



21MES102L
Engineering Graphics and Design
School of Mechanical Engineering

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21MES102L

Engineering Graphics and Design

Development of Surfaces



Topics Covered

- Principles in Development of Lateral Surfaces of Simple Solids and Polyhedrons
- Development of Lateral Surfaces of Polyhedrons
- Development of Lateral Surfaces of Solids of Revolution



Development of Surfaces

- A layout of the **COMPLETE SURFACE** of a three dimensional object on a plane is called the **DEVELOPMENT OF THE SURFACE** or **FLAT PATTERN** of the object.



Need for Development of Surfaces

- Knowledge of Development is very useful in sheet metal work, construction of storage vessels, chemical vessels, boilers, and chimneys.
- Such vessels are manufactured from plates that are cut according to these Developments and then properly bend into desired shapes
- The joints are then welded or riveted.
- Every line on the Development should show the true length of the corresponding line on the surface which is developed.

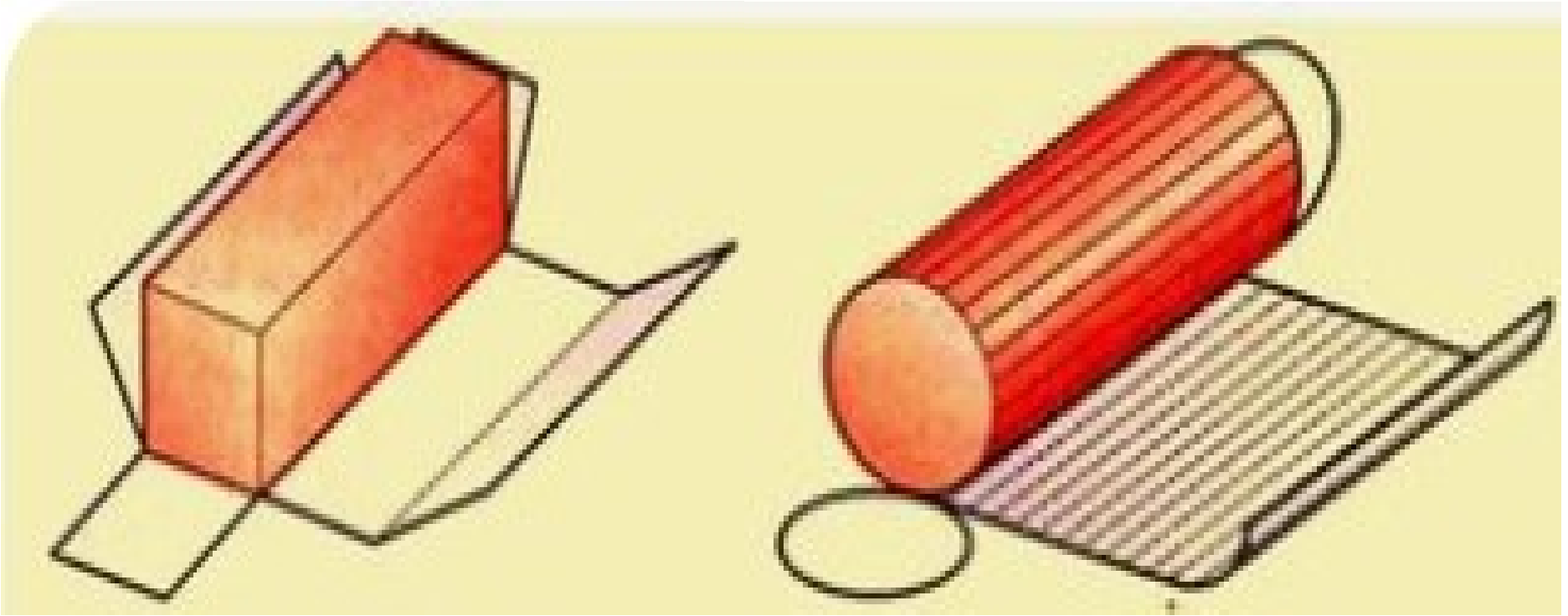


Classifications of Development of Surfaces

- The method to be followed for making the Development of a Solid depends upon the nature of its Lateral surfaces. Based on the classification of Solids, the following are the methods of Development
 - **Parallel line method**
 - **Radial line method**
 - Zone method
 - Lune method
 - Triangulation method



