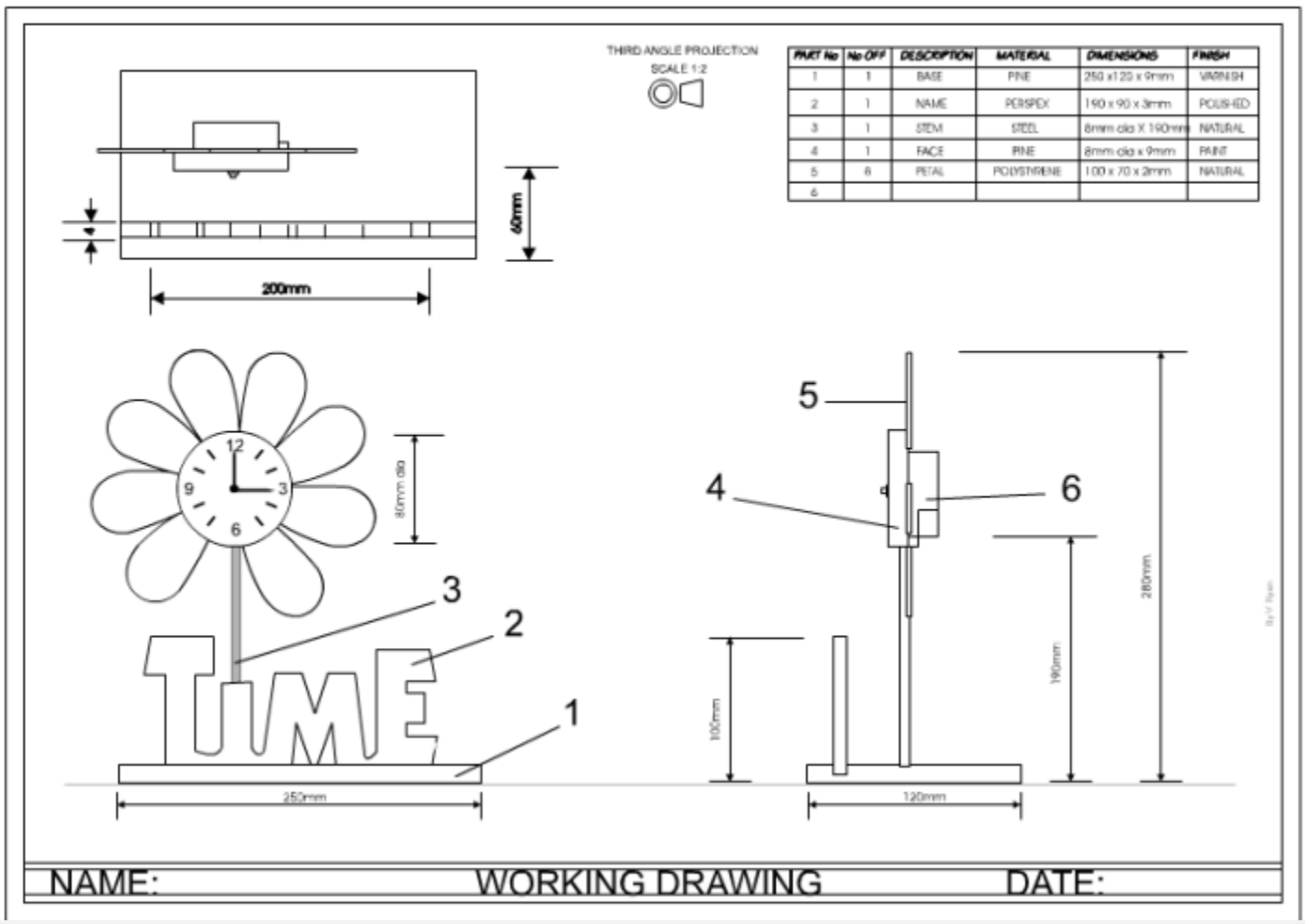
It should be possible for a designer based in the UK, to draw an working drawing of a product and for it to be manufactured in another country, by using only the orthographic drawing. This is called 'Remote Manufacture'. The orthographic drawing should be accurate and include all the information required for manufacturing. Designers often use this process for the design and manufacture of products.

THIRD ANGLE ORTHOGRAPHIC DRAWING - ANIMATION



ORTHOGRAPHIC DRAWING - HOW IT IS PRESENTED TO A MANUFACTURER

ORTHOGRAPHIC DRAWING - HOW IT IS PRESENTED TO A MANUFACTURER



PART No	No OFF	DESCRIPTION	MATERIAL	DIMENSIONS	FINISH
1	1	BASE	PINE	250 x 120 x 9mm	VARNISH
2	1	NAME	PERSPEX	190 x 90 x 3mm	POLISHED
3	1	STEM	STEEL	8mm dia X 190mm	NATURAL
4	1	FACE	PINE	80mm dia x 9mm	PAINT
5	6	PETAL	POLYSTYRENE	100 x 70 x 3mm	NATURAL
6					

Designers often use remote manufacturing, in an attempt to keep costs low. Designers also produce working drawings so that prototypes can be manufactured, and then tested. This leads to improvements being made to the product. Working drawings are usually produced using CAD, although skilled designers still draw them be hand, at least in the early stage of the designing process. Designers find sketching in orthographic projection very useful.

Information found on a working drawing / orthographic drawing:

All necessary views required for manufacturing.
All the necessary measurements (called dimensions).
A standard format for working drawings.
A parts list which includes all the information needed to make each part of the product.

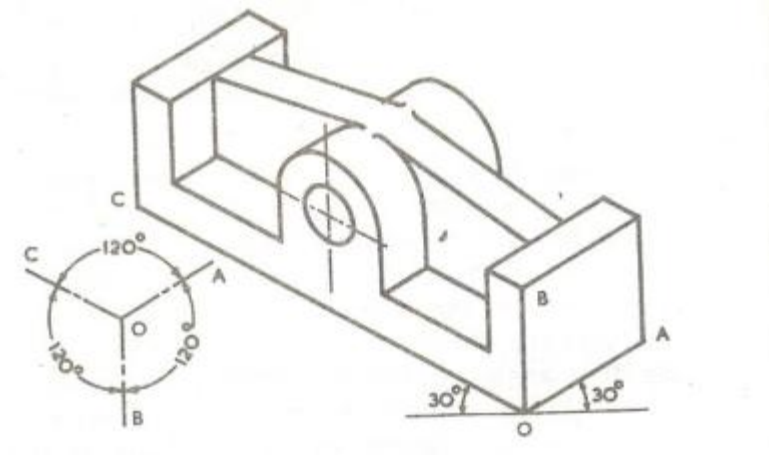
UNIT 4: PROJECTIONS (3D)

ISOMETRIC VIEW / PROJECTION

INTRODUCTION:

You might have seen the sketch of houses drawn by Architect which are three dimensional. You can see the front face as well as the side portion of the house but the rare portion, not to be seen.

In this method of projection the object is represented by a pictorial view as we see through our naked eye. Here the object is represented 3 Dimensionally with only one view. The disadvantage of this projection is that hidden profiles at the rare side, blind holes/ profiles cannot be shown in one view. In orthographic projection the object was represented with two or more views where each view represents two dimensions of the object.



METHOD OF DRAWING ISOMETRIC PROJECTION:

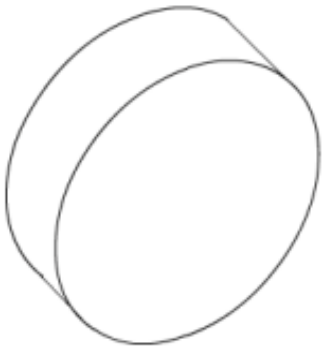
- In isometric projection, the three edges of a solid right angle of an object are shown by means of three lines, drawn from a point and parallel to the three isometric axis which meet at a point to make an

angle of 120 degree with each other as shown in the sketch. The vertical edge of the solid right angle is shown by a vertical line, while the two horizontal edges are shown by two lines inclined at 30 degree to the horizontal.

- The rectangles are drawn as parallelograms having sides parallel to two of the three axis and having included angles of 60 degree and 120 degree. Thus in an isometric view a right angle is shown by a 60 degree and 120 degree angle and circles are shown as ellipses.
- Irregular figures and curves are drawn by enclosing them within rectangles. The actual size of the object is reduced by approximately 82% in Isometric projection.

ISOMETRIC VIEW OF CIRCLE AND PRODUCING A CYLINDER:

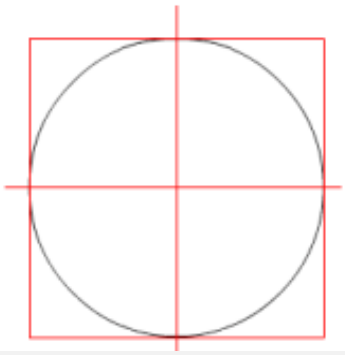
- The circle looks like an ellipse when viewed at an angle. The method of drawing is shown below. (http://www.technologystudent.com/designpro/isomet2.htm)



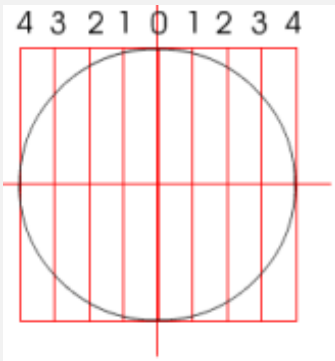
A CYLINDER DRAWN IN ISOMETRIC PROJECTION

Drawing a basic isometric shape such as cube can be difficult the first time you attempt to draw it using a T-Square and 30 degree Set Square. However, after a few attempts the technique for drawing them can be mastered quite easily. On the other hand - isometric circles and cylinders are more difficult and drawing them requires practice.

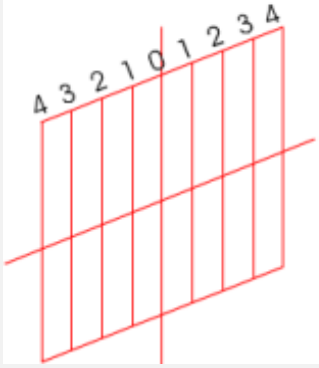
The sequence for drawing both is shown below:



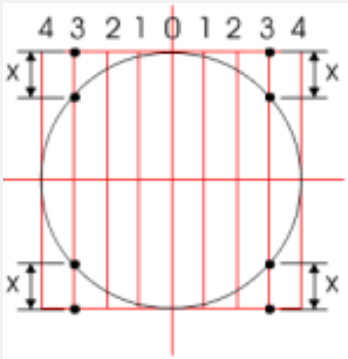
1. Draw the original circle with a compass and enclose it in a box. Add vertical and horizontal guidelines

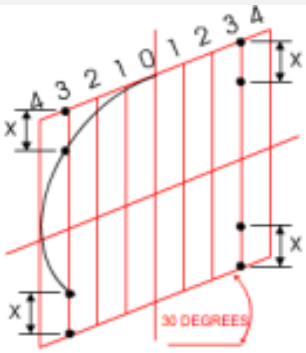


2. Number the vertical lines (these are called 'ordinate lines') as shown on the diagram opposite.

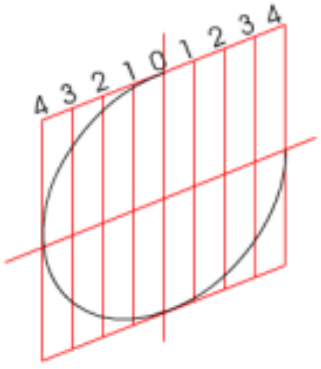


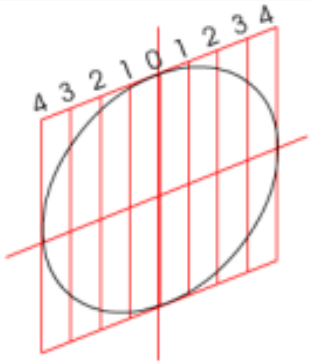
3. Draw the grid in *isometric* using a 30 degree set square, being careful to use the same measurements as the original grid which surrounds the circle.





