ENGINEERING GRAPHICS

FIRST YEAR NOTES

-AKSHANSH CHAUDHARY

Engineering Graphics Notes, First Edition

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Engineering Graphics

(TL-1)

Theory Lecture - 1

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ENGINEERING GRAPHICS

✱ Views

- Orthographic (To see the front & other views to get the projection of a 3D object in 2D)
- Pictorial or Isometric (To see the 3D object image or visualised directly).

✱ Size of Sheets

Designation	Trimmed Size (mm)	Untrimmed Size (mm)
A0	841 x 1189	880 x 1230
A1	594 x 841	
A2	420 x 594	
A3	297 x 420	
A4	210 x 297	

✱ HB : Hard ~~Brush~~ Black

↳ 2H < 3H < 4H : Lightness decreases

Dark ← ⋮ → Light.

... 4B 3B 2B ~~HB~~ HB 2H 3H 4H ...

(PL-1)

Practicle Lecture - 1

~~AUTO~~ Auto CAD

☆ DRAW COMMANDS

1) Line Commands:
   To draw st. line.
   - Alt. commands also available to draw line.
     - (i) Absolute method
     - (ii) Incremental method
     - (iii) Polar method.

2) Circle:
   To draw circle with given centre pt. & radius or diameter.

3) Arc:
   To draw circular arc

4) Ellipse:
   To draw an ellipse.

Sheet Sizes (mm)

A_0	841 X 1189
A_1	594 X 841
A_2	420 X 594
A_3	297 X 420
• A_4	210 X 297 [400 X 600]
A_5	149 X 210
A_6	105 X 149

* If we take original A4 size, area got is very less to draw diagram. So, we take approx double its size → ≈ 400 × 600 (mm)
* Open → use a wizard → Advanced setup.
* Under the precision :-
  - ✓ Decimal : Precision [0.0] (units & angle)
  - ✓ East as 0 (i.e, select east dir^n).
  - ✓ Counter clockwise dir^n.
  - ✓ 400 × 600 (length × width) (manage accordingly)
  - ✓ To show grid pts - to make easy locate sheet size
    Goto > bottom tabs → GRID (Right click ↓ Settings.
    spacing → 10
    (Make grid option on by clicking the check box).

Note :- Click finish button. Don't press enter key

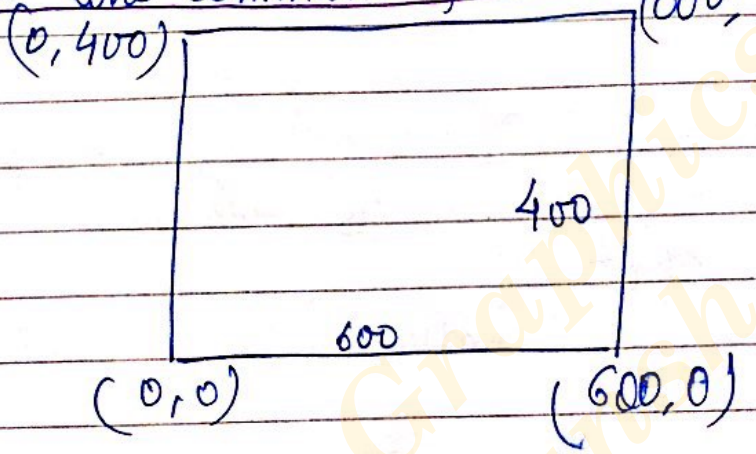
* Zoom :- ✓ Type Z for zooming
  Press 'Z'

In command box
- → Type 'Z' & then 'enter'
- → 'all' or 'a' 'enter'
- → Reduce zoom value,
  - → 'Z' 'enter' '0.9' 'enter'
    (90% Zoom value to set).
- → Restrict movt of cursor
  - → SNAP at bottom
    Right click → settings
    Put snap on (Click check box.)
    → Make 5 unit spacing in X & Y

8 Toolbars & Menu

* Menu bar :- called as Utility menu
Below that :- standard toolbar.
Below that :- Properties toolbar
Left side :- Draw toolbar
Right side :- Modify toolbar

* Select line command from draw toolbar



(i) Absolute Method.
↳ Type in Command bar
0,0↵ 600,0↵ 600,400↵ 0,400↵ 0,0↵

(ii) Incremental Method.
↳ See increment value in X & Y axis.
0,0↵ @ 600,0↵ @ 0,400↵ @ -600,0↵
@ 0,-400↵

[X increment, Y increment]

means:- from the point we are giving the incremental value in a SPECIFIC direction.

(iii) Polar Method : length & angle.
0,0↵ @ 600 ∠0↵ @ 400 ∠90↵ @ 600 ∠180↵
@ 400 ∠270↵

• ∠ : angle symbol (use < : less than)

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After doing this, still command would be running. So, right click → cancel or enter

In circle tool
↳ In command bar, the default value entered would be radius. To ~~draw d~~ enter diameter, Press 'd' ↵. Then enter diameter.

* To draw arc :- Select Arc from tools.
Sequence :-
centre, start, end. (CSE) (Comp. Sc. Chay to remember)

'c' ↵ 'Select the centre point & then select the start & end pts. in COUNTER CLOCKWISE DIR".

* 3 pt. arc.
Goto DRAW (Utility menu)
↳ Arc
↳ 3 pt.
Way :- Select 3 pts. in order. It will make an arc itself.

Ellipse : Select command.
Select one end of major axis & then the other end pt. of major axis & then any end pt. of one minor axis (half of length).

(ii) Select the mid pt. of major axis & then the end pt. of major axis & then minor.
↳ 'C' ↙ → First of all
then select the pt.

—∞—

TL-2

§ Orthographic Projection.

✓ Elements of Proj^n
↳ Object, Plane of proj^n, Observer

Projection

Multi-view proj^n (Orthographic)

Single view proj^n (Pictorial or Isometric)

- Vertical plane (VP) → front view
- Horizontal plane (HP) → top view
- Principle plane (PP) → side view
- Intersⁿ of VP & HP is called X-Y line.

✱ Glass box method :- To see various views of an object (orthographic proj^n) → & then, open the object after projecting all the key pts.

5, horizontal plane → motion

after keeping it in a box → First Angle Projection

✱ In FIRST QUADRANT :-
- Above X-Y line : Front view (i.e VP is above)
- Below X-Y line : Top view (i.e HP is below)

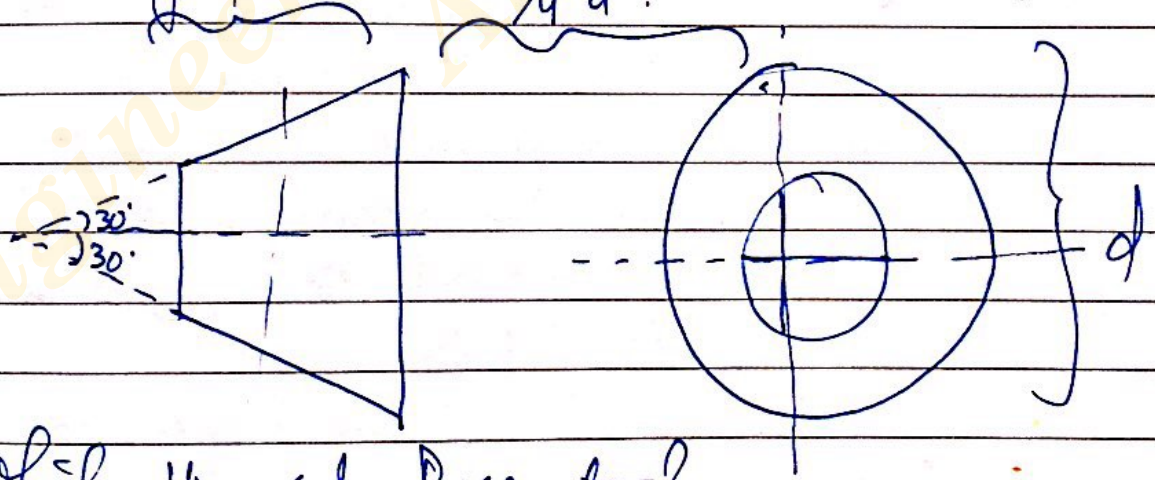
✱ In THIRD QUADRANT → Third Angle Projection
Above X-Y line : Top view (i.e HP is above)
Below X-Y line : Front view (i.e VP is below)

✱ Symbolic represent^{n} of First & Third ∠ proj^{n} :-

Draw :- ~~VP view HP~~
~~HP view VP~~

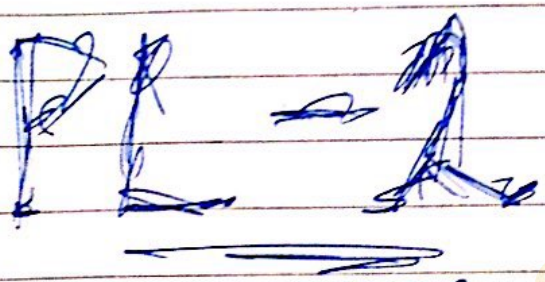
First angle :- RHS view on left side of front view.

Third angle :- LHS view on left side of front view.



✱ Which Views to Present ?
- Pick Front view that is most descriptive of object.
- Longest dimension is chosen as width (or depth)
- Most common combin^{n} :- Front, Top & Side

* Hidden line - - - - - - - - -
* Centre line ——— - - ———
*



* Polyline : For making polygons
  - ✓ Select polyline cmd from tools.
  - ✓ Edit polyline → Rt click → Edit Polyline edit. width / length
  - ✓ Type w ↵ (to edit width) 'no.' ↵

Note : To see line thickness, click lineweight tab at bottom

- ✓ The lines can be changed from properties bar and change —— By line
- ✓ Select — By layer & select other.
- ✓ Dialog box opens. → Select load.
- ✓ Hold ctrl key to select & load multiple lines.

* We have to change line type scale
  Goto → line → other → Dialogue box
  Global scale factor → change as per convenience for visualising the diff+ lines.

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✲ Hatching

Draw toolbar → Hatch icon
→ Select boundary of obj. → After selecting them, select the object & press ↵
→ Select internal area of obj } 2 ways of hatching

→ options available in the hatch dialog box.
To increase the distance b/w hatching lines, ↑ scale in the same dialog box.
or vice versa for ↓ distance

✲ For internal area hatching only, use Pick points option for selecting an 'inside portion of an object.