PARALLEL LINE METHOD

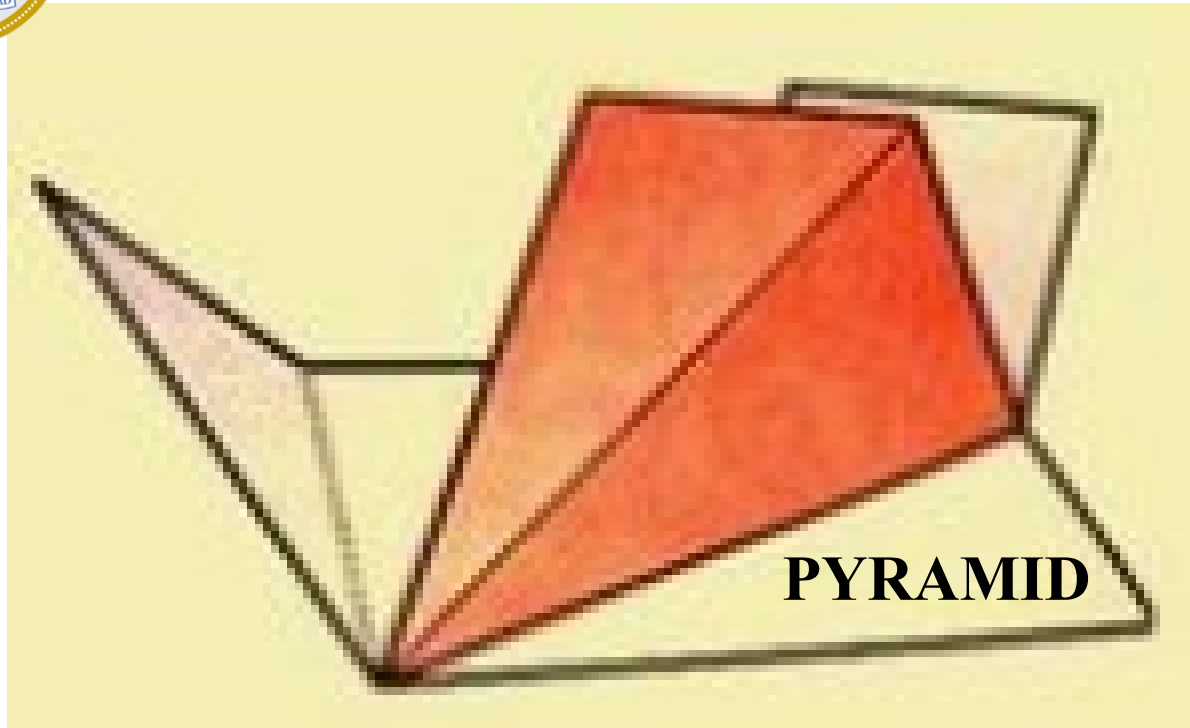


PRISM

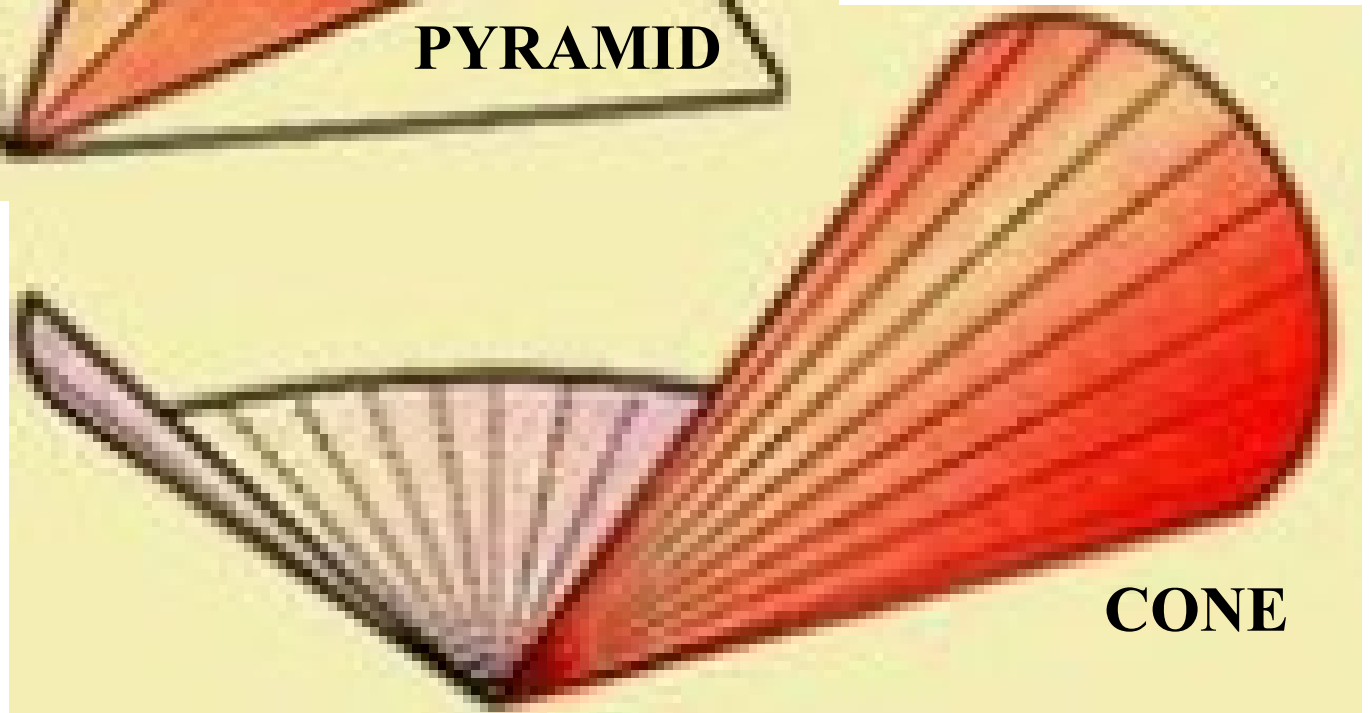
CYLINDER



RADIAL LINE METHOD



PYRAMID



CONE



A Hexagonal prism of base side **30** mm & axis length **60** mm is resting on HP on its base with two of its vertical faces perpendicular to VP. It is cut by a plane inclined at **50°** to HP & perpendicular to VP & meets the axis of prism at a distance **10** mm from the top base. Draw the development of the lateral surface of the prism.

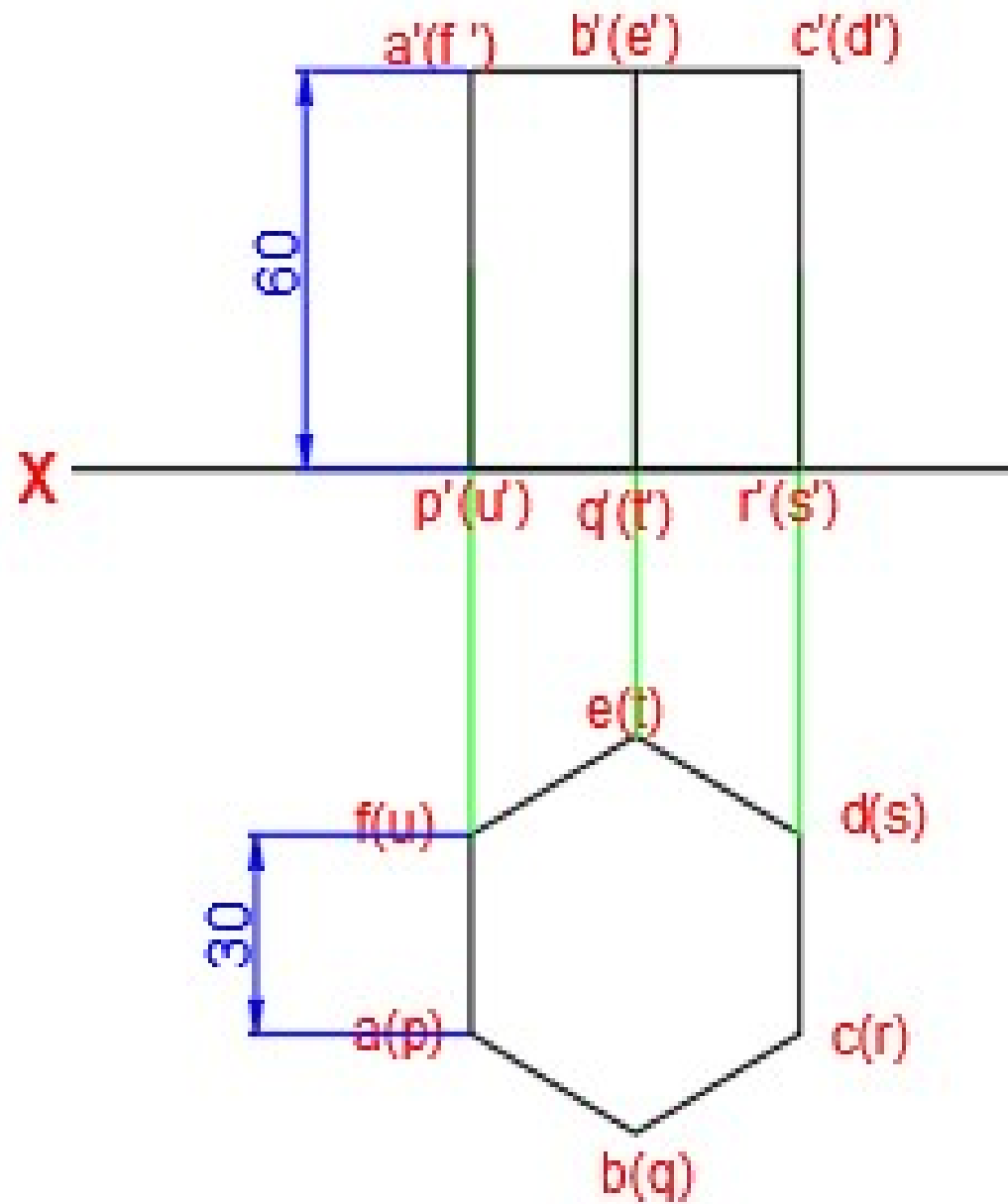
- Set the **UNITS & LIMITS** in **Drafting & Annotation Mode**
- Use the **LINE** command from **DRAW** tool bar & draw the Reference line **XY**.



- Start with **Top View** & Draw the **Hexagonal Polygon (ORTHO ON)** for the given base Edge length as **30** mm By dragging the mouse **DOWN** in order to satisfy the given condition that **Two of its Vertical Faces are Vertical to VP**.
- Project Lines from **Top View** & complete the **Front View**
- Use text command to name the Visible & Invisible corners.
- Mark the Dimensions using Annotation Tool Bar.