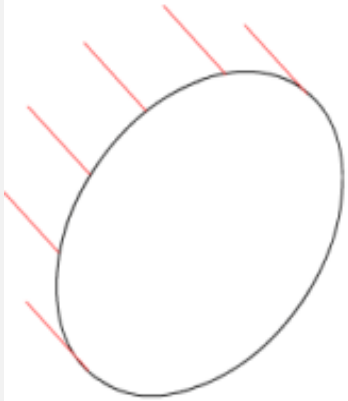
4. To draw the circle in isometric projection simply measure each distance down each vertical line on the normal grid and transfer it to the isometric grid. On the diagrams opposite - distance 'x' on guideline 3 has been transferred to the isometric grid. This is repeated for each of the guidelines 1,2, and 4.





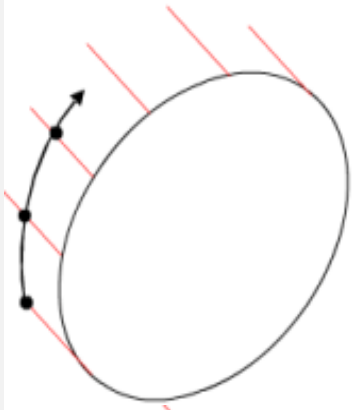
5. Continue around the isometric circle 'plotting' transferring distances from the original grid to the isometric grid - until the circle is complete.

PRODUCING A CYLINDER SHAPE IN ISOMETRIC

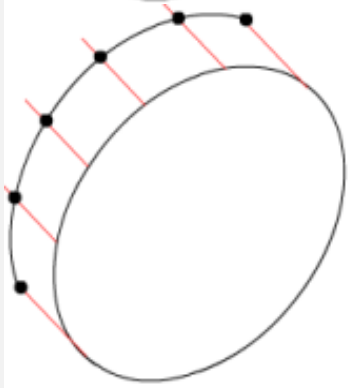


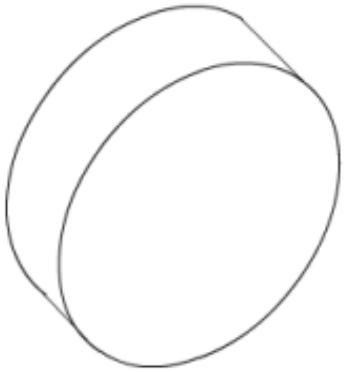
6. Having successfully drawn the isometric circle developing it further to change it into a cylinder is relatively easy.

Draw 30 degree guidelines out from the isometric circle as shown in the diagram

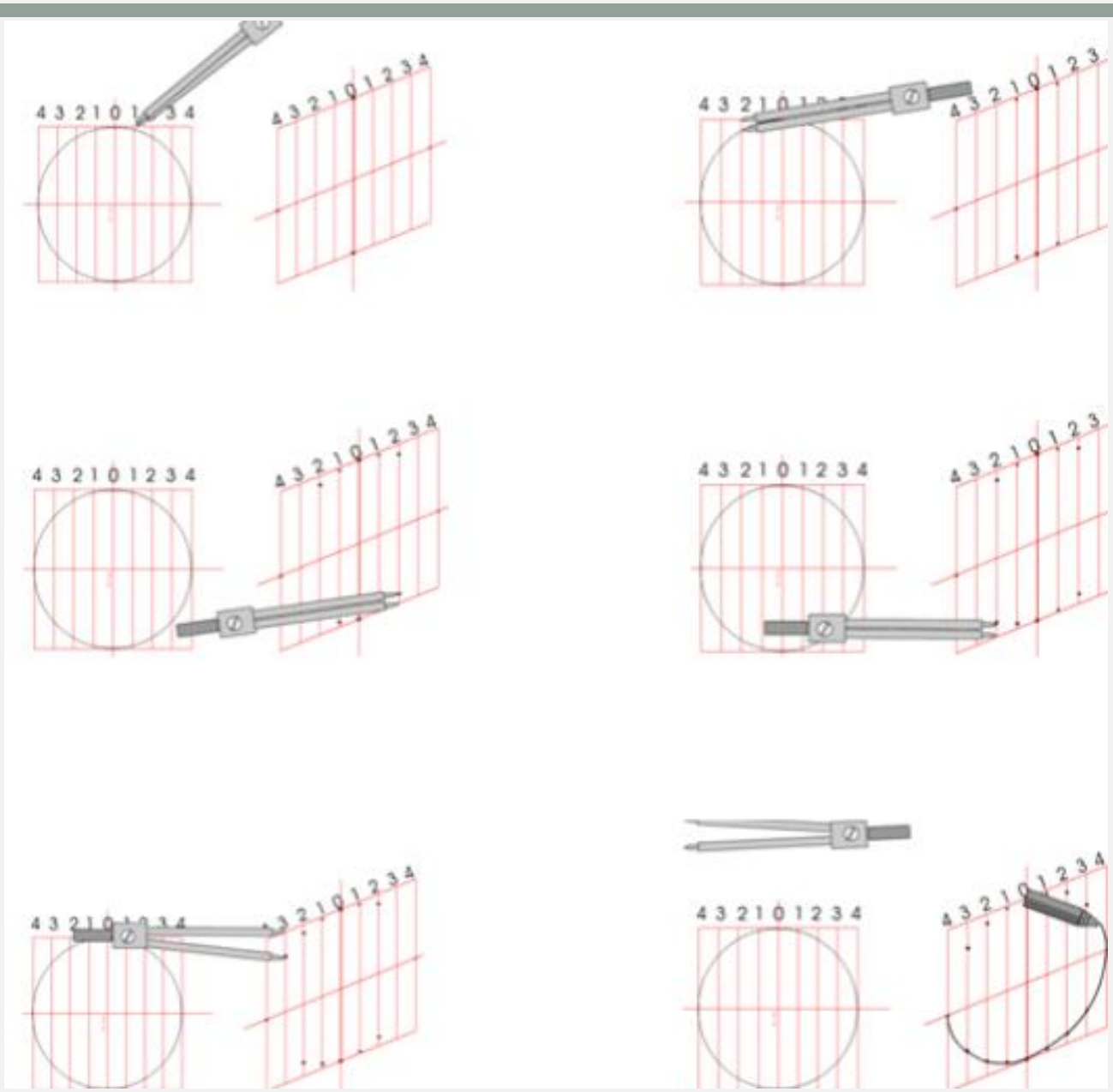


7. Measure the distance representing the 'thickness' of the cylinder along each 30 degree guideline. Start drawing a curve through each of the points.



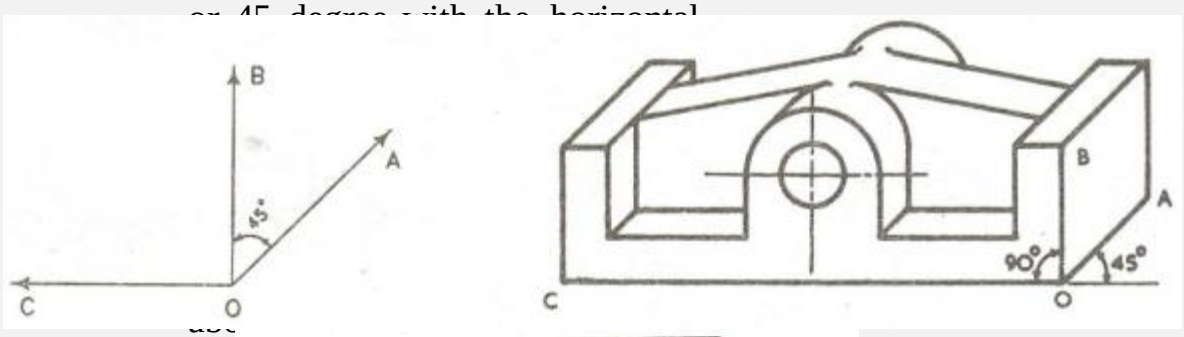


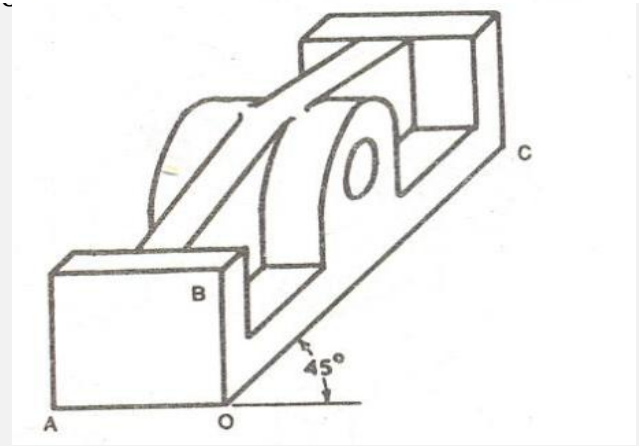
8. Draw the curve through each of the points to produce the final cylinder shade.



OBLIQUE PROJECTION:

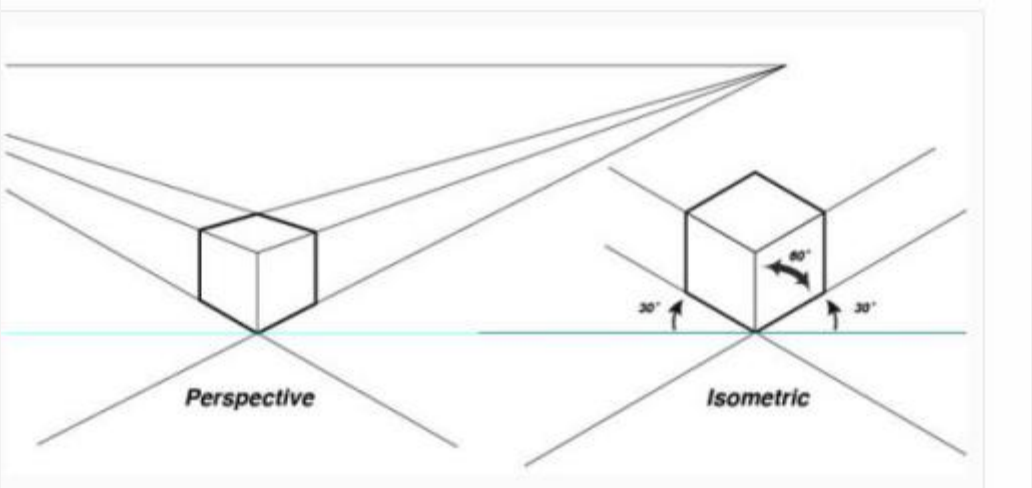
- In oblique projection, the object is assumed to be placed with one face parallel to the plane of projection. Hence, that face appears in its true shape and size as shown in fig. This gives two main dimensions of the object.
- The third dimension is shown by lines drawn at a convenient angle, generally 30 degree or 45 degree with the horizontal. To give a natural appearance these lines are drawn ¾ or ½ the actual lengths.
- Thus in an oblique projection also, there are three axis a vertical a horizontal and third, inclined at an angle of 30 or 45 degree with the horizontal





PERSPECTIVE PROJECTION:

This method of pictorial projection is used mainly in architectural drawings.



Difference between Isometric and Oblique projection

Isometric Projection	Oblique projection
Face of the object not parallel to the plane of projection	Face of the object parallel to the plane of projection
The object is oriented by 30 degrees forming an included angle of 120 degree on the object which is actually 90 degree.	Orientation of the third dimension is at an angle of 30 degree to 45 degree
Face does not appear in true shape. Rectangle is drawn like parallelogram and circle as ellipse (not true shape)	Face appears in true shape

Questions

Objectiv:

1.In isometric view the object is drawn at ---------- angle.

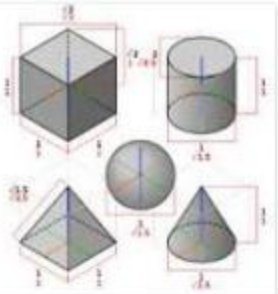
2.In oblique projection ----------of the object is parallel to the plane of projection

Subjective:

1. What is the difference between isometric and oblique projection?
2. Explain with sketch the methods of drawing oblique projection.
3. Which are the different types of projections?