✲ Type text :- Multiline text option in draw toolbar.
Select the area & type the text. To change text size after writing, double click, the same box opens.
Note ↳ We'll use only Arial font.
↳ For default font options
✲ Utility menu → Format → Text Style
Choose * Font name → Arial
* Height → 5 (min.)

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☆ Polygon :- Draw toolbar → Polygon.
• enter the 'no. of sides required' ↵
Note :- Always choose the edge method.
For that, type 'E' ↵
Then make the polygon accordingly.
For making the polygon at a particular angle, use POLAR METHOD. Use its syntax.
@ length < angle

☆ Polyline edit : To make a free line using Polyline.
✓ Draw polyline, using the dimensions given
✓ Goto Polyline edit (Rt click)
✓ Select the line (Maybe snap off/on).
✓ enter → 'S' ↵
You are done.
✓ Note :- For FIT CURVE (making a free line follow a curve) → Enter 'f' ↵ (instead of 'S' ↵)

☆ Rectangular ARRAY :-
✓ Make the object to be repeated
✓ Goto → Modify toolbar → Array option.
✓ Select rectangular ~~option~~ array →
then 'Select object' ↵. Now select the object & press ↵. Select the no. of rows & columns.
✓ Row offset :- Length from top to bottom.
✓ Column offset :- Length from rt to left.

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POLAR ARRAY

- ✓ Modify toolbar → Arraw
- ✓ Select Polar array
- ✓ No. of items } enter these
- ✓ Angle to fit }
- * To specify, enter the 'Pick centre point option' & press ↵.

OFFSET (Something like Contour from Corel)

Modify toolbar → offset.

(Fig 1)
- ✓ Enter 'distance for offset' ↵
- ✓ Select the object & specify where the new object has to be placed.

(Fig 2)
- ✓ Through method:-
  - ✓ Type 'T' ↵
  - ✓ Select object & specify distance (just by clicking the area)

Creating a + mark

Mirror cmd

- Select mirror cmd from modifier toolbar
- Select obj.
- ↵
- Goto OSNAP opt. Rt click, settings. make Object snap on and selet all click OK. Move cursor to boundary. It shows the mid pt. Come down, select the 2nd mid pt.
- Press ↵ to make obj. appear.

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Ex-3

✡ TRIM

Type → 'tr' ↵ 'all' ↵ ↵
• Put SNAP off to move freely.

✡ Show centre mark

Format → Point Style &
↳ Select the desired style
↳ Point size → 5
↳ Set size in absolute units.
(Select this 2nd option)
↳ OK ↵

✡ Pick 'Point' option from DRAW toolbar & just click on the desired posⁿ to place it there.

✡ Saving file with Password

File → Save (Ctrl+S) → Dialog box opens
↳ ~~G~~ ↵
Goto → Tools (upper lt. corner)
↳ Security options.....
↳ Dialog box opens → Give Password.
↳ OK ↵
• It asks for conformation. Confirms & save.

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* Lineweight for problems.

For linewt → select object
↳ By layer (extreme rt.)
↳ select 0.30 mm.

* For border line → give linewt as 0.5mm

* To make title block (150×50)
Pick line from Draw toolbar
↳ 450, 0 ↵ - - - - - make the box

To remove the extra lines that come in the box, use trim cmd. For other lines, select them & delete.

Write → Name
ID no.
Section
assignment no.
date.

* PRINTING
File → Plot (Ctrl+P) (Dialog box opens)
Name :- <None> → leave it.
· Select Printer :- HP LaserJet Plus (1.5) ← any one
· Paper size → A4
· Plot Area → What to plot → Limits.
· Check → Center the plot.

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Rt. side

Plot style table (pen assignment) → Monochrome.ctb *

Plot options

↳ Check Plot stamp on. (details of the print date, time, comp. no. are there)

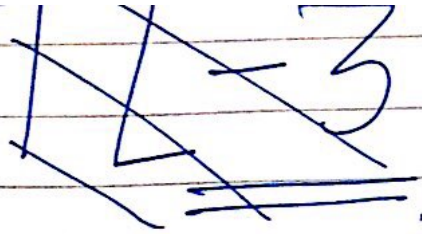
- Click on Preview. (So that all diagrams come in sheet).
- If diagrams not in sheet →

Esc → Plot area → Window option

Select window area ↵ (don't leave much space)

opens dialog box again.

- Press Esc → OK → document will be printed.



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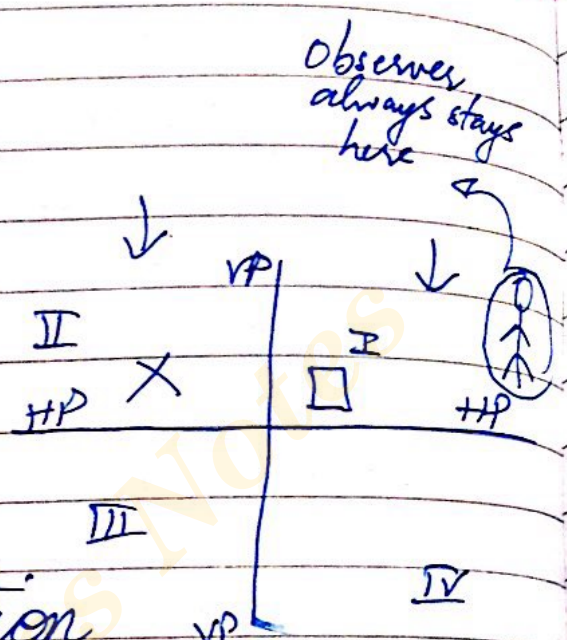
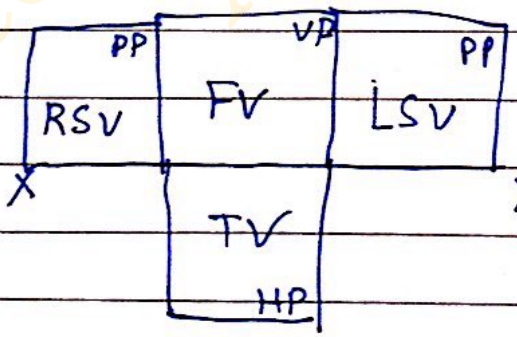


✱ Orthographic Projection

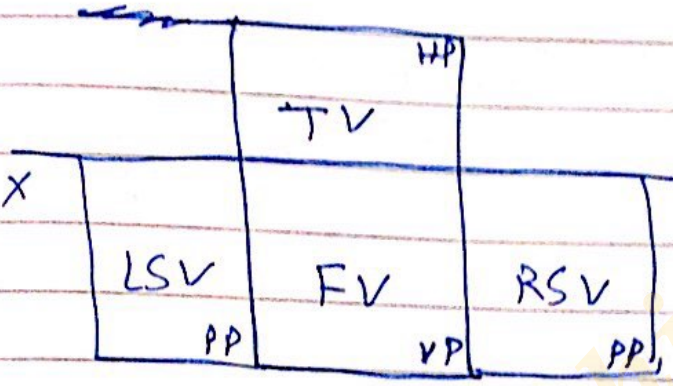
- Methods of Projection
  - Object is in b/w to the observer & the plane of proj^n
  - Plane of proj^n is in b/w to the observer & the object
- ✱ Rotate HP in ↻ dir^n.
- ✱ First angle proj^n



reference line.

I am looking for the RHS view of the object from my Rt. side & image is projected on left side. So, looking on RIGHT & image on LEFT ⇒ 1st angle.

☆ 3rd angle projection



☆ (Points) to be remembered while making Orthographic Proj^n.

- FV & TV are always vertically aligned
- FV & Side view are horizontally aligned
- The length of the TV is same as length of FV.
- Height of the side view is same as the ht. of the FV.
- Depth of side view is same as depth of TV.

☆ After making orthographic Proj^n,

→ make FV :- change color.
→ extend lines of FV below :- complete TV
→ make TV :- change color.
→ make 45° angle :- extend lines
→ make side view :- change color.

Done

1st angle

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Before making Orthographic proj^{n}

- Properties Toolbar → 3rd column → 0.00 mm line width
- Line cmd → make reference line
- Modifier Text cmd → mark X & Y VP & HP
- Only for the side view → give 0.3mm line width

PL-5

Orthographic Projections

→ Principal Surface
→ Inclined surface
→ Skew Surface
→ Curved surface.

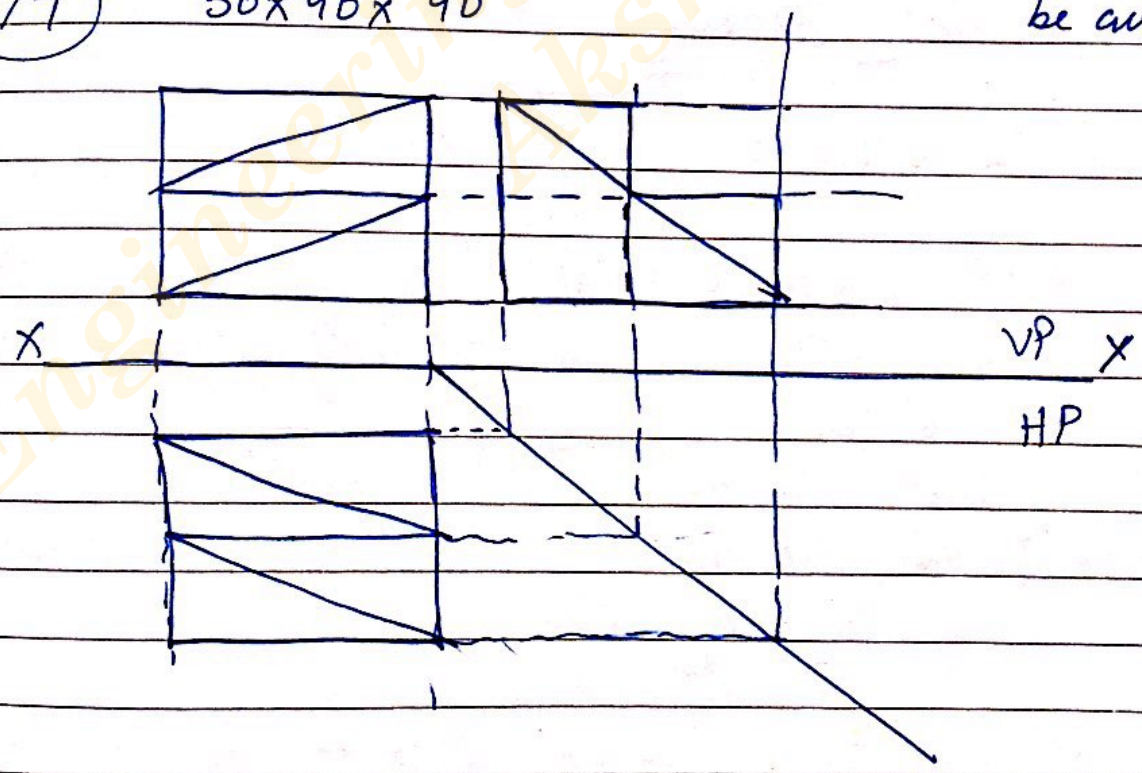
• Wherever we give centre line, It means that the both sides of that box are curved. eg

These 2 sides are meant to be curved.