- Use the **TEXT** command & Name the corners for the top visible corners as **a, b, c, d, e & f** & the bottom invisible corners as **(p),(q),(r),(s),(t) & (u)** .
- Use the **LINE** command & project the lines from top view **f, e & d** up to reference line **XY**.
- Use the **LINE** command & complete the Front view of the prism for the given height **60** mm & name the top base corners as **a', b', c', (d'), (e') & (f')** .

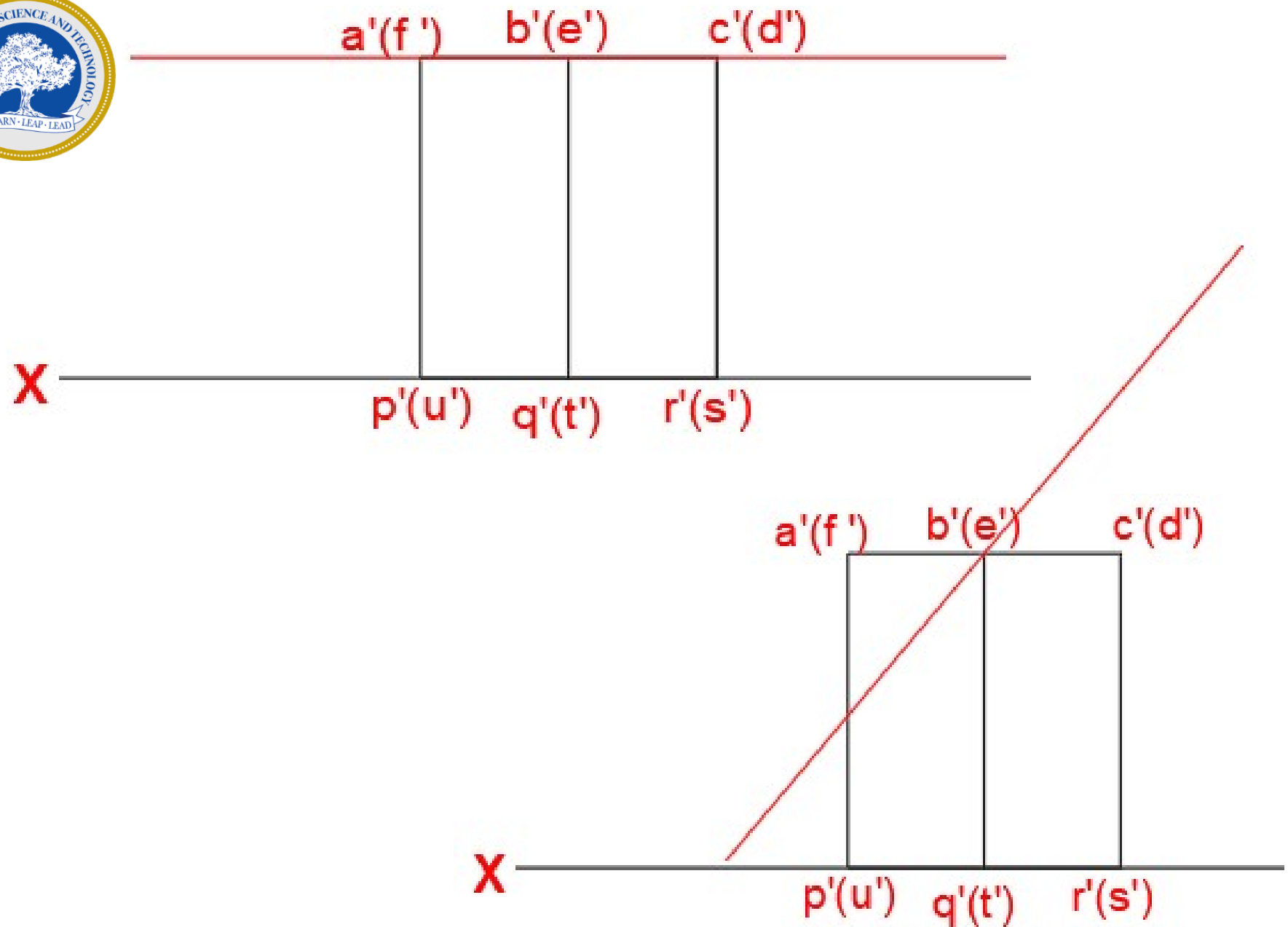


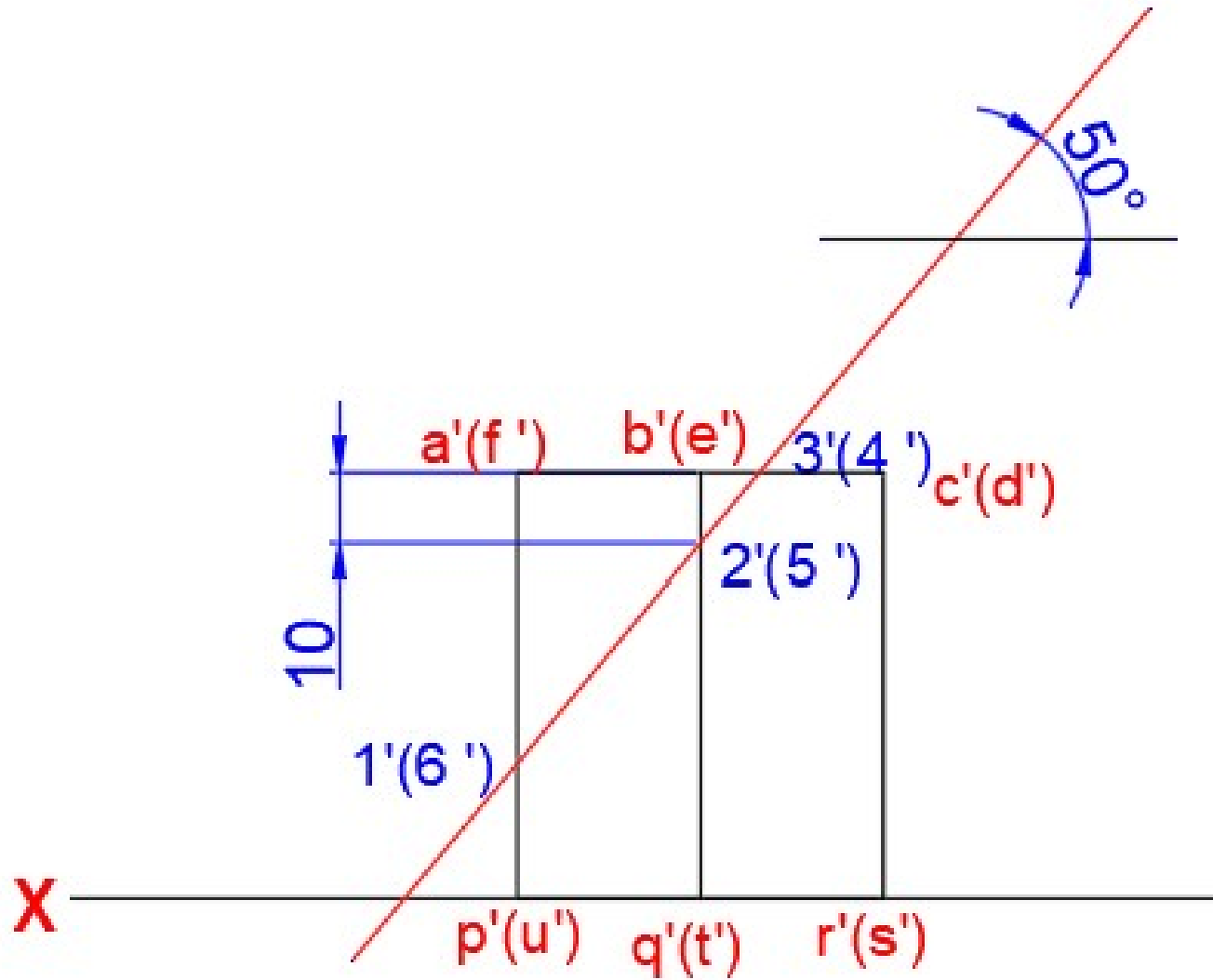


- And the bottom corners as **p'**, **q'**, **r'**, **(s')**, **(t')** & **(u')** .
- Use the **LINE** command & draw a Horizontal line on the top base of the front view for a length more than the width of the front view.