SUMMERY	At the end of the class the student should have understood what is Isometric view, the method of drawing it and be able to draw the Isometric views from the given orthographic views.
EXERCISES	Dwg file: **ortho to isometric 11 - 16 – 013 to 11 - 16 - 015 (Previous completed orthographic views to be drawn in isometric)** **For basic practice. Medium and tough ones to be selected from N.D Bhat**
AUTHORS OF TEXT	ND BHAT
TOOLROOM REF	Exercise sheet no DWG FILE
WEB SITE	http://www.technologystudent.com/prddes1/drawtec2.html
OTHERS	Additional notes for reference at the end
REMARKS	The trainee should be in position to draw the Isometric views with little or without any assistance. At this stage more concentration to be given on weak students. **ADDITIONAL EXERCISES FROM REFERANCE BOOK TO BE GIVEN TO DRAW ISOMETRIC VIEWS FROM THE GIVEN ORTHOGRAPHIC VIEWS (Min of 15-20 exercise) N.D BHAT**

Isometric projection is a method for visually representing three-dimensional objects in two dimensions in technical and engineering drawings. It is an **axonometric projection** in which the three coordinate axes appear equally foreshortened and the angle between any two of them is 120 degrees.



What Is an Isometric Drawing?

Have you ever tried to draw a 3-dimensional shape, such as a cube? It can be a bit of a challenge. Every artist faces the challenge of creating 3-dimensional images on 2-dimensional paper. A painter or sketch artist may use techniques such as shadowing to make the image appear as lifelike as possible. For a technical or engineering drawing, however, different strategies have to be used. This is where an isometric drawing becomes useful.

An **isometric drawing** allows the designer to draw an object in three dimensions. Isometric drawings are also called isometric projections. This type of drawing is often used by engineers and illustrators that specialize in technical drawings. For example, when an engineer has an idea for a new product, he or she will probably create a sketch to show a client or investor. And chances are, the sketch will be an isometric drawing.

A Third Dimension

It is simple to draw a 2-dimensional object on paper because paper has two dimensions, height and width. But objects in real life have a third dimension, depth, which needs to be represented in the drawing. In isometric drawings, all three dimensions are represented on paper.

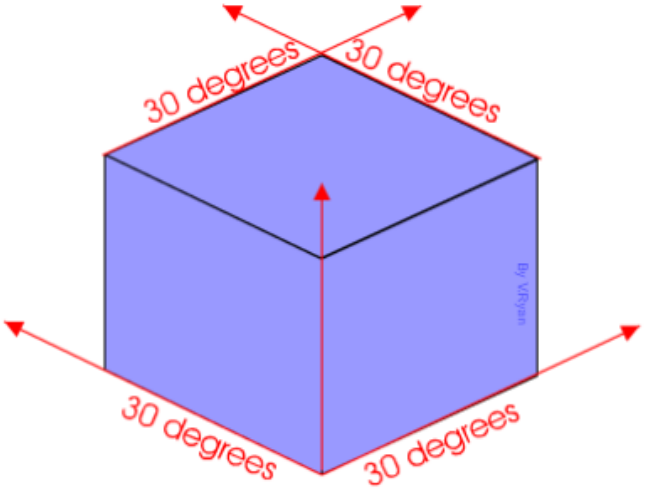
The three dimensions are represented as three axes: one vertical axis and two horizontal axes.

It's All About the Angles

So what makes an isometric drawing different from other 3-dimensional drawings? The axes are drawn so that the two horizontal axes are drawn at 30 degree angles. It's as if the vertical axis is in its true position, but the horizontal axes are bent 30 degrees from their true position.

ISOMETRIC DRAWING AND DESIGNERS

Isometric drawing is way of presenting designs/drawings in three dimensions. In order for a design to appear three dimensional, a 30 degree angle is applied to its sides. The cube opposite, has been drawn in isometric projection.



FREE HAND SKETCHING IN ISOMETRIC:

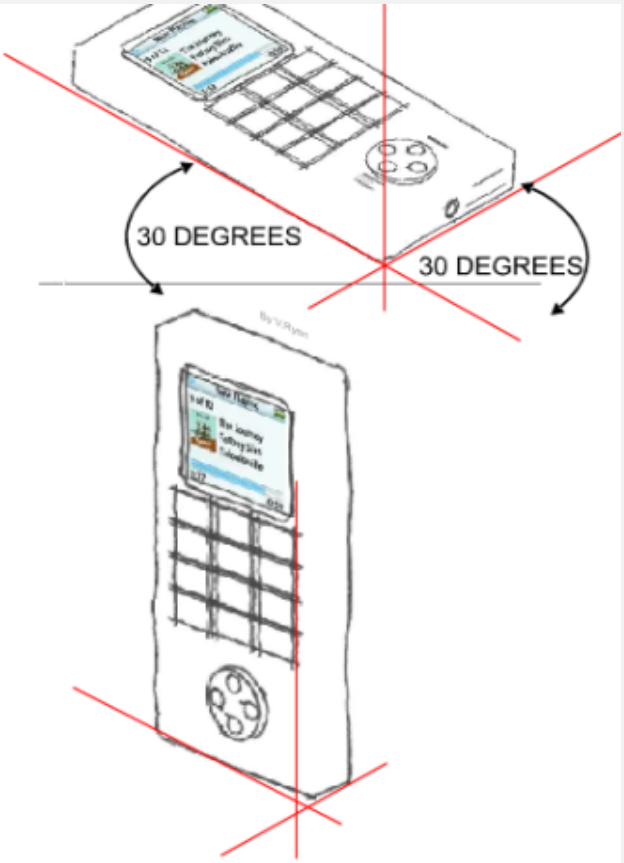
Designs drawn in isometric projection are normally drawn precisely using drawing equipment. However, designers find 'free hand' sketching in isometric projection useful.

The mobile phone / music player opposite, has been sketched in free hand isometric projection. It allows the designer to draw in 3D quickly and with a reasonable degree of accuracy. The design is still drawn at a 30 degree angle, although this is estimated, rather than drawn with graphics equipment.

Limited colour/shade has been added to the menu of the phone. This means that the sketch is not presented entirely as a 'plain' design.

These drawings are quick sketches, that allow the designer to put his / her thoughts down on paper rapidly. This helps him/her develop an idea or design concept quickly, without the need for complex drawings, at an early stage in the design process.

In early meetings with a client, the designer can display 3D drawings of this type in order to ascertain if the design is developing the way the client wants.



Drawing in isometric projection, normally means drawing very accurately using traditional drawing equipment. This includes using T-Square, set squares and measuring accurately.

The isometric drawing seen opposite has been drawn precisely, using skills learned through hours of practice. When these skills have been developed, sketching in isometric becomes second nature.

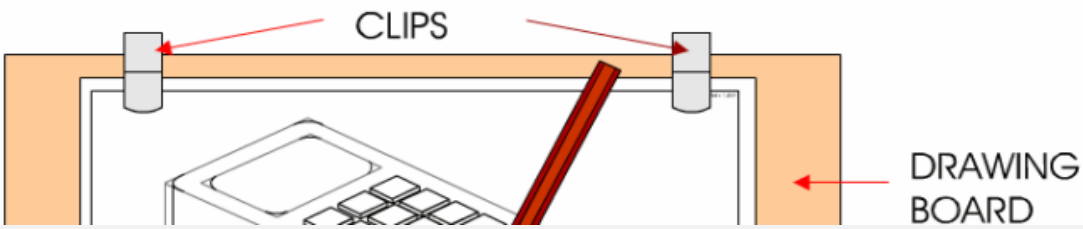
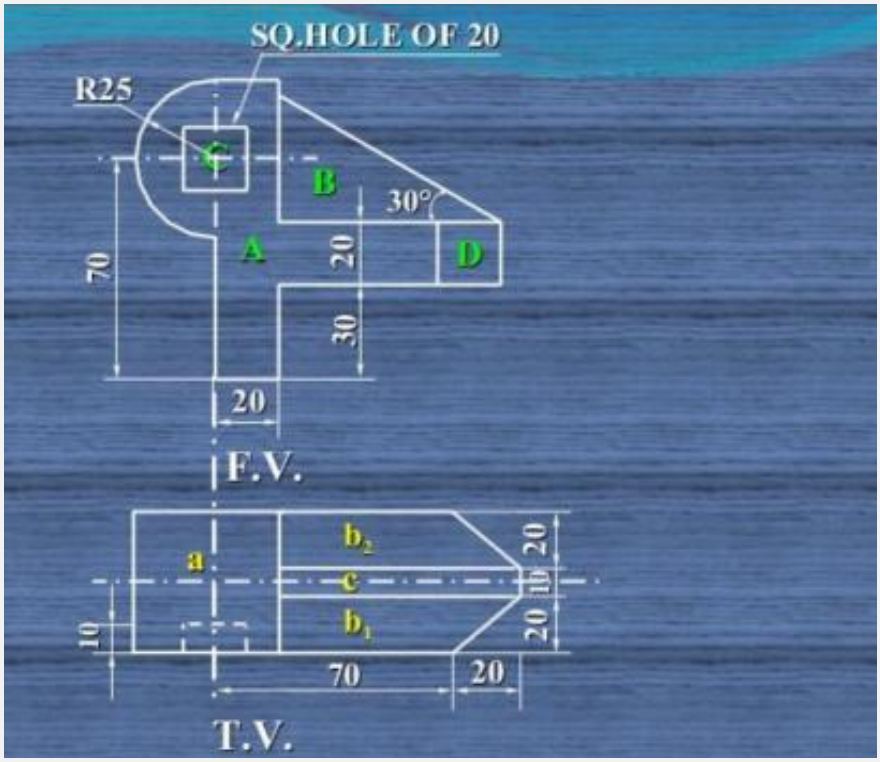
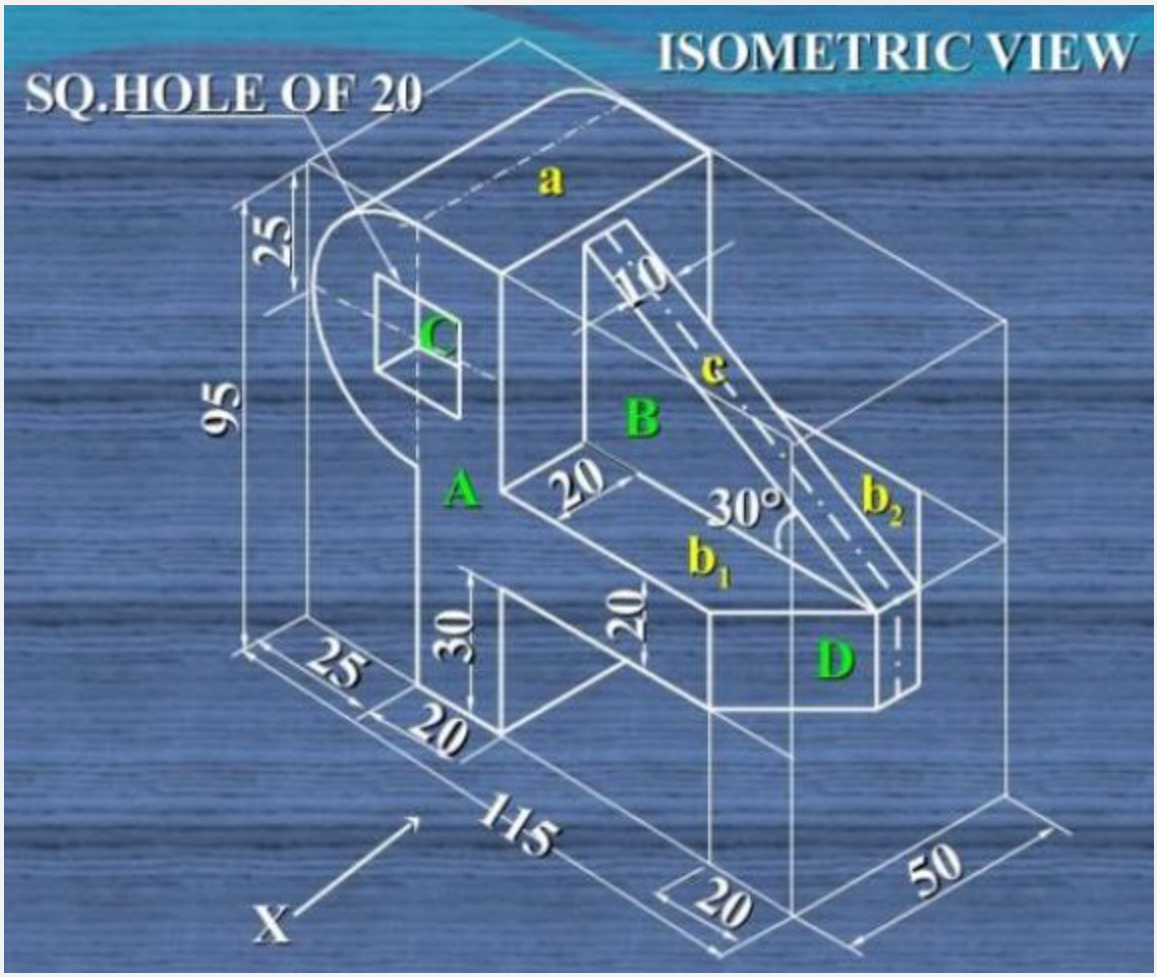
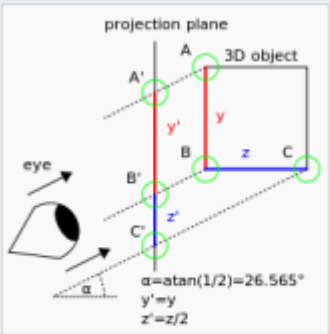