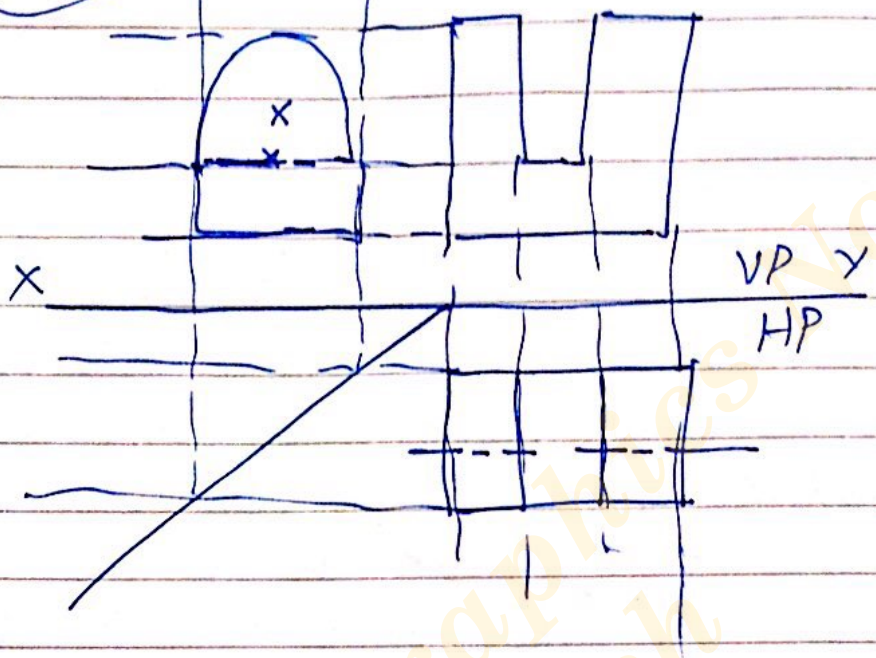
Dimensions are taken as :-

*. Length x Height x Depth.

(1/7) 50 x 40 x 40

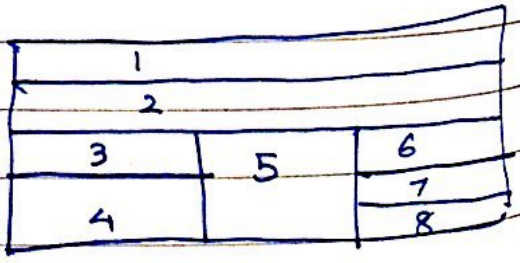


13/3 60×60×60



Title block

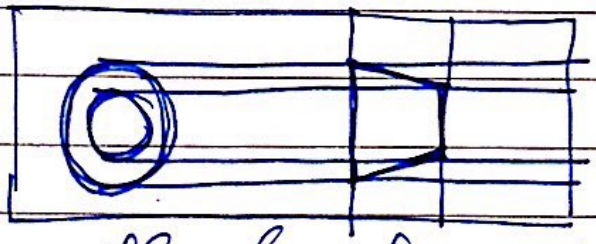
- Dimensions :- 150 × 50
  (Horizontal × Vertical)
- The box is 600×400. So, start the title block from (450, 0). Go vertically 50. & then complete.
- Select line and in the beginning.
- Divide the title block into rows & colms.
  10 – 10 row wise
  50 – 50 colm wise.
- Trim the lines to get ⇒
  (Also change the text style from format menu)



2 :- BITS, PILANI – DUBAI
(move text in the middle)

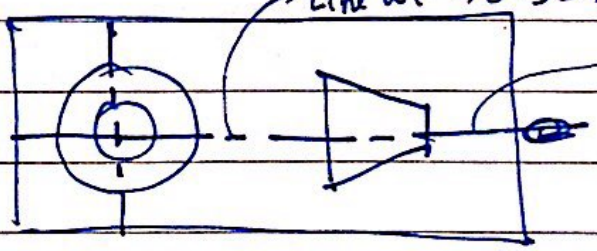
1 :- Name.
3 :- ID no.
4 :- First ∠ Proj^{n} symbol.
5 :-
6 :- Assignment no. 8
7 :- Date
8 :- Scale (1:1 / anything like this)
↳ If same scale as in assignment.

(4) :- Take 10 mm distance from left & make a 6 mm rad. circle. Make another circle in that of radius 4 mm.
From 20 mm from right make a vertical line.
Make horizontal lines from the circles.



Make another line from 10 mm distance (rt.)
Just keep the darkened portion & remove the rest of the lines.

Change global scale factor



✡ Match Property (Tool looks like a brush)

Used to make sameness of a property in one to the other.

It can be used to color lines similarly.

✡ Dimension

Goto → Dimension → Style....

↳ Dialog box opens.

↳ Modify... → select this

↳ Select lines & Arrows tab.

↳ Extension lines.

↳ Extend beyond dim lines:- 3mm.

↳ offset from origin :- 2mm

↳ Arrow heads (Closed filled)

↳ Arrow size → 5mm

↳ Center mark for circles.

↳ Size → 5mm.

↳ Text tab

↳ Text appearance

↳ Text ht → 6 (see)

↳ Text Placement.

↳ Vertically: above

↳ Horizontally:- centered

Text tab.

- offset from dim line :- 2.
- Text Alignment
  - ⊙ Align. with dim line.

Making dimension

- ~~Solo~~ Goto → Dimension
  - → linear.
- Select the ~~is~~ Start & end pt. & move along the extension line to some desired distance

Ily give radius, Aligned (for inclined)

center mark (for circle/semicircle).

Cond^us to be kept in mind

- ✱ Dimension lines should not intersect each other
- ✱ Avoid repitition
- ✱ Avoid dimensioning inside the object.

TL-5

CHAPTER-6

Isometric proj^{n}	Isometric Drawing
• The size (actual) of the object as it turns to 36°. (81.5% scale)	• It is the apparent size of the object to make simple (V 100% scale.)

PL-6

Mid Sem Examination

Test-1 (Ortho. Pro) → 40 marks
Assignment (1-3) → 30 marks

Total 70 marks

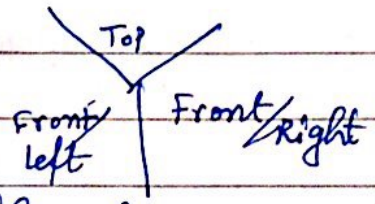
Isometric Drawing

- Reference box method
- Coordinate Axis method.

Change snap settings →
↳ rectangular to Isometric
↳ Click OK

Keep ortho on

when you make line, it will make diagonal lines. To make horizontal & vertical lines, press F5 & make



Make the diagram on this axis & delete the reference lines that were made.

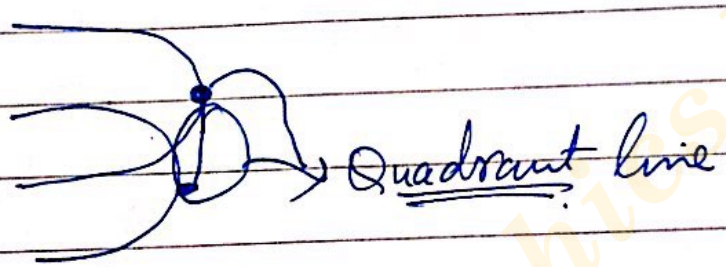
Goto → Dimension
↳ leader (no line wt. for it (indicating FV)

Draw arrow line over the front view.&
(Keep ortho on/off if you find difficulty in moving through cursor)

- To make circles / arcs in isometric drawing.

⇓

Goto Ellipse → Isocircle cmd
↳ Press 'I' ↵
(Press & F5 key to change views of the circle in 3D)



PL - 1

✗ Things to be done on every startup.

- Text Style
- Point Style
- Line wt. management
- Dimension settings.

☐ Save the orthographic drawing (Test 1) as Q1 ortho. Make a copy of it & rename it as Q2 iso.

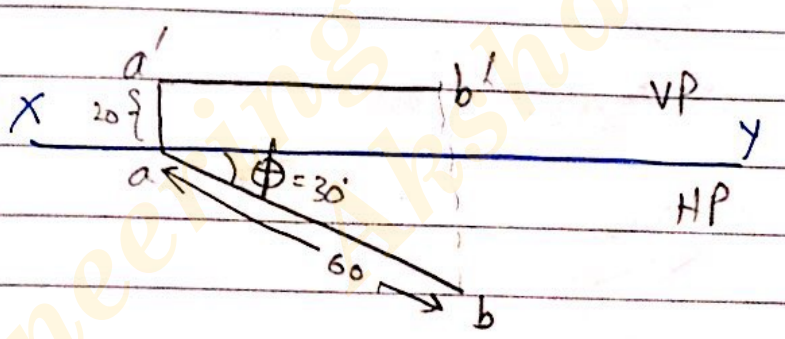
Both of these would be placed in folder (with our ID as its name) on desktop.