- Use the **ROTATE** command from **MODIFY** tool bar & rotate the horizontal line for the given angle **50°** with respect to **HP**.
- Use the **MOVE** command from **MODIFY** tool bar & move (**ORTHO ON**) the Rotated line linearly downward direction for given **10** mm.



- The rotated line is the representation of **SECTION** plane cutting the **HEXAGONAL** prism at **50°** with respect to **HP** as given in the problem.
- Name the points on the intersection of the section line with the solid as **1' (6') , 2' (5') , 3' (4')** & Calculate the length of the development (base Edge length Multiply by **6** as the given Polygon is Hexagon)



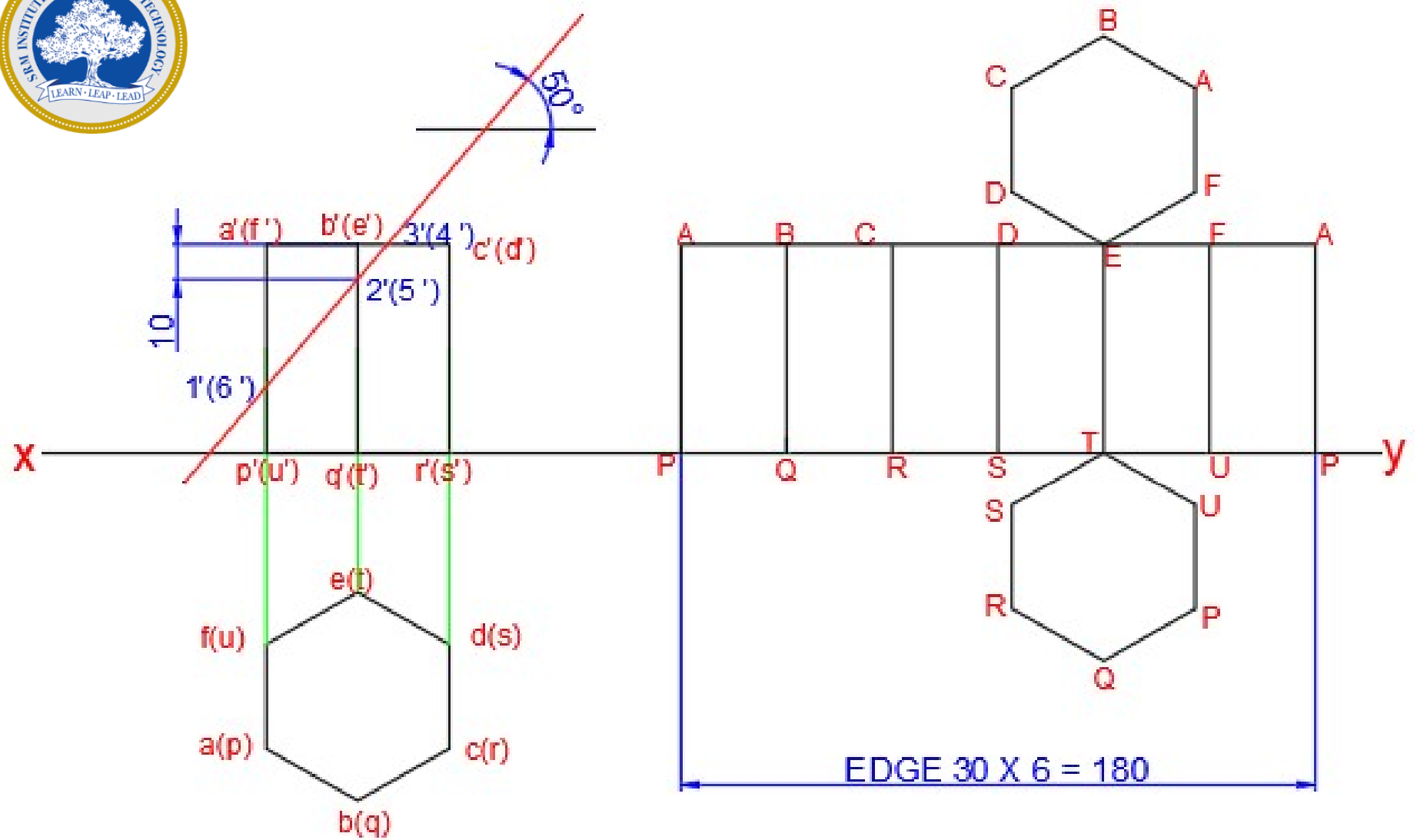
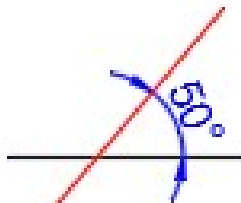