Figure shows Front View and Top View of a machine parts. Sketch its isometric view & dimension it.





Oblique projection is a simple type of technical drawing of graphical projection used for producing two-dimensional images of three-dimensional objects. The objects are not in perspective, so they do not correspond to any view of an object that can be obtained in practice, but the technique does yield somewhat convincing and useful images.



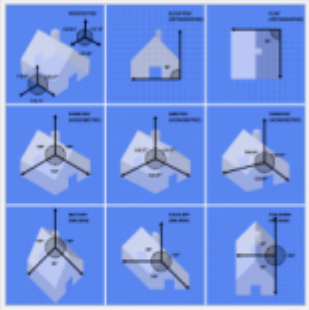
Oblique projection with foreshortening by half, seen from the side.

Oblique projection is a type of parallel projection:

- it projects an image by intersecting parallel rays (projectors)
- from the three-dimensional source object with the drawing surface (projection plane).

In both oblique projection and orthographic projection, parallel lines of the source object produce parallel lines in the projected image. The projectors in oblique projection intersect the projection plane at an oblique angle to produce the projected image, as opposed to the perpendicular angle used in orthographic projection.

Mathematically, the parallel projection of the point (x, y, z) on the xy-plane gives $(x + az, y + bz, 0)$. The constants a and b uniquely specify a parallel projection. When $a = b = 0$, the projection is said to be "orthographic" or "orthogonal". Otherwise, it is "oblique". The constants a and b are not necessarily less than 1, and as a consequence lengths measured on an oblique projection may be either larger or shorter than they were in space. In a general oblique projection, spheres of the space are projected as ellipses on the drawing plane, and not as circles as you would expect them from an orthogonal projection.



Comparison of several types of graphical projection. The presence of one or more 90° angles is usually a good indication that the perspective is oblique.

Oblique drawing is also the crudest "3D" drawing method but the easiest to master. Oblique is not really a 3D system but a two-dimensional view of an object with 'forced depth'. One way to draw using an oblique view is to draw the side of the object you are looking at in two dimensions, i.e. flat, and then draw the other sides at an angle of 45°, but instead of drawing the sides full size they are only drawn with half the depth creating 'forced depth' – adding an element of realism to the object. Even with this 'forced depth', oblique drawings look very unconvincing to the eye. For this reason oblique is rarely used by professional designers and engineers.

Oblique pictorial [edit]

In an *oblique pictorial* drawing, the angles displayed among the axis, as well as the foreshortening factors (scale) are arbitrary. More precisely, any given set of three coplanar segments originating from the same point may be construed as forming some oblique perspective of three sides of a cube. This result is known as Pohlke's theorem, from the German mathematician Pohlke, who published it in the early 19th century.[2]

The resulting distortions make the technique unsuitable for formal, working drawings. Nevertheless, the distortions are partially overcome by aligning one plane of the image parallel to the plane of projection. Doing so creates a true shape image of the chosen plane. This specific category of oblique projections, whereby lengths along the directions x and y are preserved, but lengths along direction z are drawn at angle using a reduction factor is very much in use for industrial drawings.

- *Cavalier projection* is the name of such a projection, where the length along the z axis remains unscaled.[3]
- *Cabinet projection*, popular in furniture illustrations, is an example of such a technique, wherein the receding axis is scaled to half-size[3] (sometimes instead two thirds the original).[4]

Cavalier projection [edit]

Further information: Mathematics and art

In **cavalier projection** (sometimes **cavalier perspective** or **high view point**) a point of the object is represented by three coordinates, *x*, *y* and *z*. On the drawing, it is represented by only two coordinates, *x*″ and *y*″. On the flat drawing, two axes, *x* and *z* on the figure, are perpendicular and the length on these axes are drawn with a 1:1 scale; it is thus similar to the dimetric projections, although it is not an axonometric projection, as the third axis, here *y*, is drawn in diagonal, making an arbitrary angle with the *x*″ axis, usually 30 or 45°. The length of the third axis is not scaled.[5][6]

It is very easy to draw, especially with pen and paper. It is thus often used when a figure must be drawn by hand, e.g. on a black board (lesson, oral examination).

The representation was initially used for military fortifications. In French, the « cavalier » (literally *rider, horseman*, see *Cavalry*) is an artificial hill behind the walls that allows to see the enemy above the walls.[7] The cavalier perspective was the way the things were seen from this high point. Some also explain the name by the fact that it was the way a rider could see a small object on the ground from his horseback.[8]

Cabinet projection [edit]

The term **cabinet projection** (sometimes **cabinet perspective**) stems from its use in illustrations by the furniture industry.[9] Like cavalier perspective, one face of the projected object is parallel to the viewing plane, and the third axis is projected as going off at an angle (typically 63.4°). Unlike cavalier projection, where the third axis keeps its length, with cabinet projection the length of the receding lines is cut in half.

Mathematical formula [edit]

As a formula, if the plane facing the viewer is *xy*, and the receding axis is *z*, then a point *P* is projected like this:

$$P\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} x + \frac{1}{2} z \cos \alpha \\ y + \frac{1}{2} z \sin \alpha \\ 0 \end{pmatrix}$$

Where α is the mentioned angle.

The transformation matrix is:

$$P = \begin{bmatrix} 1 & 0 & \frac{1}{2}\cos\alpha \\ 0 & 1 & \frac{1}{2}\sin\alpha \\ 0 & 0 & 0 \end{bmatrix}$$

Alternatively you could remove one third from the leading arm projected off the starting face, thus giving the same

UNIT 5: DIMENSIONING & SCALES

INTRODUCTION TO DIMENSIONING

After you have come across projections / views you need to dimension it. What is dimensioning? Have you heard dimensioning or come across dimensioning? Have you measured your height? Yes that's a dimension. When you stich a pant or a shirt the tailor takes measurement and takes a note of it, that is nothing but dimension. The required dimension is specified in the drawing and indicated using arrow heads in engineering drawing is termed as Dimensioning or we can also call it as a required dimension (**related to the manufacturing of object eg: Length, Breadth, Hole size/ depth and distance from reference etc**) shown in written form in drawing.

DEFINITION: Engineering drawings must be able to tell you everything you need to manufacture a component or assemble several components together.

Dimensioning terms and notations(ref sketch for each term):

- **Dimension line:** Dimension line is a thin continuous line. It is terminated by arrowheads touching the outlines, extension lines or center lines.
- **Extension line**: An extension line is also a thin continuous line drawn in extension of an outline. It extends by about 3mm beyond the dimension line.
- **Arrow head**: An arrow head is placed at each end of a dimension line. Its pointed end touches an outline/extension line/ center line. The size of an arrow head should be proportional to the thickness of outline. The length of the arrowhead

  should be about 3 times the maximum width. It is drawn freehand with two strokes made in the direction of its pointed end. The space between them is neatly filled up.

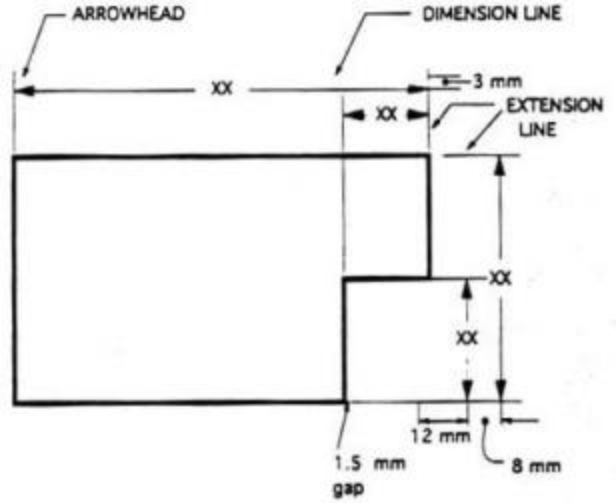
- **Note**: A note gives information regarding specific operation relating to a feature. It is placed outside a view but adjacent to the feature concerned.
- **Leader**:

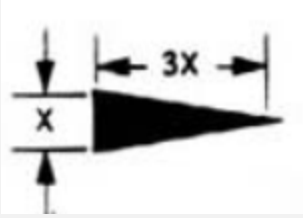
  1) A leader or a pointer is a thin continous line connecting a note or a dimension line to the feature it applies. One end of the leader terminates either in a arrow head or a dot. The arrow head touches the outline, while the dot is placed within the outline of the object.

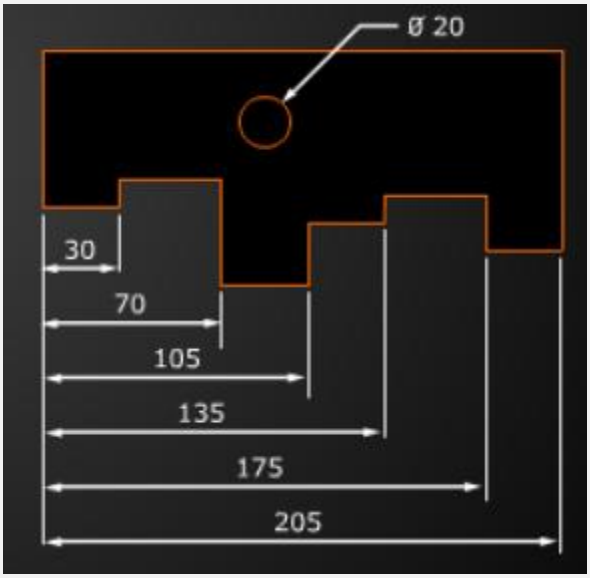
  2) The other end of the leader line is terminated in a horizontal line at the bottom level of the first or last letter of the note.**The leader is never drawn vertical, horizontal or curved but drawn at an angle not less than 30 degree to the line it touches.** A leader line is meant only for one feature.