TL

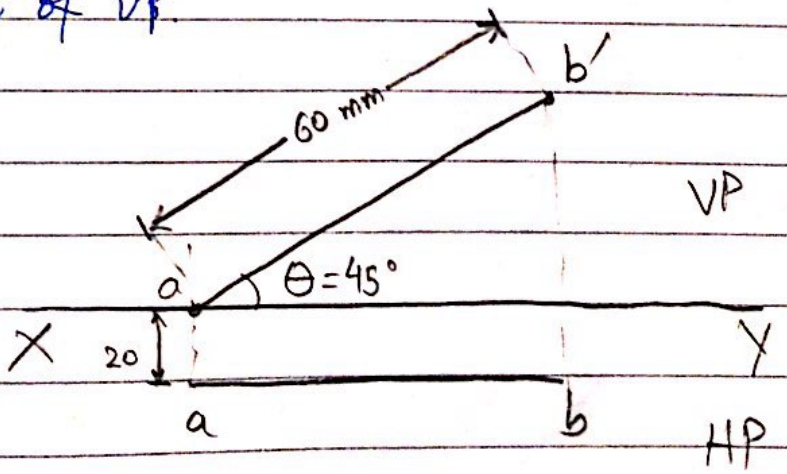
Projection of lines

- Inclin^n for HP : notation : True, Apparent : θ, α
  VP : : ϕ, β

Q. A st. line AB, 60 mm long, makes an angle 30° to VP & ll to HP. The end A is in the VP & 20 mm above HP. Draw proj^n



Q. A st. line AB, 60 mm long, makes an angle 45° with HP & ll to VP. The end A is in HP & 20 mm in front of VP.



Errors — Angle : ±0.1° } accepted.
Length : ± 0.1 mm
Error more than that ⇒ marks deducted

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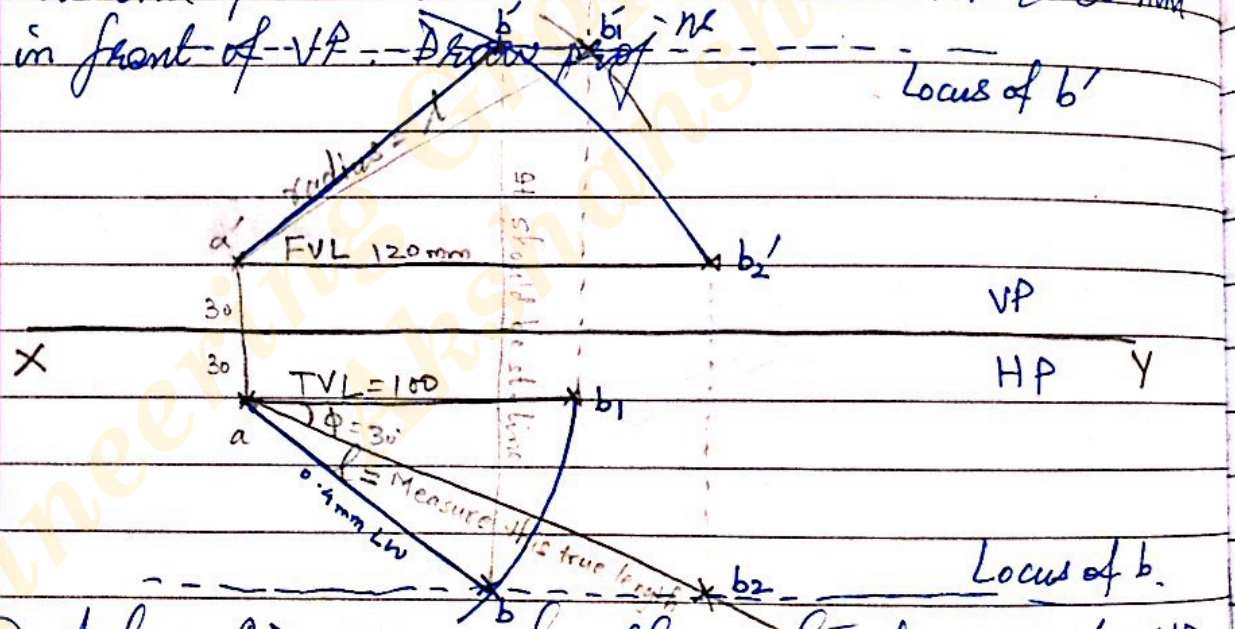
PL

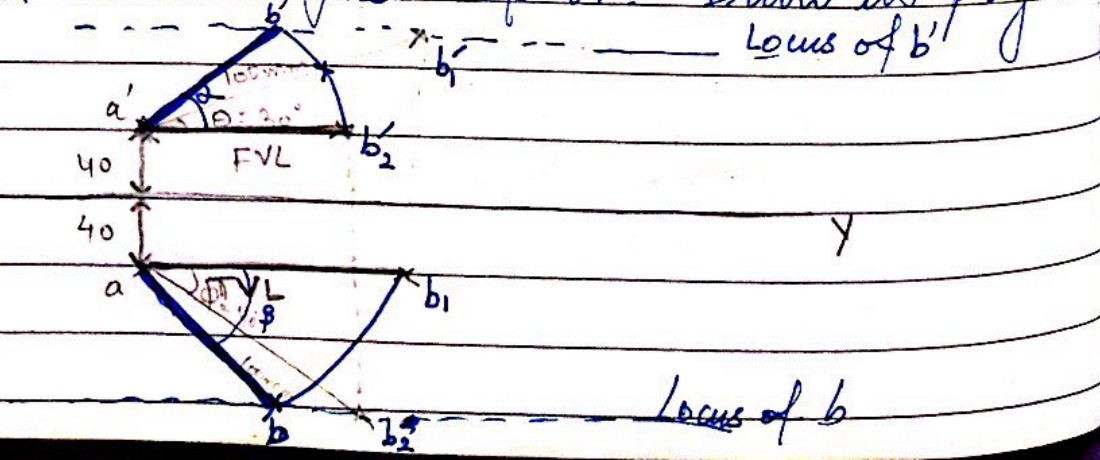
✡ Projection of Straight lines

○ Line inclined to both HP and VP.

eg. The top view & FV of a line AB measures 100 mm & 120 mm resp. The line is inclined $\phi = 30°$ (VP). The end pt. A is 30 mm is above HP & 30 mm in front of VP. Draw proj^n.



eg② A line AB 100 mm length inclined 30° to HP & 40° to VP. The end pt. A is 40 mm above HP & 40 mm in front of VP. Draw its proj^n.



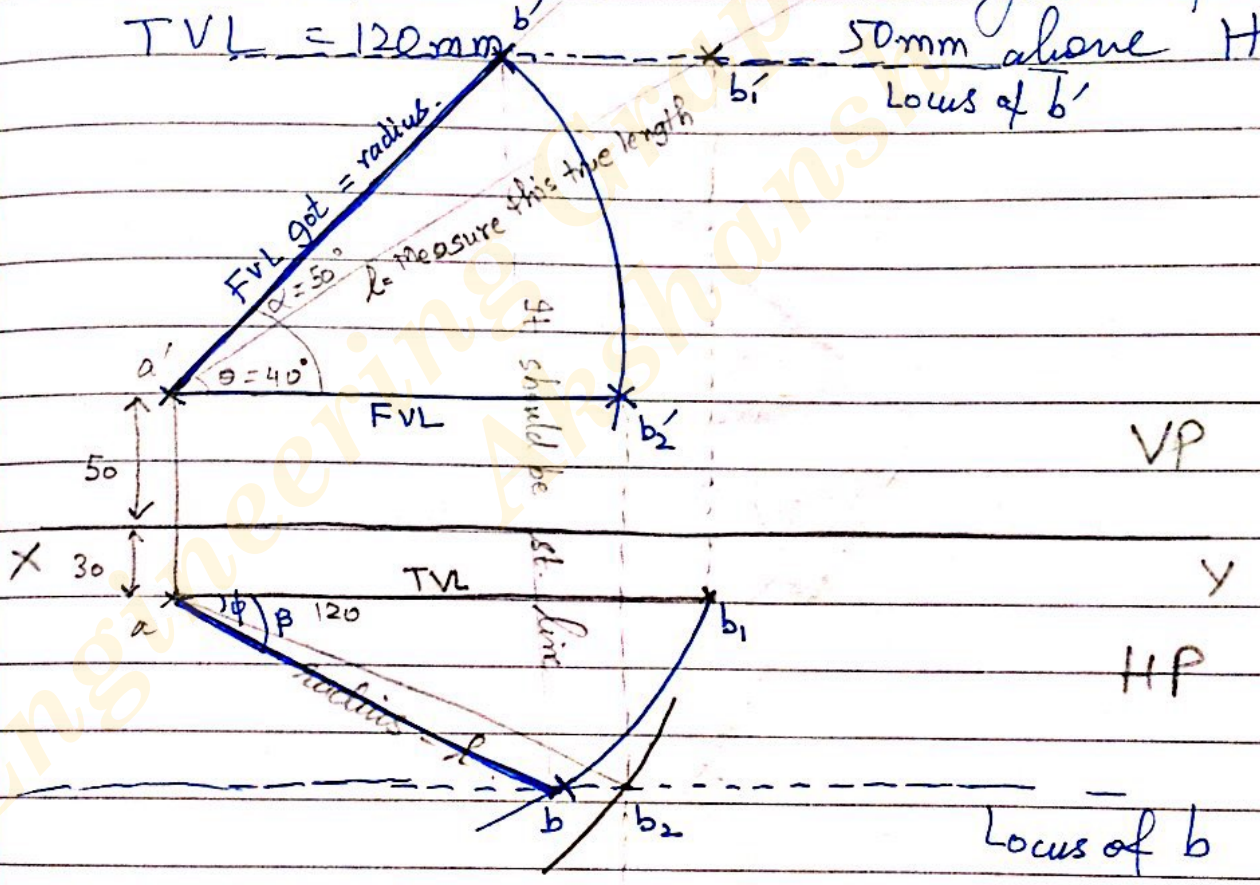
eg (3) The end pt. A of a line AB is 30 mm in front of VP & 50 mm above HP. The line is inclined at 40° to HP & FV is 50° to XY. The TV is 120 mm long. Draw its projⁿ.