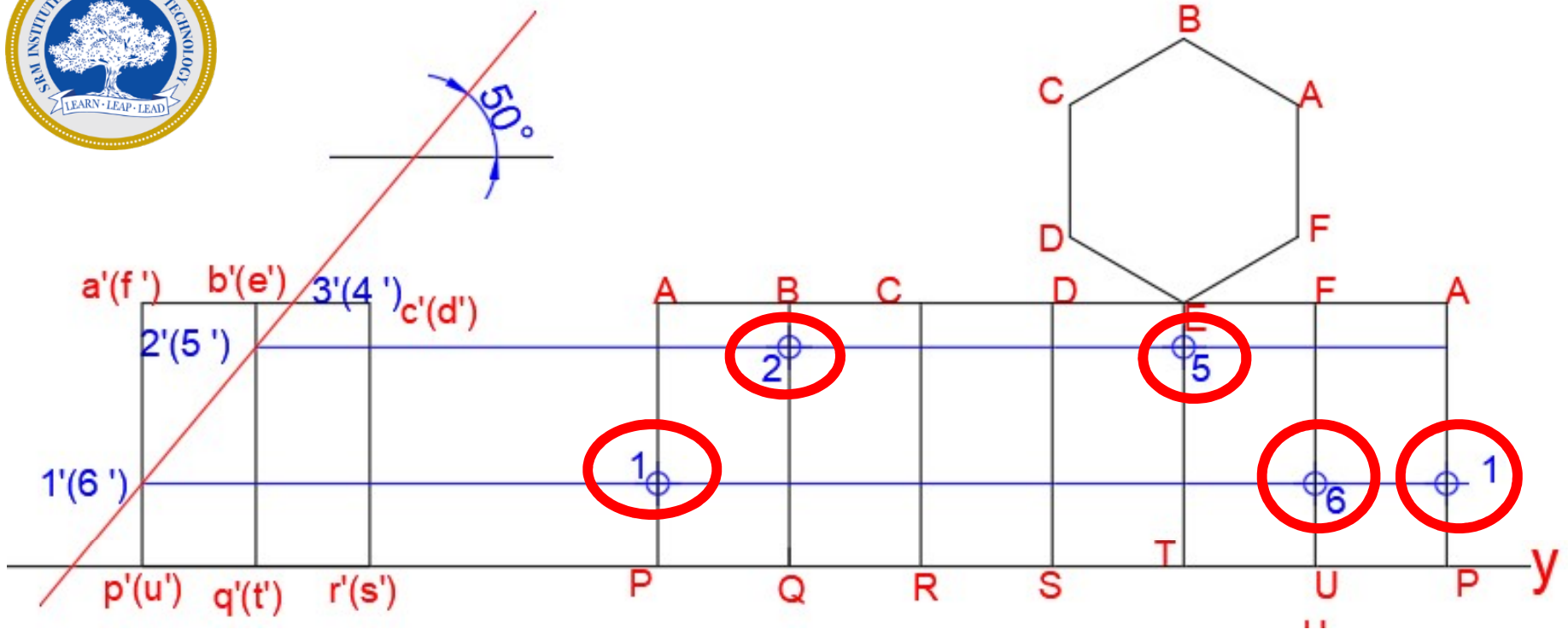


- Use the **LINE** command to draw the line for the calculated length of **180** mm on the reference line & name the ends as **P & P**
- Use the **LINE** command to draw the vertical lines from each ends **P & P**.
- Use the **OFFSET** command from **MODIFY** tool bar & give the **OFFSET** distance as given base length **30** mm & select the **left extreme entity** & show the **right side direction** for **5** times.

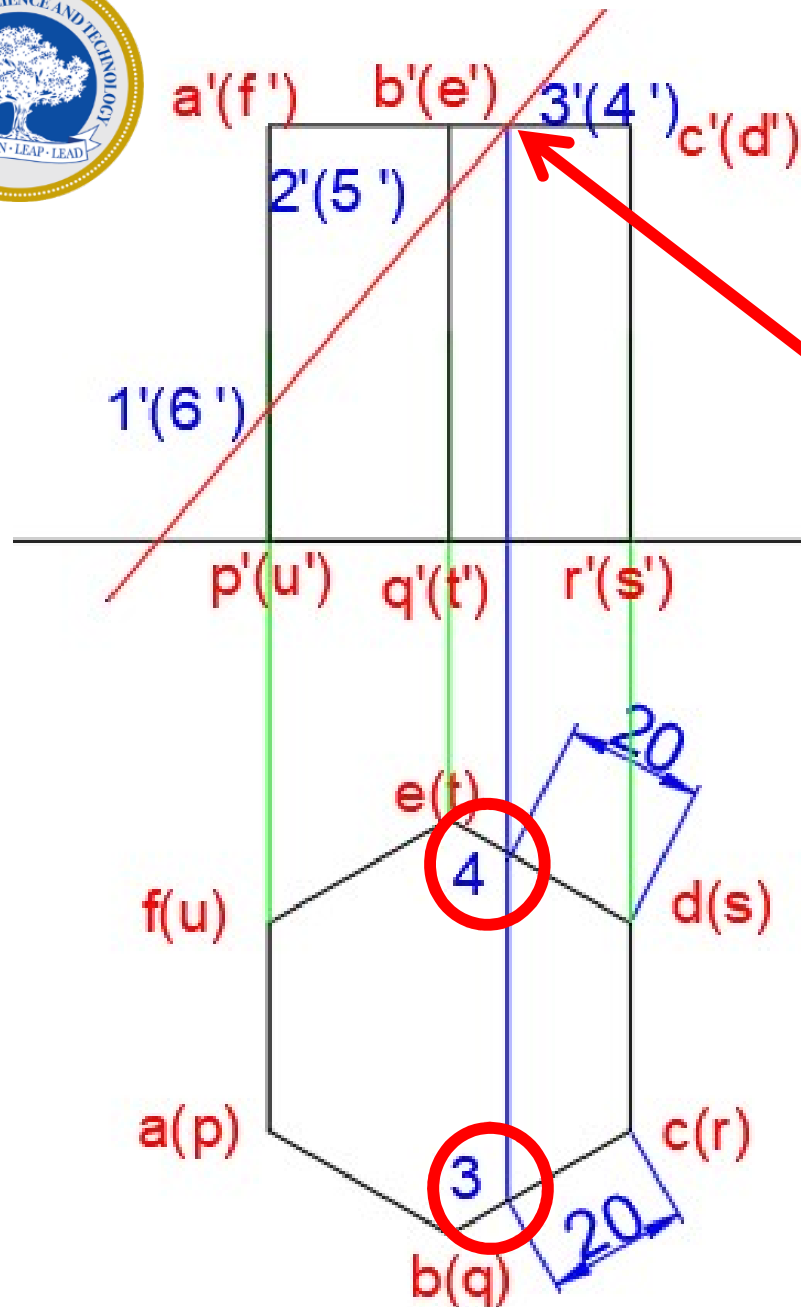


- Draw the top side line & name it as **A** & **A** .
- Name all the Vertical lines on the Top from **A** as **B ,C,D, E & F**
- Name all the vertical lines on the bottom from **P** as **Q ,R,S, T & U**
- The diagram **P A A P** represents the development of the given hexagonal prism with 6 sides without section
- Draw Hexagon on above & Below the Development to show the **Top base & Bottom base** of the Prism