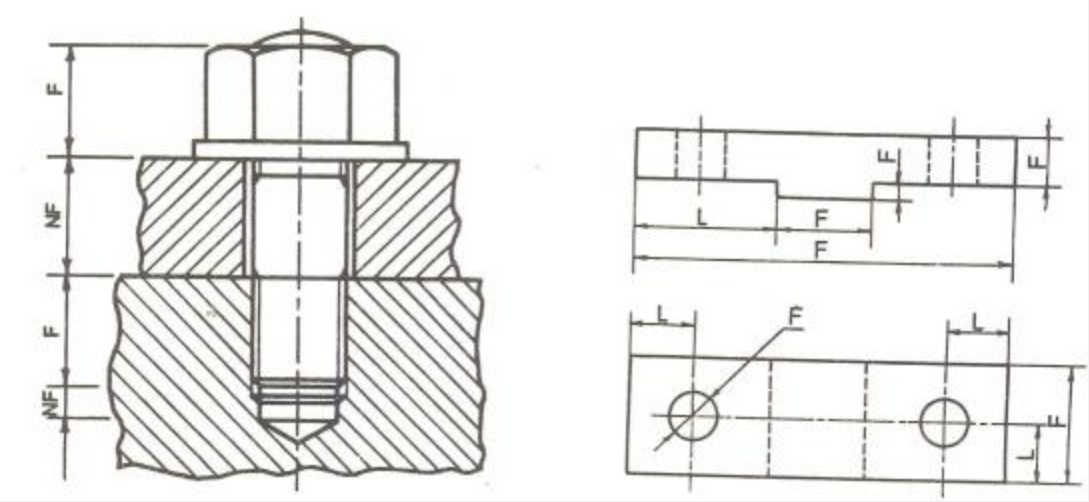
Example:

Leader lines are thin continuous lines that indicate where dimensions, notes and item numbers apply. The leader line should terminate with an arrow head at the feature end and short horizontal line (approx 5 mm) at the dimension end.









SYSTEM OF DIMENSIONING

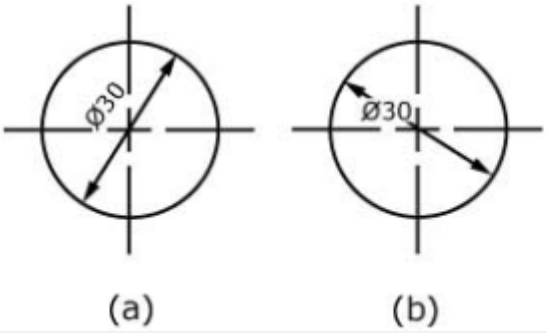
Placing of dimensions: The two systems of placing the dimensions are

1) Aligned system
2) Unidirectional

1) Aligned system: In the aligned system as shown in the figure the dimension is placed perpendicular to the dimension line in such a way that it may be read from the bottom edge or the right- hand edge of the drawing sheet. The dimension should be placed near the middle and above, but clear of the dimension lines.

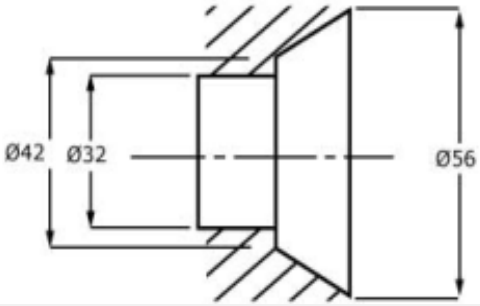
Dimensions of circular features can be written in several ways.

1. **Aligned** - See (a) where the dimension is shown in the same direction as the dimension line.
2. **Unidirectionally** - See (b) where the dimension is shown parallel to the bottom of the drawing sheet.



2) **Unidirectional:** In unidirectional system all dimension are so placed that they can be read from the bottom edge of the drawing sheet. The dimension lines are broken near the middle for inserting the dimensions. This system is mainly used on large drawings like aircrafts, automobiles,etc where it is **inconvenient** to read dimensions from the right –hand side.

3. **From the side view and unidirectionally**
Note the use of projection lines extending from the object but not touching it. These help clarify the shape, keep the diagram neat and the information readable.



Unit of dimensioning: As far as possible all the dimensions should be given in millimeters, omitting the abbreviation mm. Even when other unit is used only the dimension figures are written but with a **foot note** specifying that **"ALL DIMENSIONS IN mm"** in the **title block**.

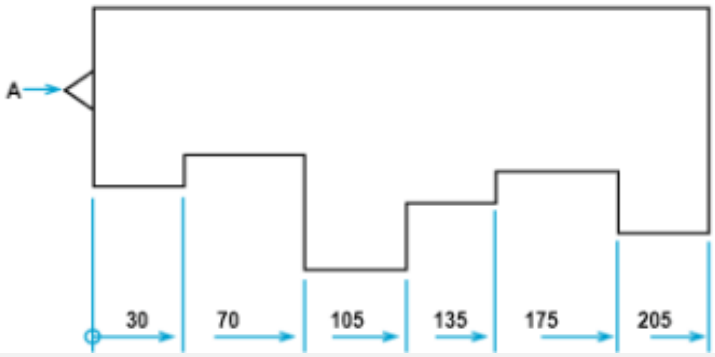
What is datum?

Why do we use a datum?

A **datum** is a point, line, or surface from which **dimensions** are taken. It is the place to start. This is important to note when **marking out** a job. The datum can be a single point eg the centre of a hole or face of a feature to a component.

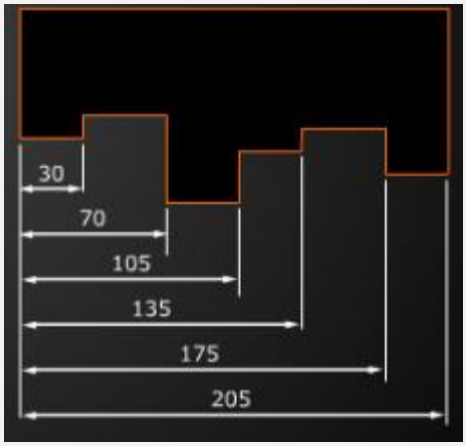
A datum is used to reduce errors when marking out, and measuring by reducing the accumulation of errors.

Can you find the datums on this drawing?



TYPES OF DIMENSIONING

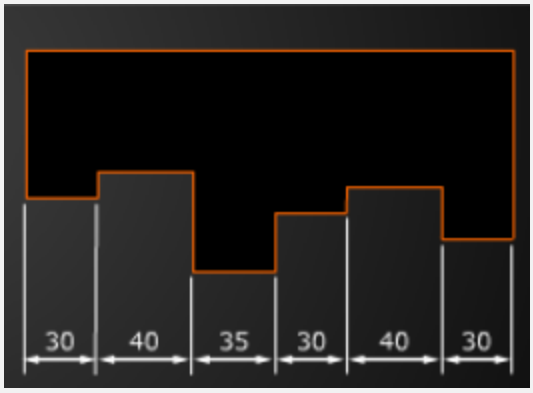
Parallel dimensioning:



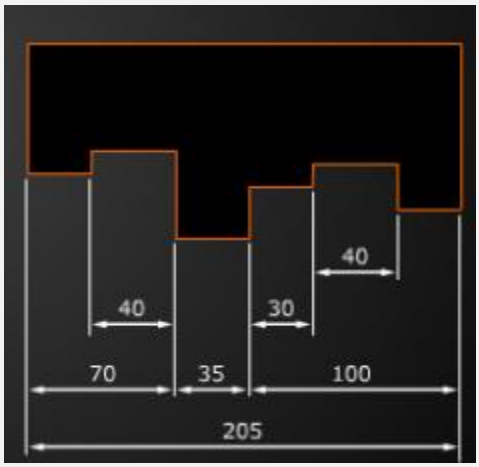
The measurements all originate from the same line or datum point so a tolerance error does not accumulate. More space is required on the drawing for all the dimension lines.

Chain dimensioning:

Chain dimensioning also uses minimal space on a drawing. However it accumulates a tolerance error because each individual dimension has its own tolerance. Adding the individual errors means the overall error could be greater than general tolerance given in the drawing. Chain dimensioning is only used when the function of the object will not be affected by errors.



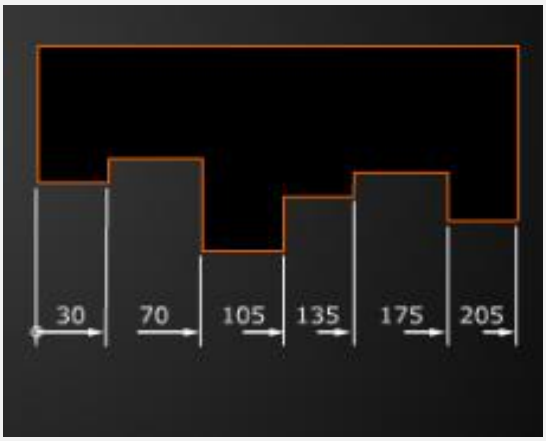
Combined dimensioning:

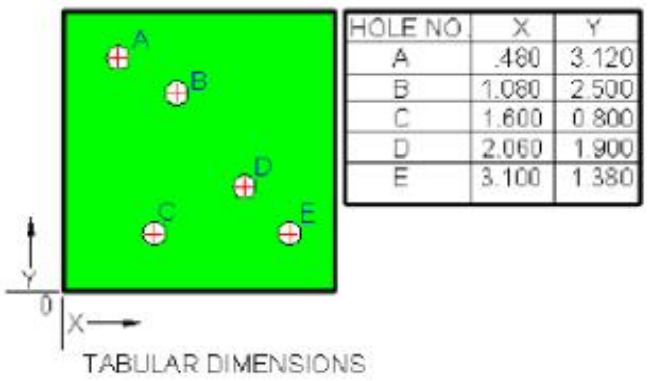


Combined dimensioning is a combination of chain and parallel dimensioning .This method uses less space than parallel dimensioning and accumulates less of a tolerance error than chain dimensioning,

Running dimensioning:

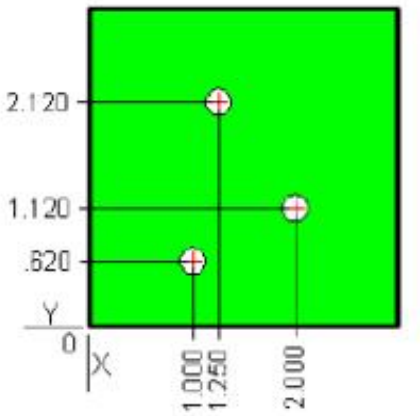
Running dimensioning is similar to parallel dimensioning but takes less space. It dosen't accumulate a tolerance error either as all measurements originate from the same line. Running dimensions are not often seen in drawings as more care is needed in reading the dimensions to make sure you have the right measurement.





HOLE NO	X	Y
A	.480	3.120
B	1.080	2.500
C	1.600	0.800
D	2.060	1.900
E	3.100	1.380

TABULAR DIMENSIONS



COORDINATE DIMENSION

Tabular Dimensions - When a company manufactures a family of parts or assemblies that are exactly alike in shape except for dimensions , tabular dimensioning is used on a drawing. Letters and numbers in a tabular from are used instead of dimensions to denote size.

Coordinate Dimensions - Coordinate dimensioning is used on prints that would require many dimension and extension lines. Coordinate dimensioning helps to keep the drawing from becoming difficult to read. This type of dimensioning is frequently used on prints of parts to be machined by numerical control

Figure 1

ASME repetitive feature dimensioning scheme

ASME Y14.5-2009 actually provides a linear method to detail feature patterns, called *repetitive features and dimensions*. See Figure 2. Unfortunately, the standard does not provide any tolerance rules for its prescribed scheme. Presumably, this leads us to interpret a repetitive feature dimension as though it is shorthand for *chain dimensioning*. Chain dimensioning accumulates tolerance as the pattern departs from the dimensioned start position. Sometimes this is OK, but often this is unacceptable since the accumulation of tolerance can quickly lead to features that do not align to mating features on other components.