$\theta = 40°$, $\alpha = 50°$

TVL = 120 mm

30 mm front of VP

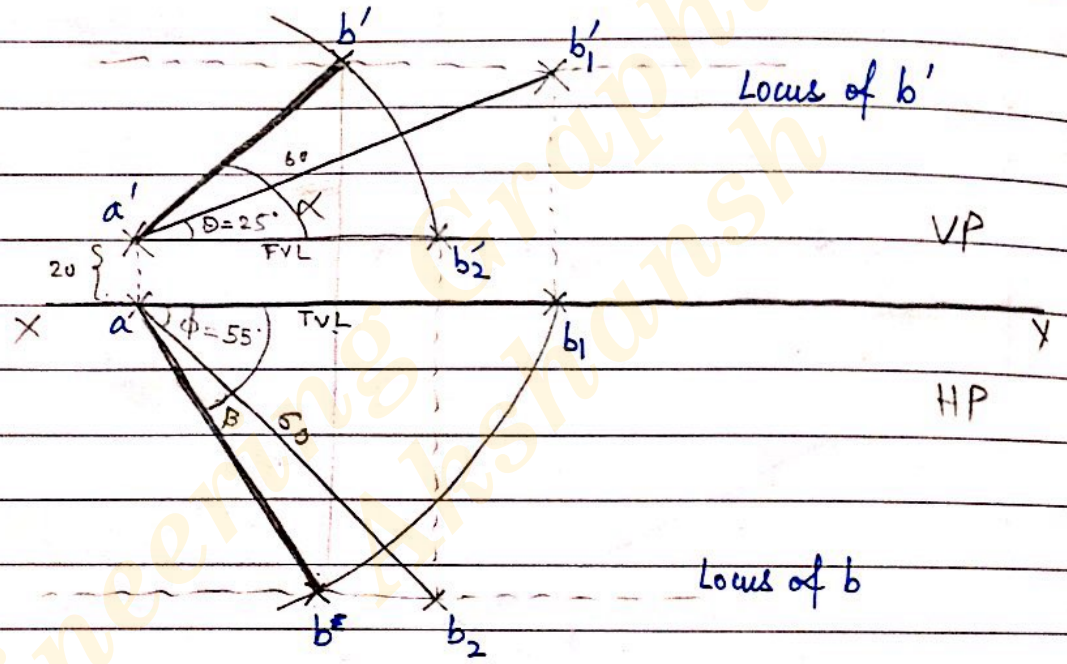
50 mm above HP



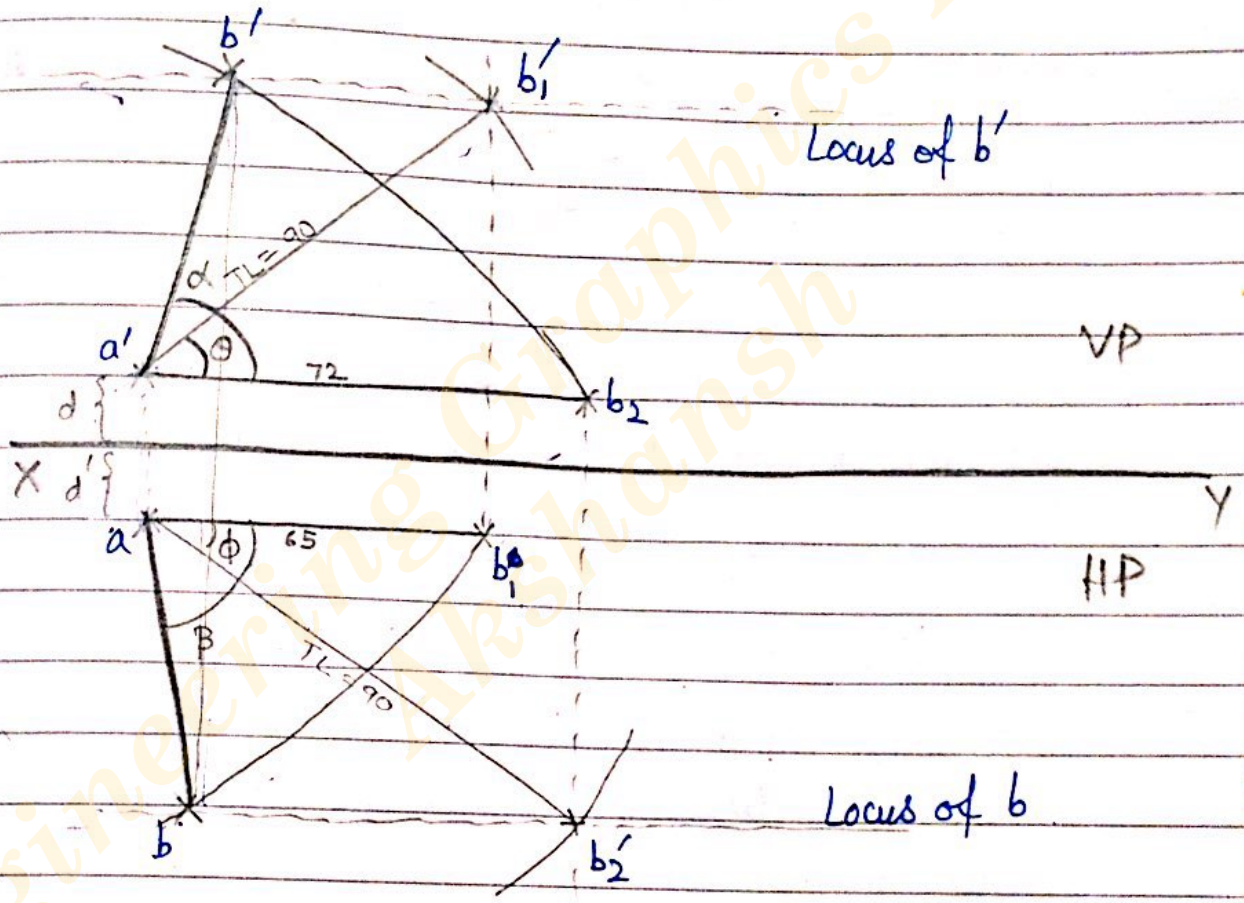
TL

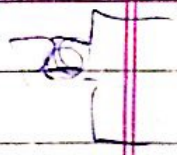
Line Inclined to both planes

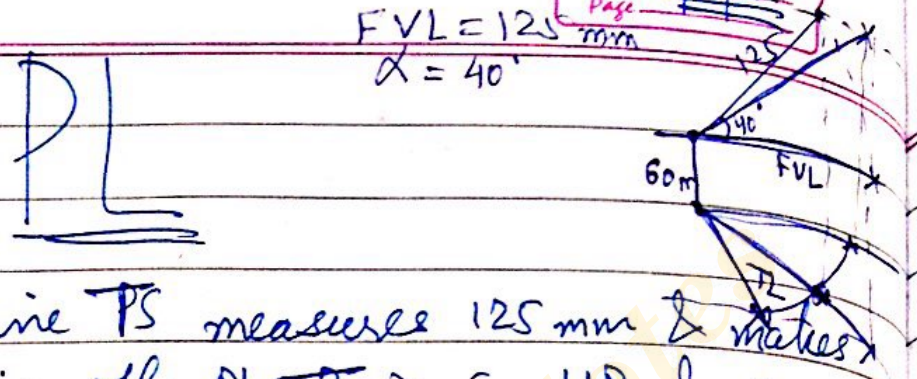
Q. A st. line AB, 60 mm long makes an angle of 25° to HP & 55° to VP. The end A is in VP & 20 mm above HP. Draw ~~the~~ proj^n



Q. A line AB 90 mm long measures 72 mm in FV & 65 mm in TV. Draw 2 views of the line. Fully in 1st quadrant. Find true inclin^n of the line. Assume a pt. A at a suitable distance from resp. planes.





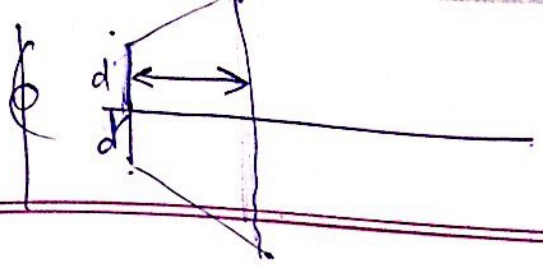


Q.1) The FV of a line PS measures 125 mm & makes 40° to XY line. The P.T is in HP & 60 mm in front of VP. The line is inclined 40° to VP. Draw its projns. FVL = 125 mm
$\alpha = 40°$
$\phi = 40°$

Q.2) A line CD
$\phi = 45°$ (VP)
C 40 mm in front of VP, 50 mm above HP
Distance b/w projectors is 100 mm with ~~end pt D~~
~~120 mm above~~
D 120 mm above HP & infront of VP
Draw projns.

Q.3) Line AB
A in HP, 100 mm infront of VP &
FV is inclined at 45° to XY ($\alpha = 45°$) &
has length (FVL) = 160 mm.
End B in VP.
Draw projns.

** The horizontal distance from starting pt. to the joining line of the 2 final (projected lines) is distance b/w projectors.