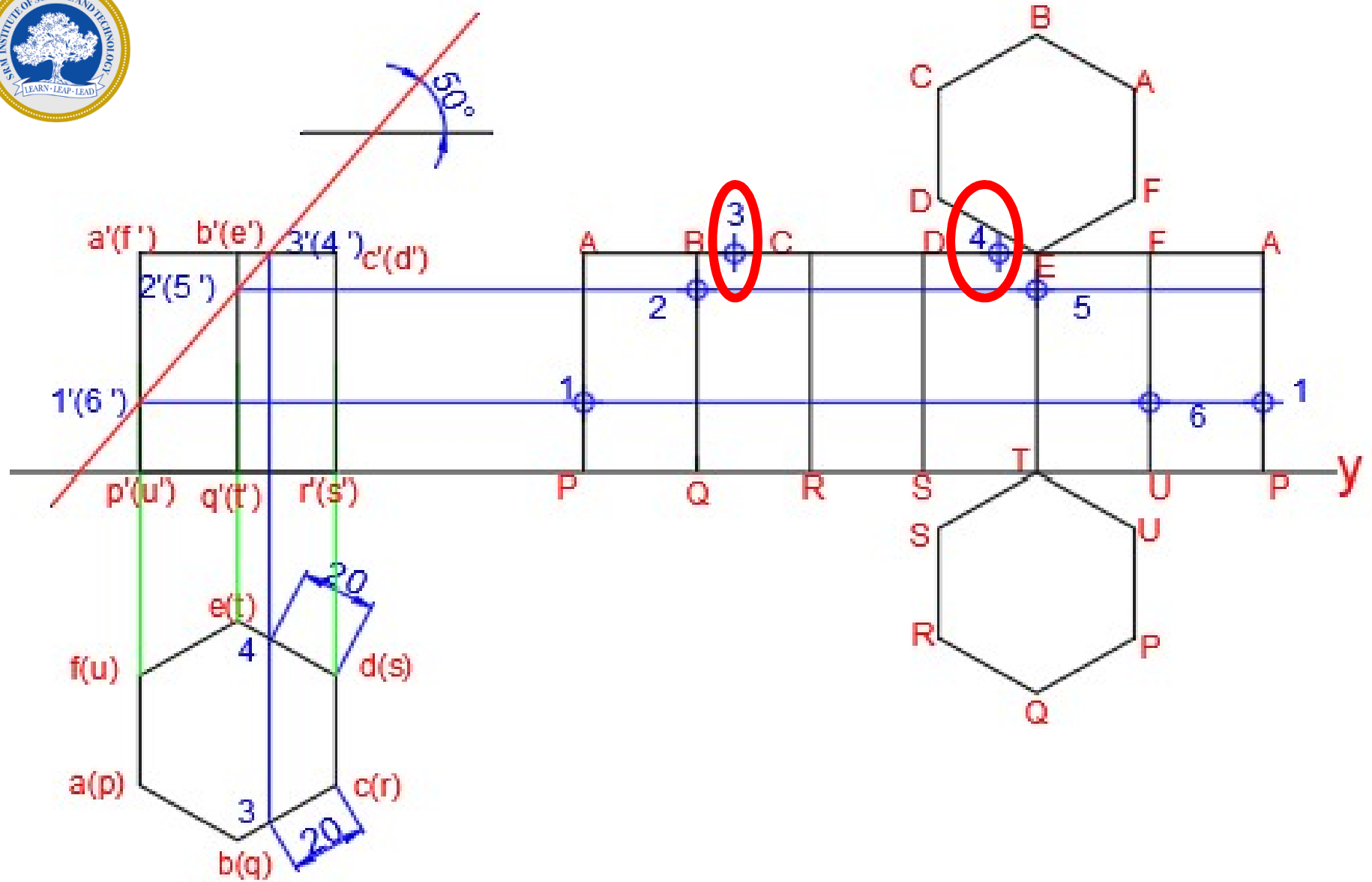




- Project the lines from the section line cutting the front view of the prism to the development diagram **P A A P**
- Mark the Points on the intersection & name as **1 , 2 , 5 , 6 & 1** on the **Projected line** from **1'(6')** & **2'(5')**