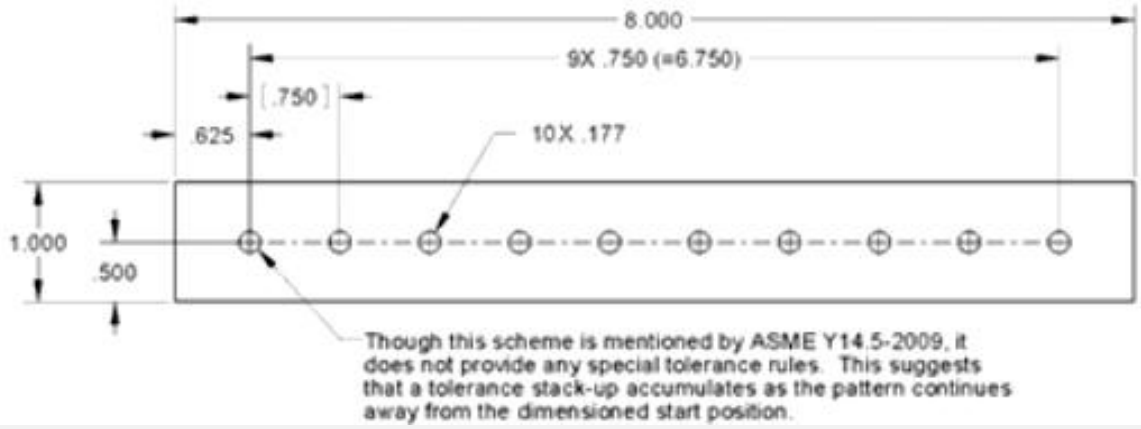


Figure 3

Baseline dimension scheme

To avoid the issues associated with other direct dimensioning schemes, one may choose to use baseline dimensioning, which may also be called *rectangular coordinate dimensioning* in some scenarios. The advantage of a baseline dimension scheme is that it limits the accumulation of tolerances to the stake-up from just two dimensions. This is because the total stack-up between any two positions within the feature pattern are related through a common baseline. The problem with baseline dimensioning is obvious in Figure 4; its take up a lot of space on the drawing.

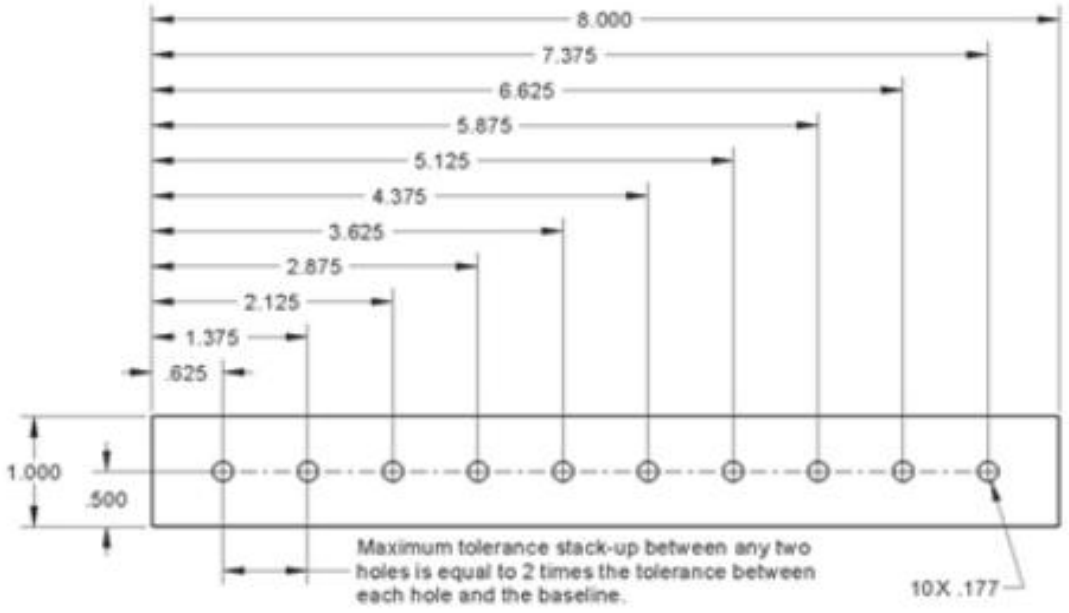
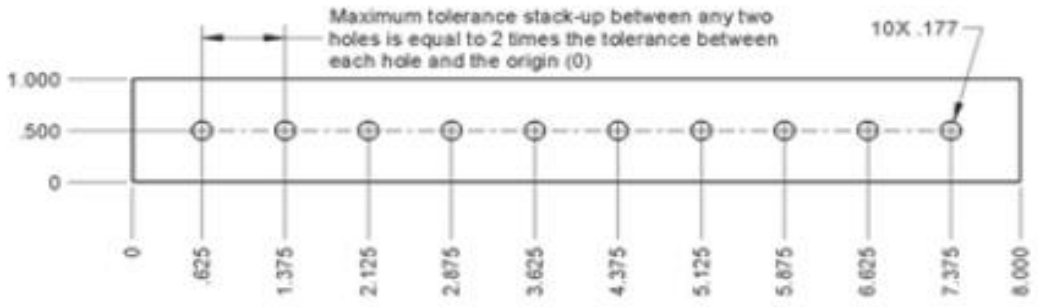


Figure 4

Ordinate dimensioning

A common alternative to baseline dimensioning is ordinate dimensioning, also known as *rectangular coordinate dimensioning without dimension lines*. This scheme also relies on a baseline, referred to as zero (0), from which all of the features are dimensioned. The advantage of ordinate dimensioning is that it takes up far less space on a drawing, as shown in Figure 5. Tolerance stack-up is limited to just two dimensions between any two positions within the pattern.

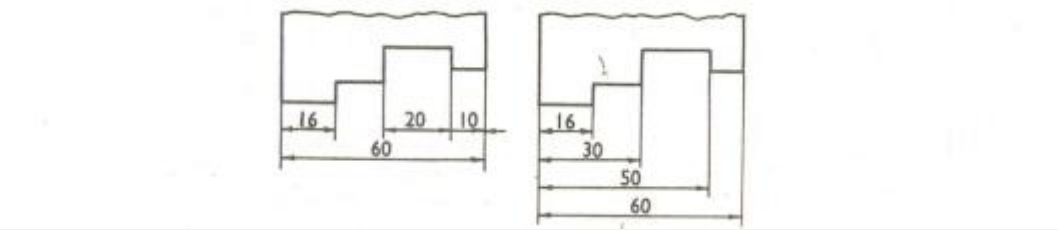


General rules for dimensioning:

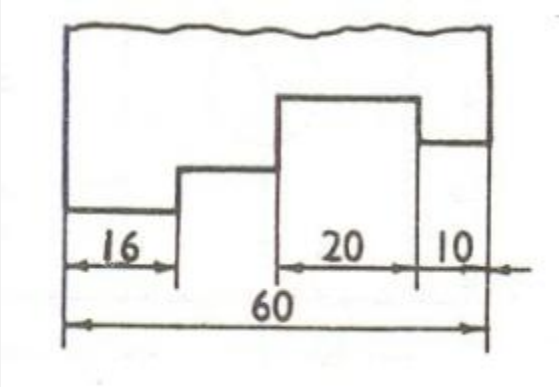
- Dimensioning should be done completely in such a manner that further calculation, assumption or direct measurement from drawing is not necessary.
- All dimensions to be shown and see that dimension for the same is not repeated.
- Dimension should be placed on the view where its use is shown more clearly.
- Dimensions should be placed outside the view unless its clearer and more easily read inside.
- Dimension lines should not cross each other and also dimensioning between hidden lines to be avoided. (SMALLER DIMENSIONS TO BE PLACED CLOSEST TO THE OBJECT)
- Outline and centerline should not be used as dimension line. Centerline may be extended to serve as an extension line.
- Aligned system of dimensioning recommended.

Practical hints on dimensioning:

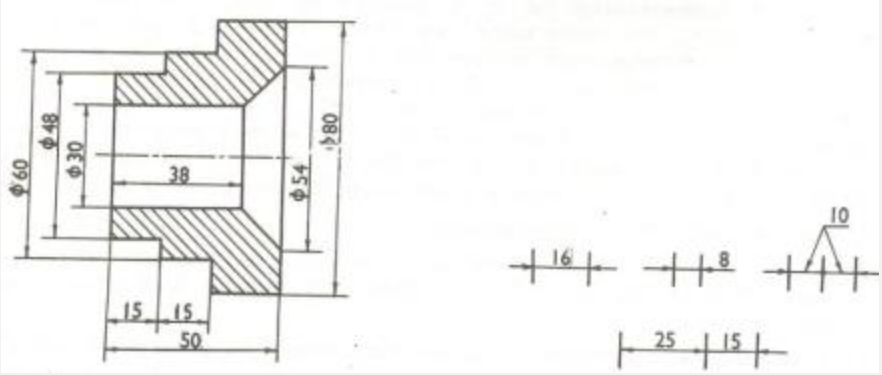
- Dimensioning lines to be drawn 8mm away from the outline and each other.
- Smaller dimension should be placed nearer to the view and larger apart
- Dimensioning can be done in two ways:
  i) continuous or also called chain line dimensioning (ref sketch).
  ii) Progressive or parallel dimensioning.(ref sketch)



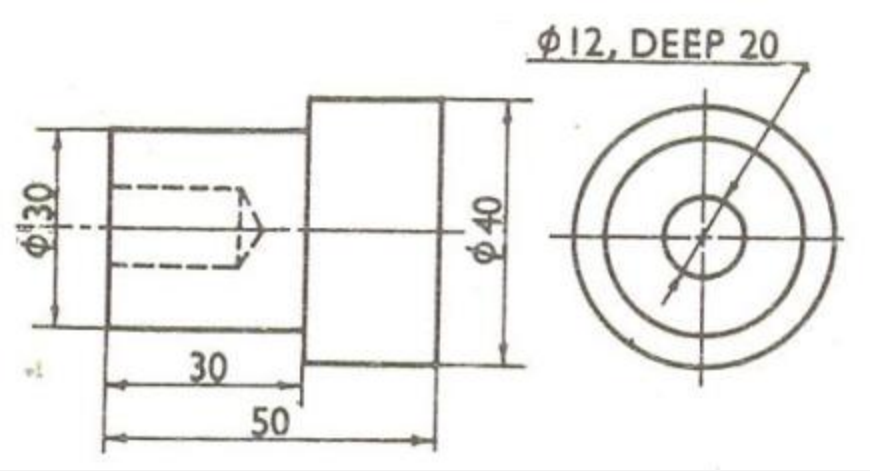
- The smallest dimension should be placed inside &Overall dimension(Biggest) is placed outside.The least important dimension is omitted. Ex: dimension 14 is omitted in the below sketch in chain line dimensioning.



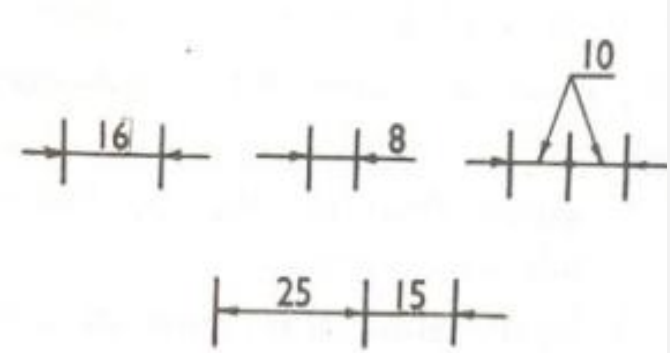
- When a number of parallel dimensions are to be shown near each other the placement of the dimension can be staggered as shown in the sketch below.



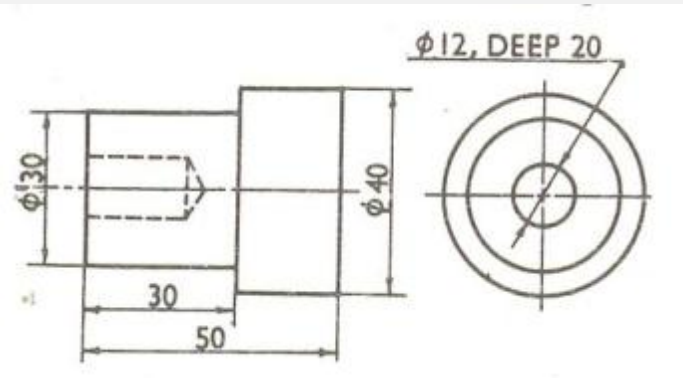
- Dimensions of cylindrical parts as far as possible be placed in the view where circle seems to be rectangle.