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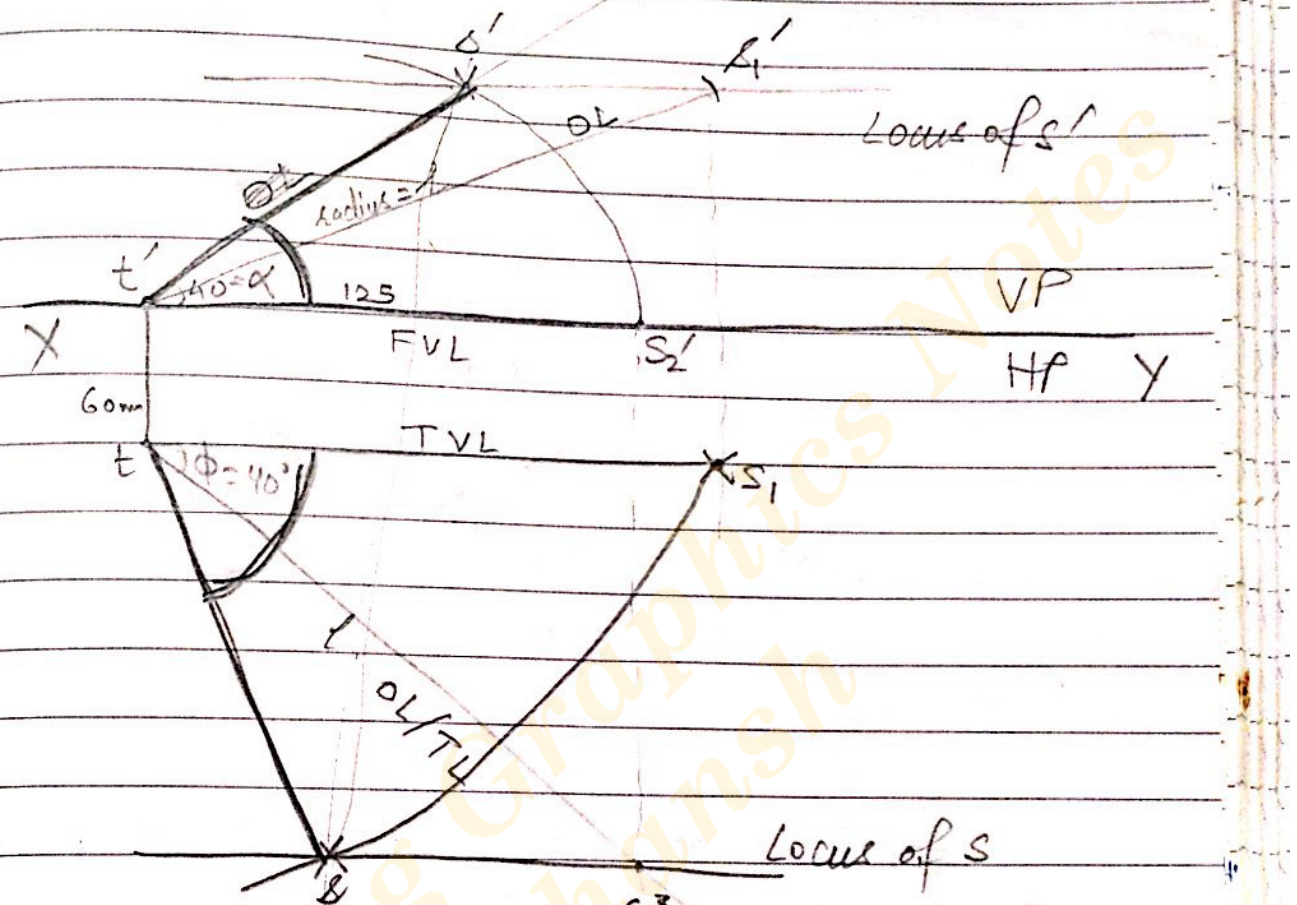
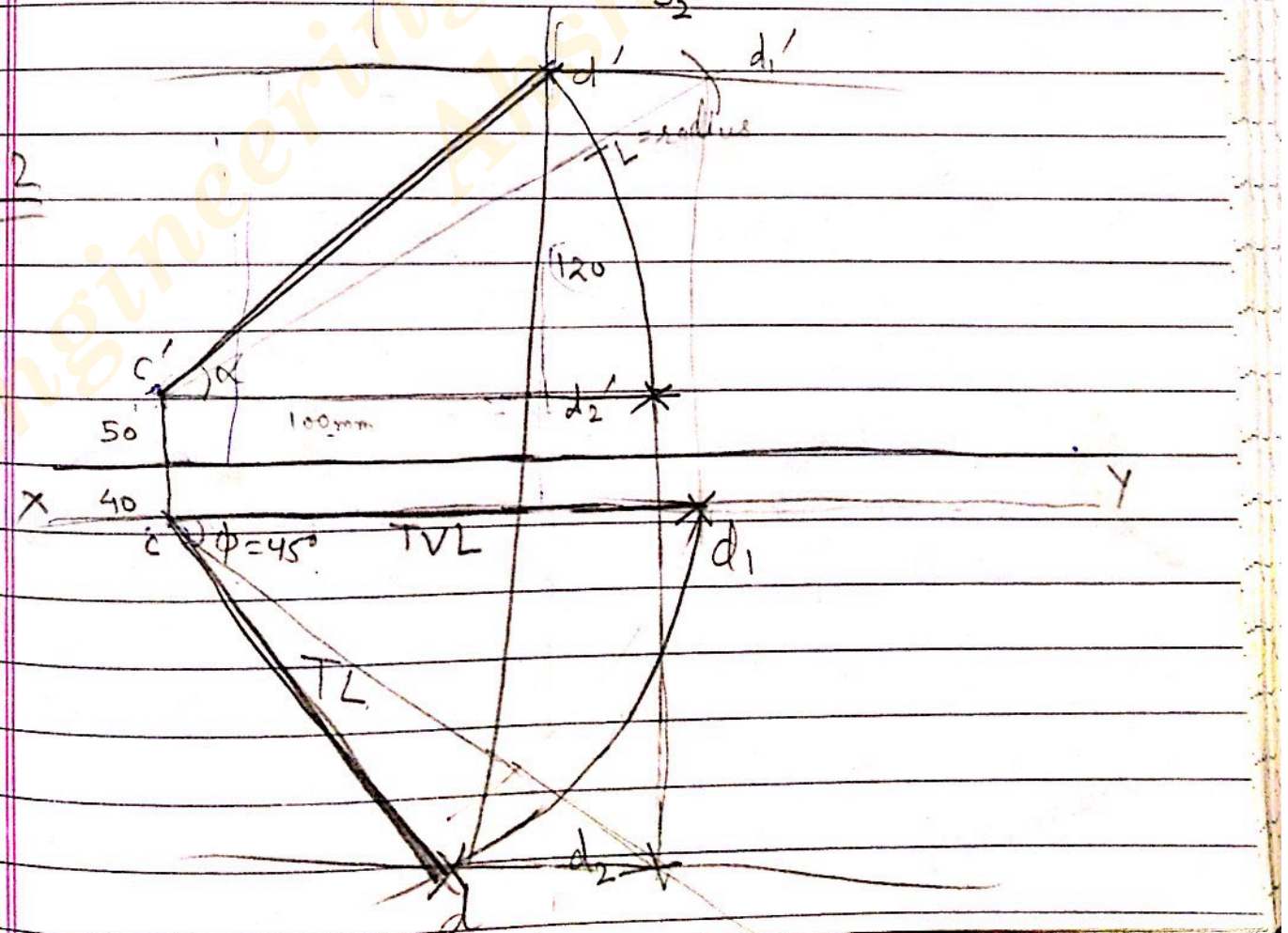
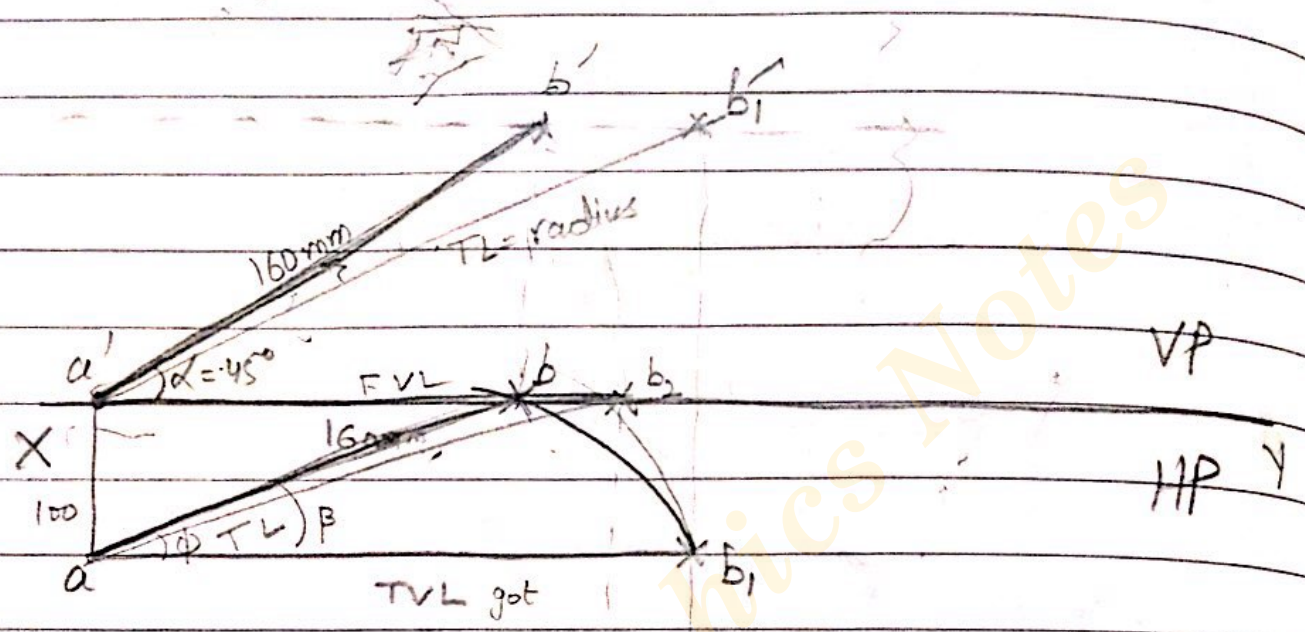
Q.1



Q.2





PROJECTION OF SOLIDS

Polyhedra

It is defined as a solid bounded by faces. When all the faces are equal & regular, the polyhedra is said to be Regular Polyhedra, otherwise, it is an Irregular Polyhedra.

eg: cube

eg: Prism, Pyramid

Solids of Revolution

Revol^n of a st. or curved edge above an axis generates a solid called Solids of Revol^n.

eg: Cone, Cylinder, Sphere.