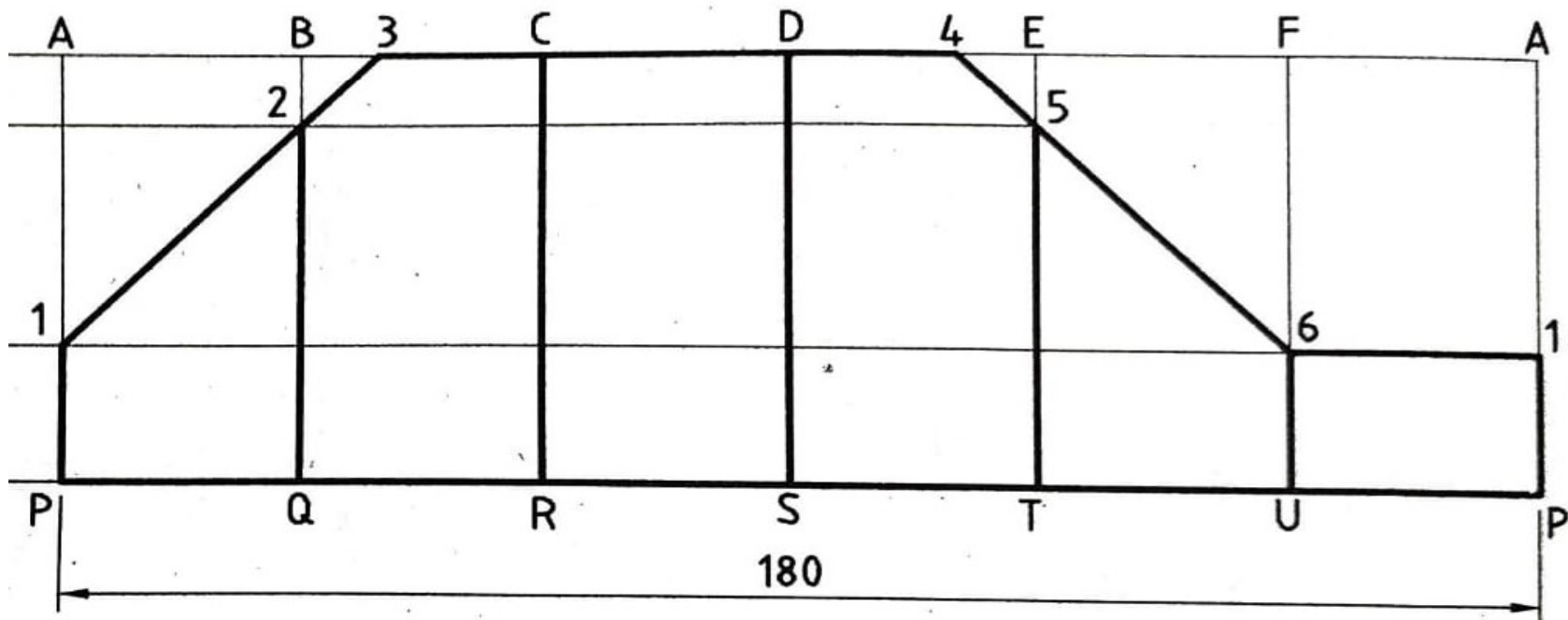


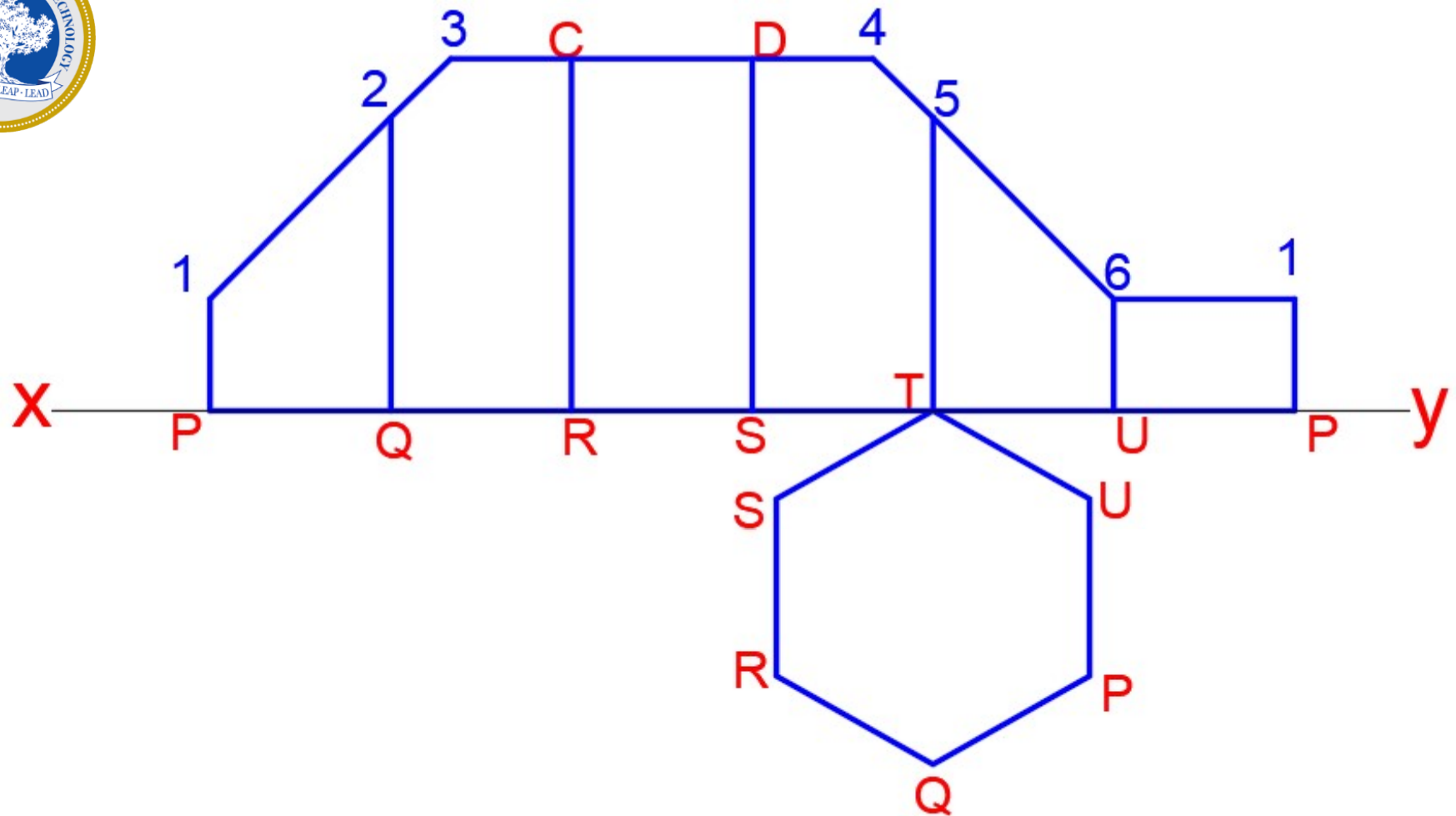
- Project the line from **3' (4')** to meet the top base **b c & d e** & name it as **3 & 4**
- Measure the distance between **c** to **3** & **d** to **4**
- Mark the Measured distance from **C & D** to get **3 & 4**





- Draw the lines from **P** to **1**, **1** to **2**, **2** to **3**, **3** to **C**, **C** to **D**, **D** to **4**, **4** to **5**, **5** to **6**, **6** to **1**, **1** to **P** & **P** to **P**
- And join the Vertical lines **1** to **P**, **2** to **Q**, **C** to **R**, **D** to **S**, **5** to **T**, **6** to **U** & **1** to **P**





➤ Development of the **SECTIONED HEXAGONAL PRISM** using **Parallel Line Method**.

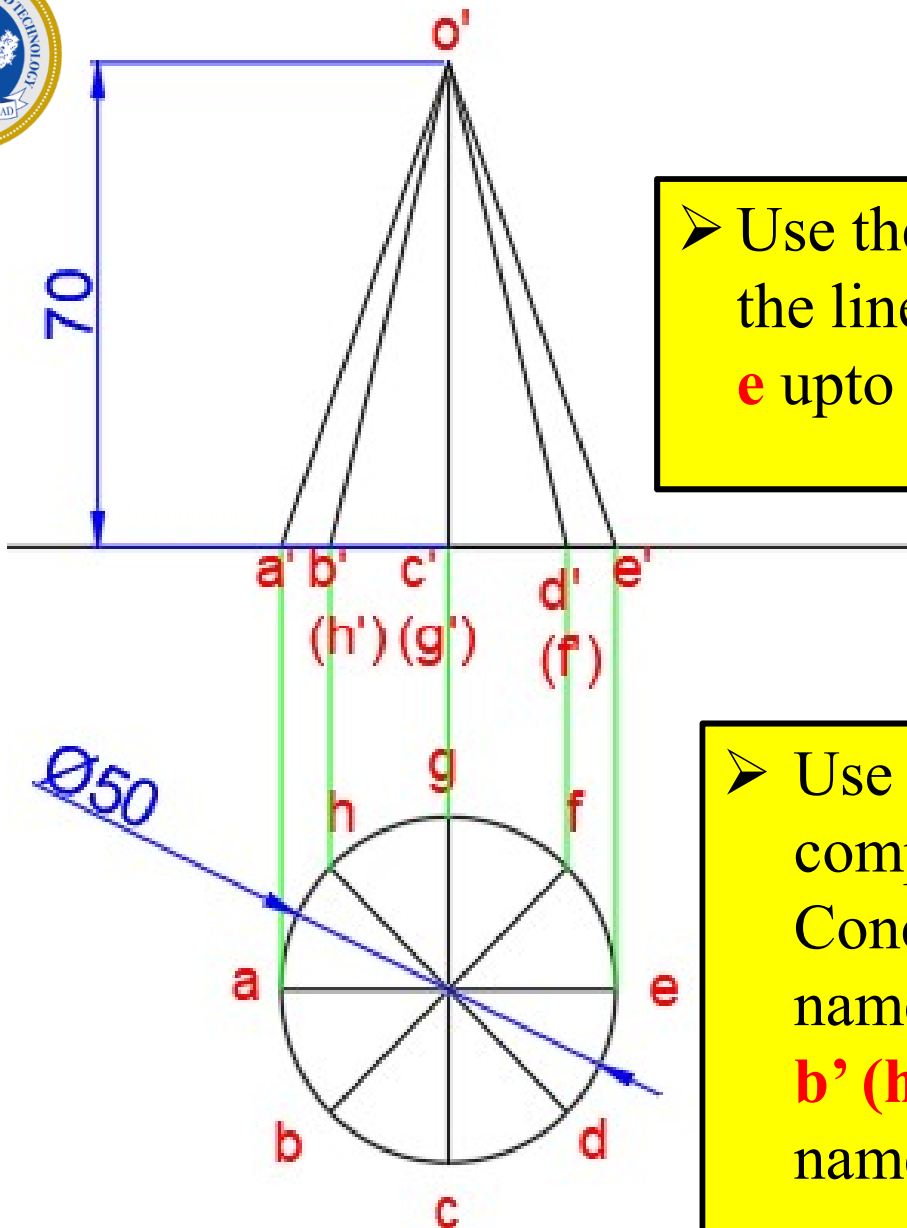


A Cone of base side **50** mm & axis length **70** mm is rests with its base on HP . It is cut by a plane perpendicular to VP & inclined at **35°** to HP & meets the axis at a distance **35** mm from the Apex. Draw the development of the remaining portion of the Cone.

- Set the **UNITS & LIMITS** in **Drafting & Annotation Mode**
- Use the **LINE** command from **DRAW** tool bar & draw the Reference line **XY**.