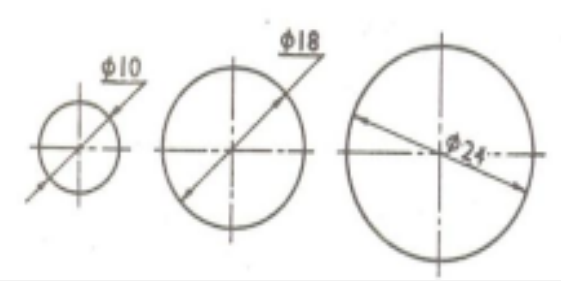
- Dimensions should not be repeated in other view.
- Dimension of a cylinder should not be specified as radius.
- If the space is too narrow the dimension can be written above the extended portion of the dimension line but preferably on the right side (DIMENSION 8).



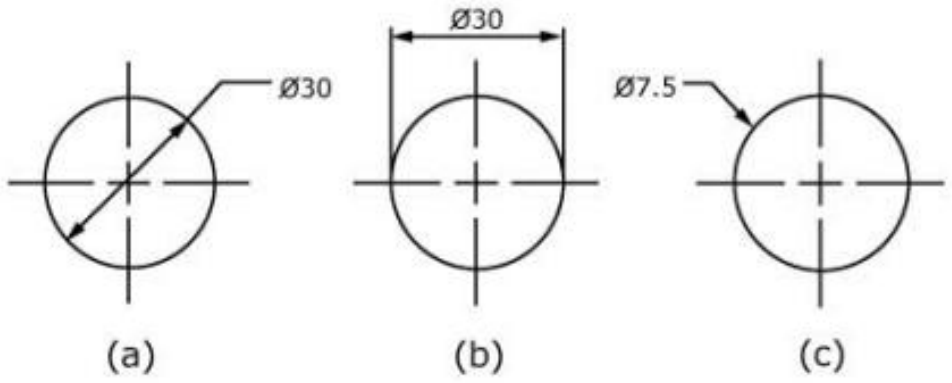
- Holes should be dimensioned in the view where they appear as circles.



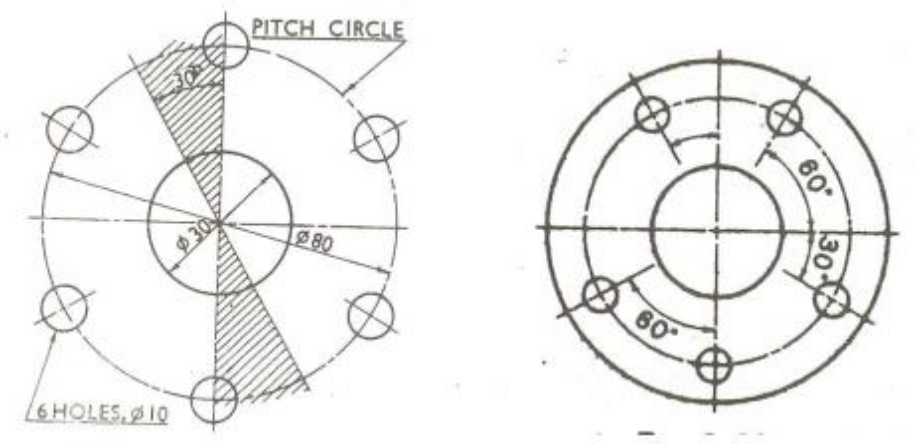
Methods of dimensioning differen circles



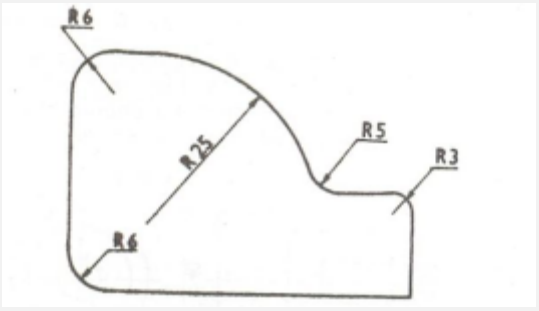
6. **For small diameters**
Here the dimensioning information needs to sit outside the circle. This can be achieved in several ways:
(a) uses a leader line and a dimension line
(b) uses projection lines and a dimension line
(c) uses a **leader line** which must be in line with the centre of the circle.



Dimensioning of P.C.D Equally spaced and Non equally spaced

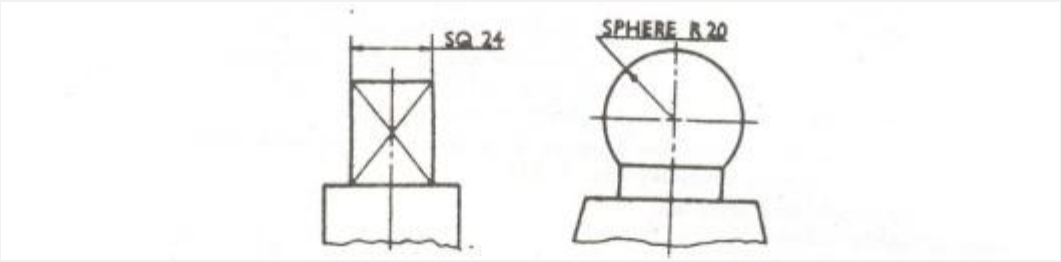


- Arcs of circles should be dimensioned by their respective radii. Dimension line for the radius should pass through the center of the arc. The dimension fig should be preceded by the letter R.

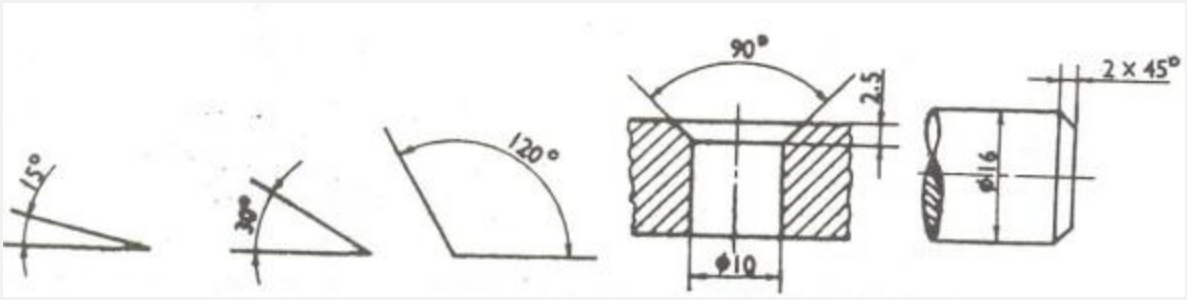


- Letter SQ should precede the dimension for a rod having square cross-section Ex: chuck key used in lathe. The diagonal lines as shown in the drawing represents that its flat.

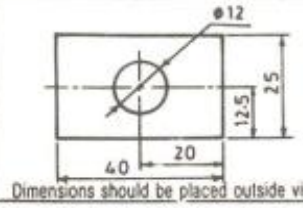
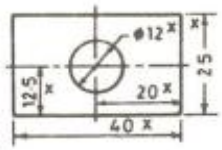
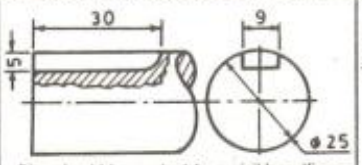
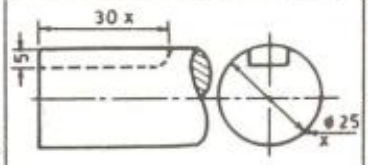
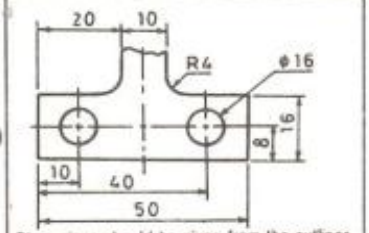
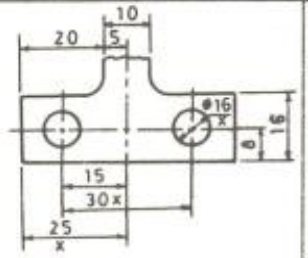
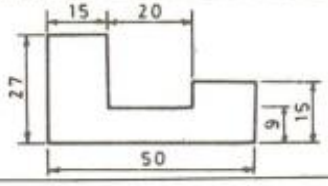
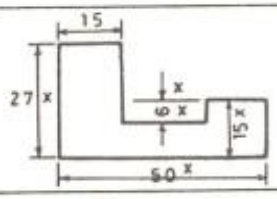
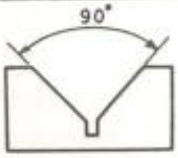
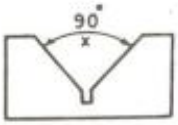
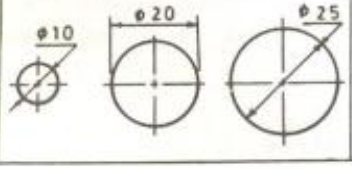
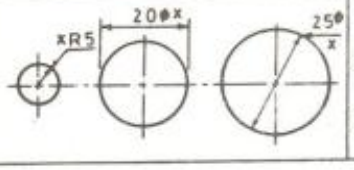
- The word sphere has to be mentioned before representation (R or Diameter) for a spherical part.



- The below mentioned sketches shows how angular dimensions and chamfers are to be represented.