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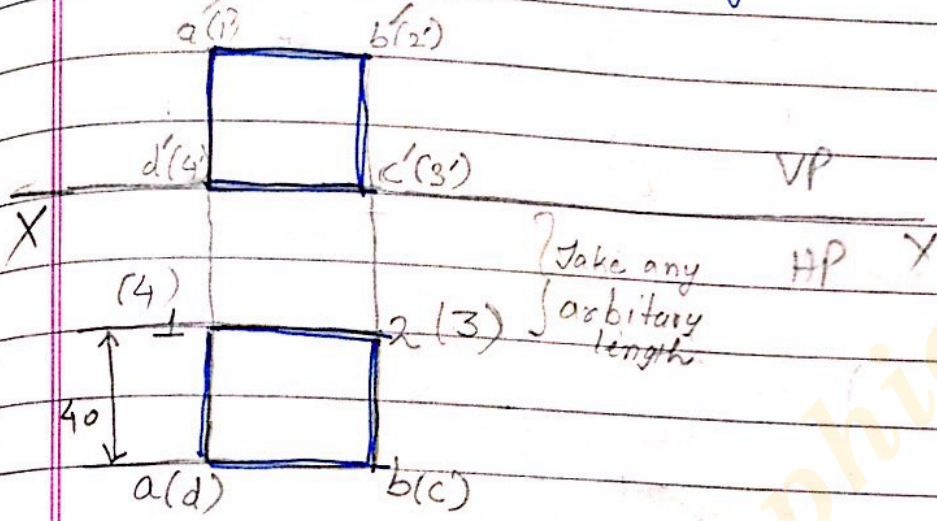
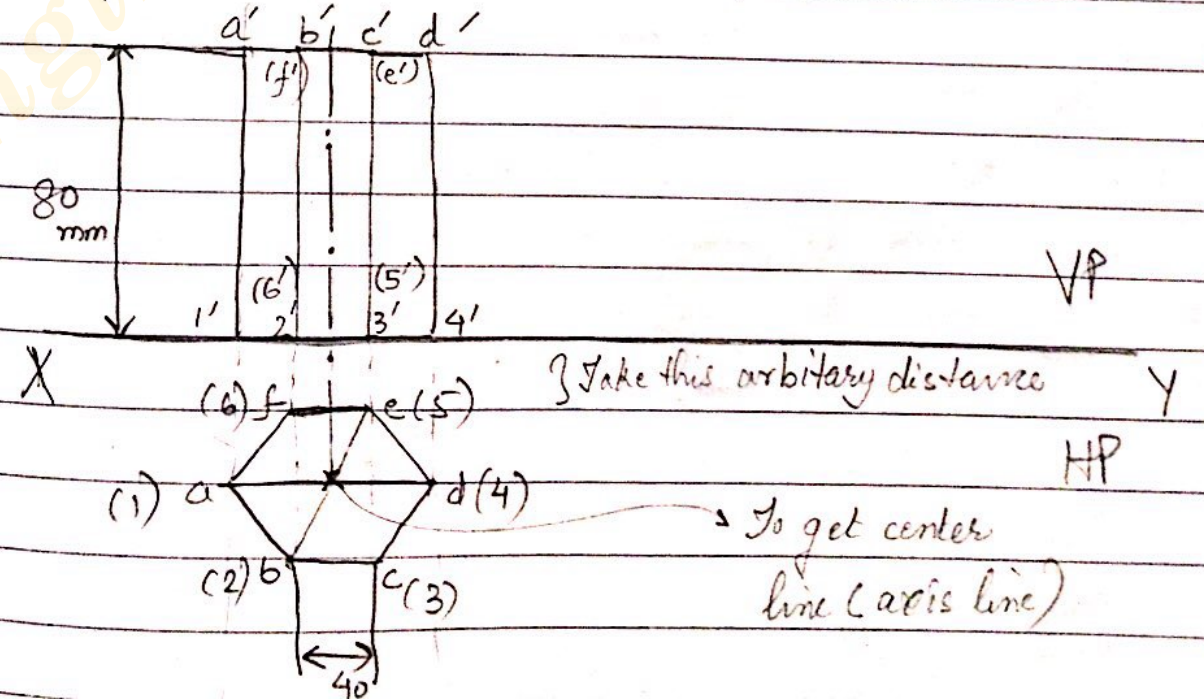
Q.1 A cube of side 40mm is resting on HP with axis ⊥ to VP. Draw projns.



* In case of cube, mention only one side.
* Give LW of 0.4mm to the projections.

Q. Draw projn of a hexagonal prism of base side 40mm & axis length 80mm, resting on HP with one of its base sides ⊥ to VP.



Generater line : Line joining apex to base.

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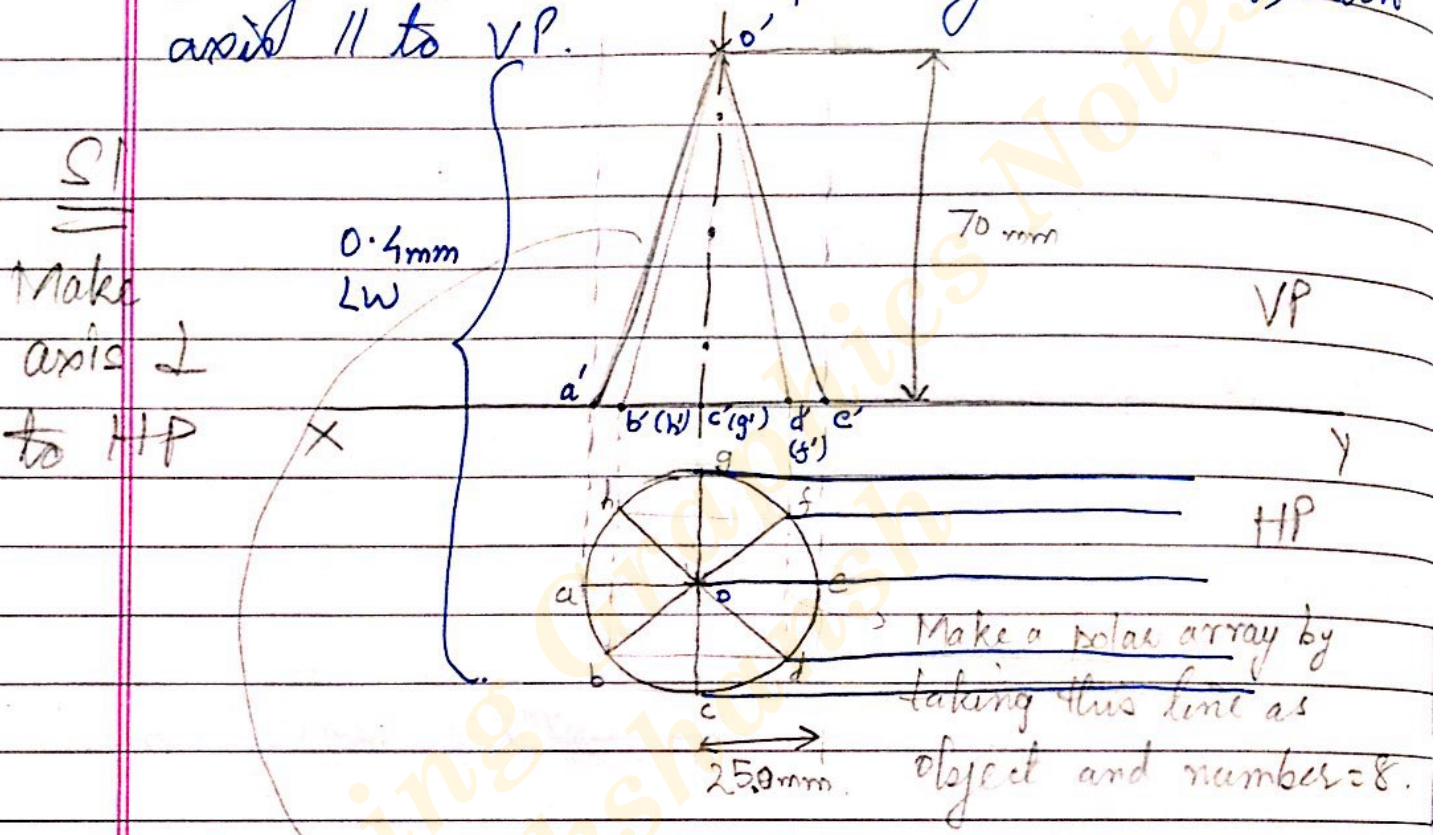
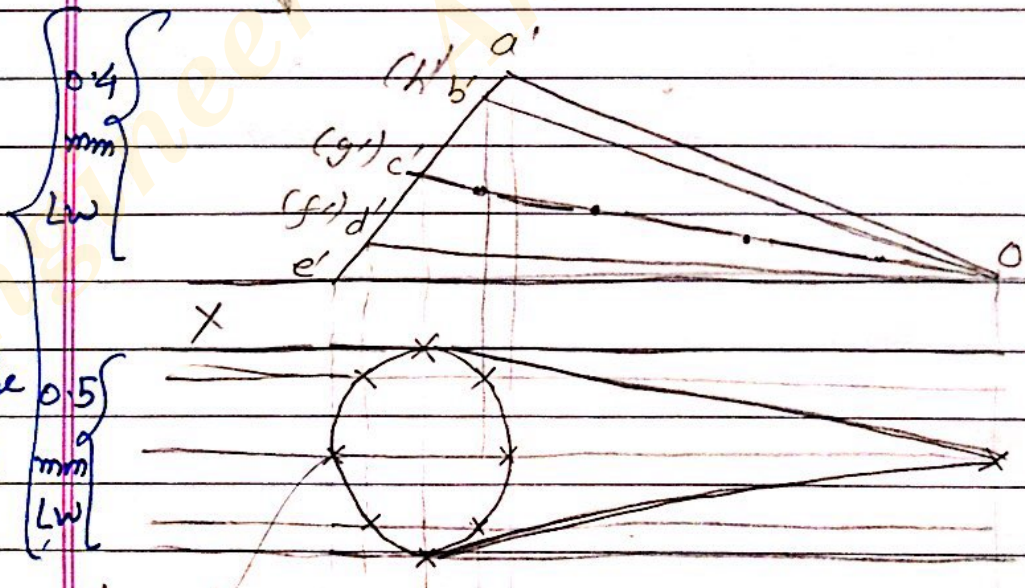
Q. Draw the proj^ns of a cone of base diameter 50 mm & axis length 70 mm when it is lying on the ground on one of its generators, with axis // to VP.





Join all these points with polyline. Goto polyline edit & do fit curve

* Trim excess lines after making the final view.