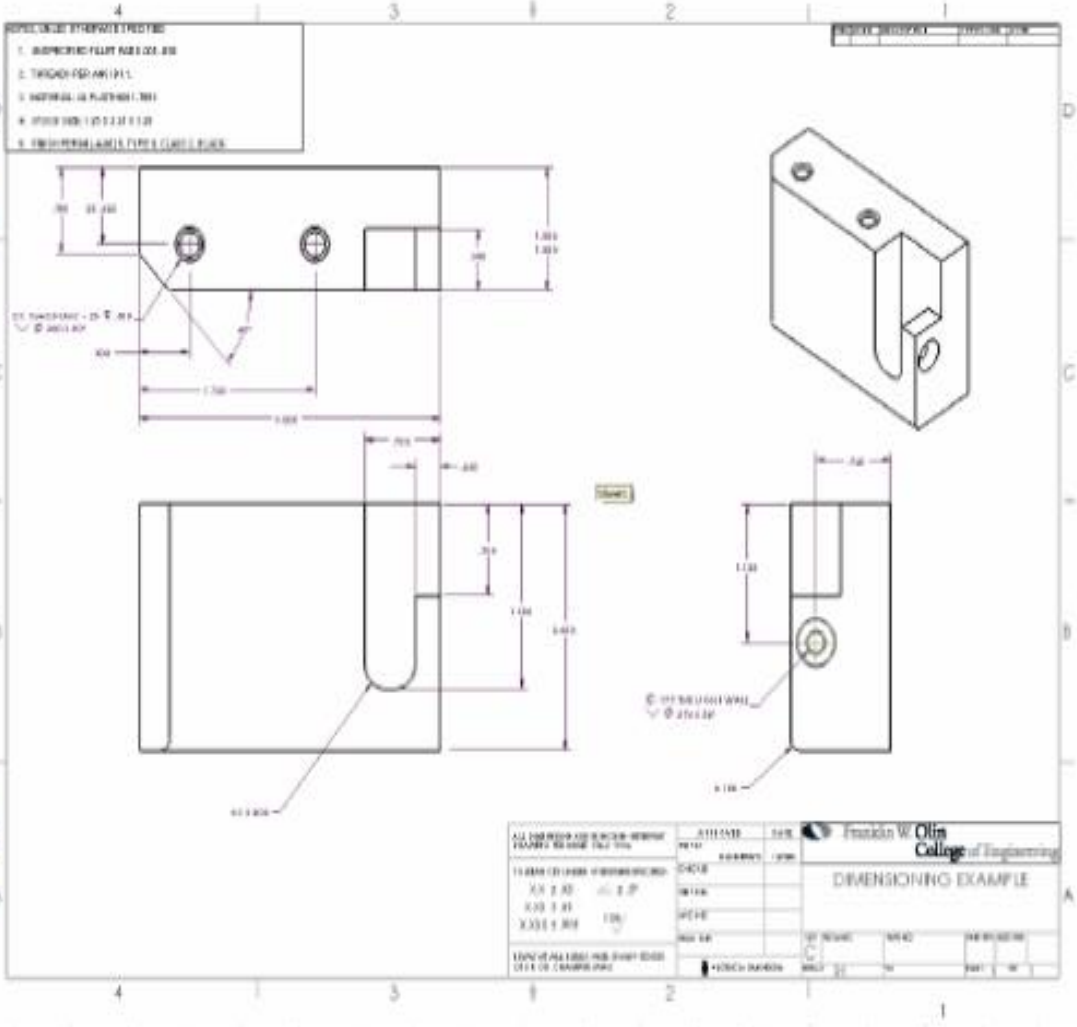


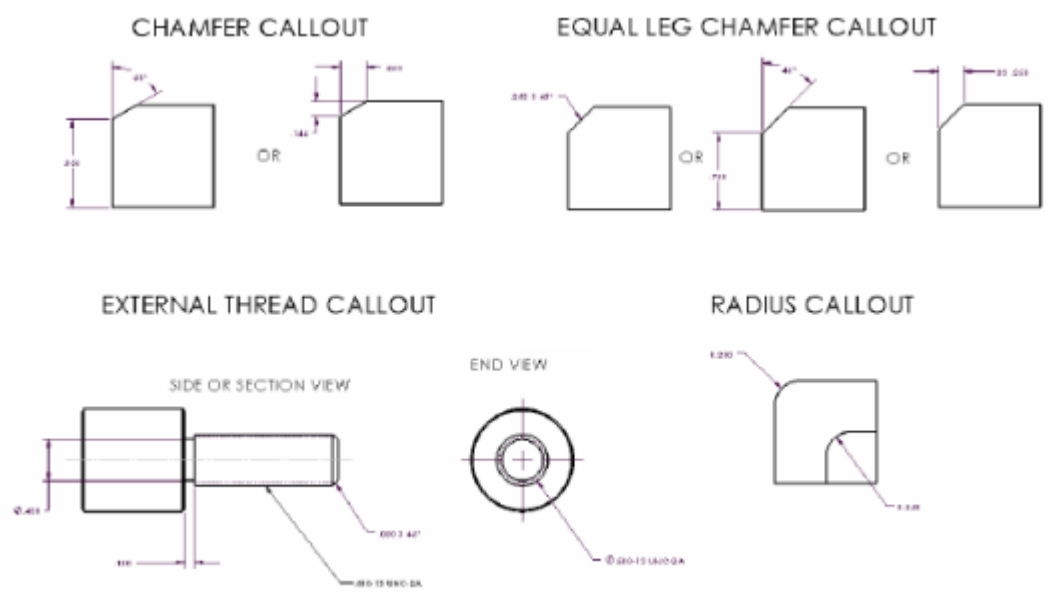
STUDY CAREFULLY THE CORRECT WAY OF DIMENSIONING.INCORRECT DIMENSIONING IS SHOWN BY CROSS (X) IN THE DRAWING

	CORRECT	INCORRECT	REASONS FOR INCORRECT
(i)	 Dimensions should be placed outside view		1. Arrow head not proportionate. 2. Hole dimension shown in figure. Leader line not ends horizontally. 3. Dimension '40' is too close. 4. Placing dimensions methods mix. Dimension '40' is acco-rding to aligned method.
(ii)	 Dim. should be marked from visible outlines		1. A key-way is shown with dotted line where the dimensions are placed. 2. Leader line for the shaft diameter is drawn horizontal touching the boundary line.
(iii)	 Dimensions should be given from the outlines (finished surfaces) or a centre line of a hole		1. Dimensions are given from the mid-line of the object. 2. Dimensions of holes are shown inside the figure. 3. Dimensions are shown in vertical line. 4. Smaller dimensions (25 mm) precedes the larger dimensions (30 mm). 5. Fillet radius is not shown.
(iv)			1. Dimension lines are used as extension. 2. Dimensions are placed inside the view. 3. Dimension 27 and 50 not written according to aligned system.
(v)			Section-lines overlap the dimension 21.
(vi)			The outlines of the object are used as the extension lines.
(vii)			1. Smaller circle is designated with radius. 2. Convention 'ϕ' for diameter is placed after dimension. 3. Leader has arrow and it is drawn horizontal.

Drawing Standards – Dimensioning Rules

1. All CAPS!
2. All Decimals
3. Select a front view that best describes the part
4. Remove hidden lines always, unless absolutely necessary
5. Do not duplicate dimensions
6. Do not dimension to hidden lines
7. Place dims between views if possible
8. No dims allowed on body of part. Offset .38" inch from object outline
9. Place all dims for feature in one view if possible
10. Dim lines cannot cross dim lines
11. Dim lines should not cross extension lines
12. Extension lines can cross extension lines
13. Center marks in view(s) only where feature is dimensioned only
14. Centerlines in view(s) where feature is dimensioned





Best Practices/Basic Rules

1. All CAPS!
2. All Decimals
3. Select a front view that best describes the part
4. Remove hidden lines unless absolutely necessary to describe the shape of the object
5. Consider datums and dimensioning scheme based on
    1. Feature relationship
    2. Manufacturability and inspection
    3. Reduce math for machinist
6. Do not duplicate dimensions, use reference dims if necessary to duplicate
7. Do not dimension to hidden lines
8. Place dims between views if possible
9. No dims on body of part. Offset .38" inch from object outline
10. Place all dims for same feature in one view if possible
11. Dim lines cannot cross dim lines
12. Dim lines should not cross extension lines
13. Extension lines can cross extension lines
14. Use center marks in view(s) only where feature is dimensioned
15. Use centerlines and center marks in views only if feature is being dimensioned or referenced otherwise omit.
16. When multiples of the same feature exists in a view, dimension only one of the features and lable the dim as "NumberX" DIM meaning that the feature exists in that view"Number" times. For example, "4X .250" implies that in the view, there exists 4 like dimensions for the dimensioned feature
17. Minimize use of centerlines between holes etc, they add little value and clutter the object being drawn.

Why are notes sometimes used instead of dimensions?

Dimensions pass on basic information to the person making the component.

Notes give detailed information about dimensions, tolerances, materials or manufacturing processes and can be repeated in different positions on a drawing.

There are two sorts of notes:

- **general notes**, and
- **local notes**.

General notes apply to all of a drawing.

They usually appear in the title block or in a convenient place aside from the views.

ALL FILLET WELDS TO BE 5mm
IN ACCORDANCE WITH AS1554
UNLESS OTHERWISE STATED

Local notes apply to a particular part of a drawing only.

They are placed close to the component they refer to. This example is on the same drawing but is about drilling a series of holes on a given **Pitch Circle Diameter (PCD)**. Here the general notes will not apply and the engineer will follow the instructions on the local note.

DRILL 8 HOLES Ø 10 ON A 200 PCD

Glossary

- Dimension
- General notes
- Local notes
- Notes
- Pitch circle diameter

SCALES

INTRODUCTION

What is meant by **scales** in engineering drawing?

Have you seen a world map/ India map. Is the map of our country as big as country itself. No the map is smaller as it is not possible to draw the map 1:1 (full scale) in a sheet of paper. This (1:1)is called scale (Actual size). Below the map you might have observed its written SCALE 1: 55,00,000 (one is to fifty five lakh) or so depending on the size of the map. So the map is of reduced scale to fit it in a sheet of paper. In a reduced scale the numerical value on the right size of the ratio scale will be greate

If you are asked to draw the views of the components inside the watch in assembled condition, how do you draw that? You find it difficult why because it contains very minute components. What has to be done here then? Here we need to draw the view in an enlarged scale so that the shape of the component and its working principle is visible. Still if not understood have you seen a watch mechanic wearing a magnifying glass when he repairs. By using the magnifying glass he finds the object enlarged and removes the assembled parts using a small screw driver.

Like this smaller components have to be drawn in an enlarged scale to visualize. This is called enlarged scale where the left numerals in the ratio scales are greater eg: 2:1, 5:1, 20:1 Etc. You can also see SCALE mentioned in the plan of your house.

Irrespective of whether the scale is reduced or enlarged the dimension you mention in the drawing is actual dimension in other words only size of the drawing increases or decreases according to the scaling factor but the dimension you write on it will be the actual size.

The scale of the Assembly drawing must be indicated in the **title block** whether itsfull size scale enlargement scale or reduction scale. When details are drawn to the different scale in the same drawing sheet corresponding scale should be mentioned **under each such detail**.

Refer GTTC standard Drg. No. :11 - 16 - O47 Drg. No. : 11 - 16 - 048

SUMMERY	At the end of the class the student should have understood what is dimensioning, necessity, the terms used in dimensioning and the 2 methods of placing the dimensions. The different types of dimensioning and the use of scales and its application.
EXERCISES	**Dimensioning exercises**:Dwg file: Sheet no: 11 - 16 - Q27 to 11 - 16 – Q30Sheet no: Exercise Drg. No. : 11 - 16 – 059 to 11 - 16 – 061 **Exercise for scales:dwg file11 - 16 – 061 to 11 - 16 – 063**
AUTHORS OF TEXT BOOKS	ND BHAT
TOOLROOM REF	Engineering drawing file

BEST WEBSITE/link	https://books.google.co.in/books?id=N97zPAvogxoC&pg=PA340&lpg=P A340&dq=Equi-+distance+dimensioning&source=bl&ots=cIHxsf9Tmt&sig=XpDizWOpr2RHI5LD6YchlOHmepg&hl=en&sa=X&ved=0ahUKEwjUrd6Jq9PTAhVJzb wKHe8UDhcQ6AEIMTAF#v=onepage&q=Equi-%20distance%20dimensioning&f=false http://metal.brightcookie.com/2_draw/draw_t5/htm/draw5_2_1.htm http://dlia.ir/Scientific/e_book/Technology/Mechanical_Drawing_Engineer ing_Graphics/052060.pdf
OTHERS	http://www.kuet.ac.bd/webportal/ppmv2/uploads/1386659781Mechanical %20Engineering%20Drawing%20(ME%201200).pdf
REMARKS	The trainee should select the appropriate drawing from the engineering drawing file and dimension by following the rules and practical hints to acquire the skills of dimensioning. **Format given below.** **NOTE: Teachers may need to break this chapter into 3 and give practice exercises in the middle so that student does**

(See that all points are covered with a maximum of 6 drawings). FORMAT

Sl no	Component	Dimensioning Skill covered
1.	The component should have the contents in the skill covered. **THIS IS JUST AN EXAMPLE**	1)Aligned method 2)Representation of chamfer
2.	The component should have the contents in the skill covered. **THIS IS JUST AN EXAMPLE**	3)Dimensioning cylindrical components 4) dimensioning holes 5) P.C.D
3.	The component should have the contents in the skill covered. **THIS IS JUST AN EXAMPLE**	6) Staggered dimensionig 7) angular dimensionin
4.		**MORE SKILLS**

5.		**MORE SKILLS**
6.		**MORE SKILLS**

QUESTIONS

Objective:

1. Dimensioning lines to be drawn _8__mm away from the out line and each other.
2. Irrespective of whether the scale is reduced or enlarged the dimension you mention in the drawing should be of _____dimension.
3. 5:1 is _____ scale.
4. Holes should be dimensioned in the view where they appear as _____.
5. Overall dimension is placed _____.
6. The length of the arrowhead should be about 3 times the maximum_____.

Subjective:

1. Define dimensioning and explain the methods of dimensioning?
2. Differentiate between aligned and unidirectional system of dimensioning.
3. How do you represent unequally spaced holes on a P.C.D
4. Draw a sketch and show representation of external and internal chamfer.
5. Name any 5 general rules of dimensioning?
6. Explain when to use an enlarged scale.