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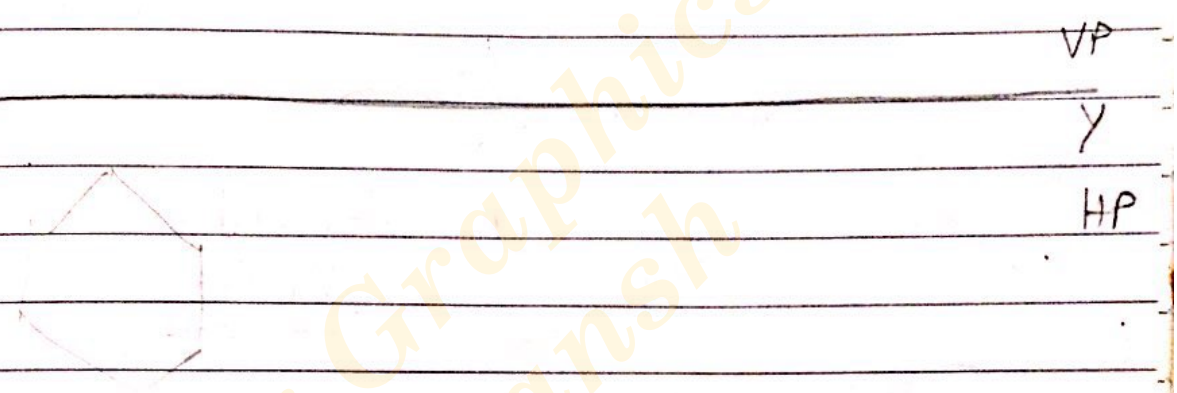
Q. Draw projns of a cylinder of base diameter 60 mm & axis length 80 mm, resting on its base with its axis inclined at 30° to HP & ∥ to VP



Q How to rotate the object.

* Copy the view & paste it seperately
* Select object, rt. click → Rotate
* Give base pt. on the reference line
* Select reference option by ~~typing~~ typing :
  'r' ↵
* Select 2 end pts. of the line that is going to be ∥ to X-Y line (Cmd box asks → Give angle of rotn)
* Adjust the posn & you get the object
  Move the object to ~~the~~ reqd posn.

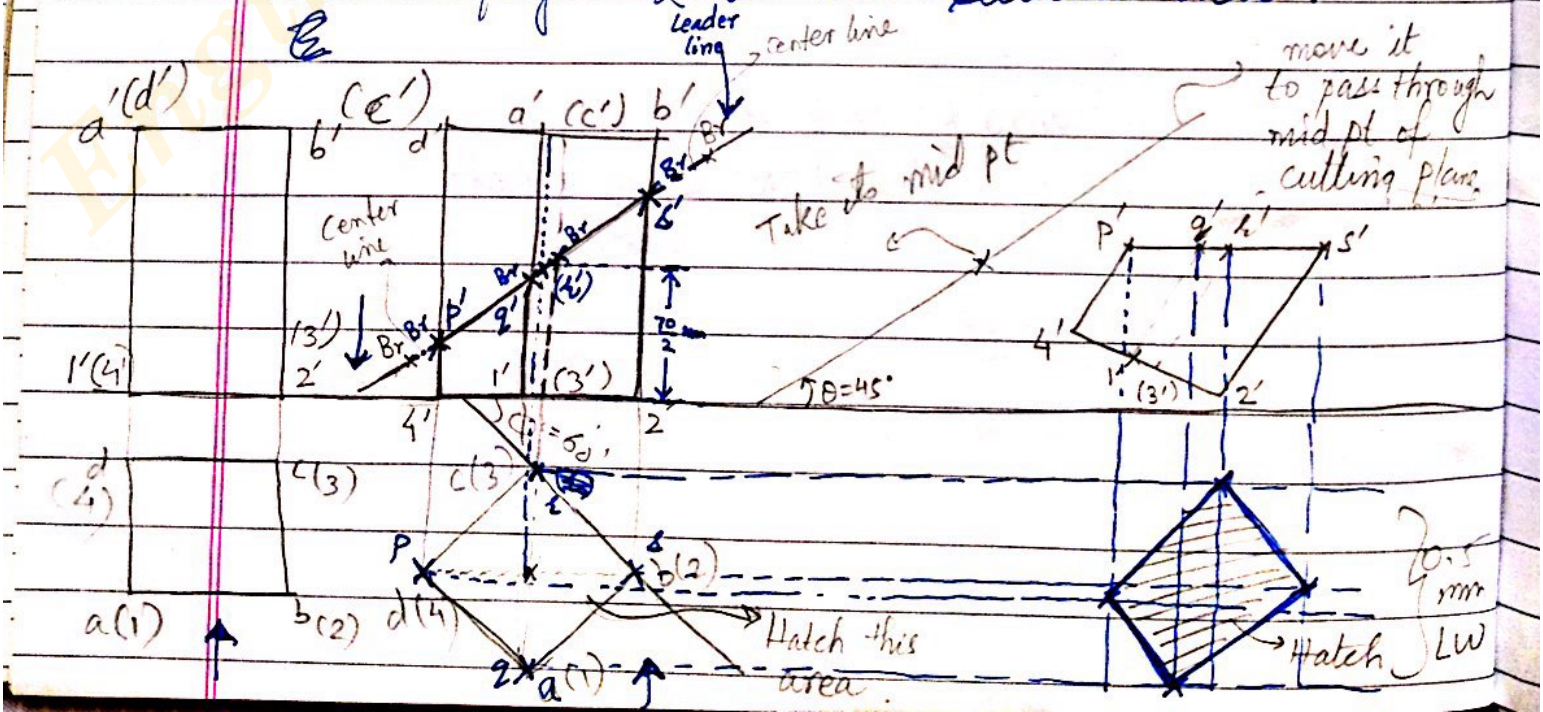
PL

Q. A hexagonal pyramid of base side 50 mm & axis length 100 mm is resting on one of its base edges on HP with its axis inclined at 30° to HP & ll to VP. Draw projns.

PL

✱ Section of Solids.

(Q.1) A sq. prism of base side 50 mm & ht 70 mm is resting on its base on ground (HP) with one of the vertical faces inclined at 60° to VP & is cut by a cutting plane inclined at 45° to HP & passing through mid pt of the axis. Draw its projns & its true sectional view.



* Break at a pt.

- Modify → Break at a pt.
  (In fig, it has been shown which lines to break → 'Br' written).

- p', q', (r') & s' are cutting pts. in all the 4 vertical edges.
  ↳ project these cutting pts. to Top view & Put a cross mark on the pt.

- Now we have to rotate fig. 2 s.t. its sectional surface is ∥ to XY.
  ~~Delete~~ copy the view
  Trim top portion
  Make inclined line ∥ to XY
  In the end, trim the area not required.

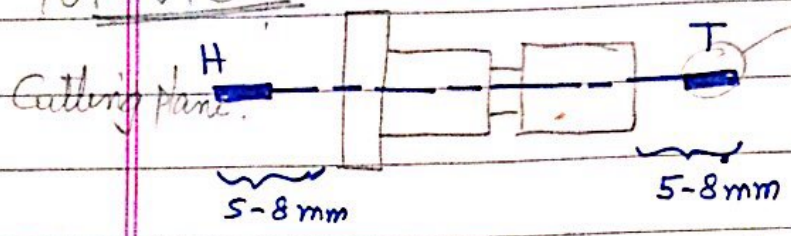
HW

Q. A cylinder of base diameter 60 mm & ht 80 mm is resting on the ground with axis ∥ to & HP & ⊥ to VP & is cut by a cutting plane inclined at 40° to VP & ⊥ to HP, passing through mid pt. of the axis. Draw its projⁿs & its true sectional view.

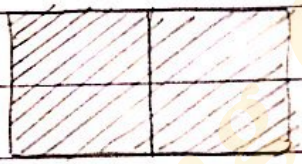
TL

* Showing the cutting plane / section plane

TOP VIEW



* Line name of cutting line :-
  - HT : If its in HP
  - VT : If its in VP.
* Represent^{n} of cutting plane.



* AVP : Auxiliary Vertical Plane (Plane ⊥ to HP, inclined to VP)
  AIP : Auxiliary Inclined Plane (Plane ⊥ to VP inclined to HP)

Extra Questions

Q 3) A pentagonal pyramid of base side 50 mm & axis 80 mm is resting on its base with one of the base edges making 40° inclin^{n} to VP & is cut by a cutting plane inclined at 30° to HP & ⊥ to VP passing through the axis at a distance of 40 ~~60~~ mm from the base.

Draw its proj^{ns} & true sectional view.

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Q.4) A cone of base diameter 80 mm & ht 120 mm is resting on ground with its axis ∥ to HP & ⊥ to VP. It is cut by a cutting plane ⊥ to HP & ∥ to VP passing through the axis at a distance of 60 mm from the base.
Draw its proj^ns & true sectional view.

Q.5) A hexagonal pyramide of base side 60 mm & ht 120 mm is resting on ground with its axis ∥ to HP & ⊥ to VP. It is cut by a cutting plane ⊥ to HP & ∥ to VP passing through the axis at a distance of 50 mm from the base.
Draw its proj^ns & true sectional view.

* For cone

$$\theta = \frac{r}{l} \times 360^\circ$$

$$\theta = \frac{80}{120} \times 360^\circ$$

$$= 240^\circ$$

* No. of

Q. A triangular prism of base side 125 mm & ht 150 mm is resting on its base with one of its vertical faces ∥ to VP. It is cut by a cutting plane inclined at 30° to HP & ⊥ to VP, passing through mid pt. of axis. Draw projns, section, true shape & devt.

Q. A cone of base diameter 150 mm & ht 200 mm is resting on its base on HP. It is cut by a cutting plane inclined at 30° to HP & ⊥ to VP, passing through the axis at a distance of 70 mm from base. Draw projns, true sectional view, sectional view & lateral surface devt. of frustrated cone.

Q. A pentagonal pyramid of base side 60 mm & axis length 100 mm is resting on its base with one of the base edges making 45° inclination to VP & is cut by a plane at 30° to HP & ⊥ to VP, passing through axis at a distance of 60 mm from the base.
Draw projns, sectional view, shape of section, lateral surface devt. of sectional part.

PL

* Development of Surfaces

1. Total Surface development
2. Lateral Surface development

* For cone

$$\theta = \frac{r}{l} \times 360^\circ$$

no. of segments = 9 for 8 equal parts

* Use capital letters for development.
* Give LW to outer portion
* Show θ & l after completing dev.