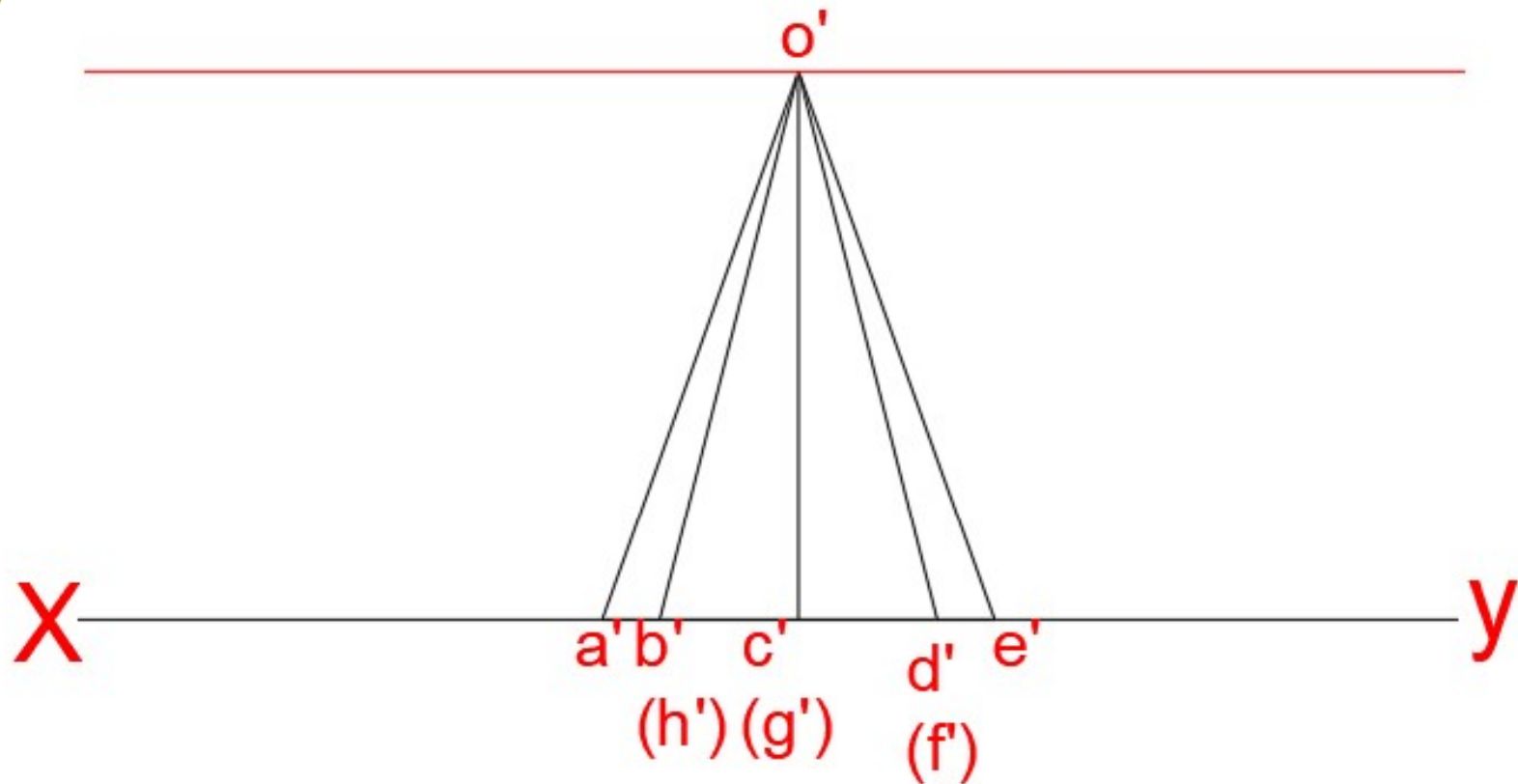


- Use Circle command from **DRAW** tool bar & create the **CIRCLE** for the given diameter as **50** mm.
- Use **DIVIDE** command to divide the circle into 8 equal number of parts
- Use the **TEXT** command & Name it as **a, b, c, d, e, f, g, & h** for circumferential points on the **Bottom base of the Cone** & **o** for **Apex of the Cone**.

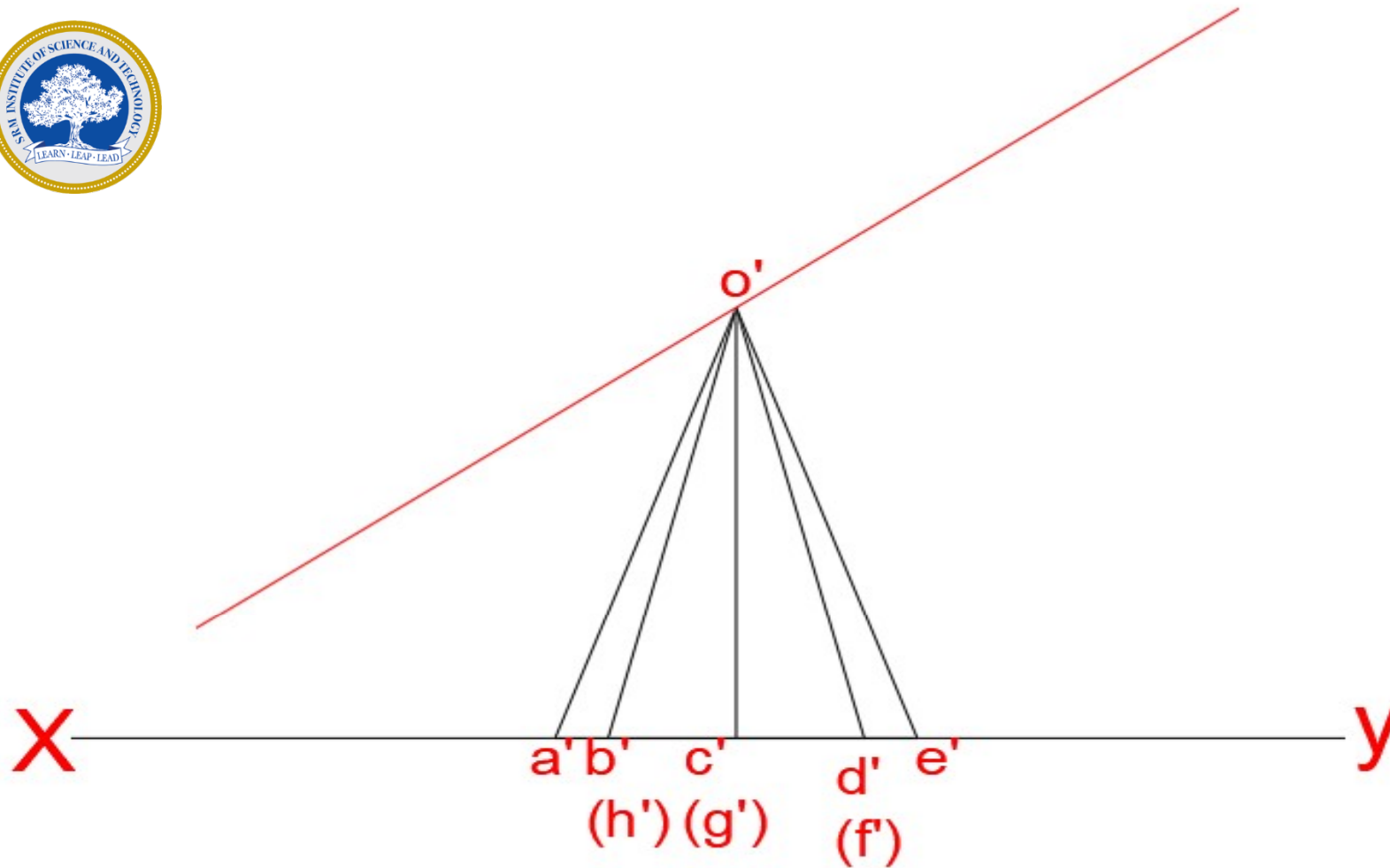


➤ Use the **LINE** command & project the lines from **Top view a, h, g, f & e** upto Reference line **XY**.

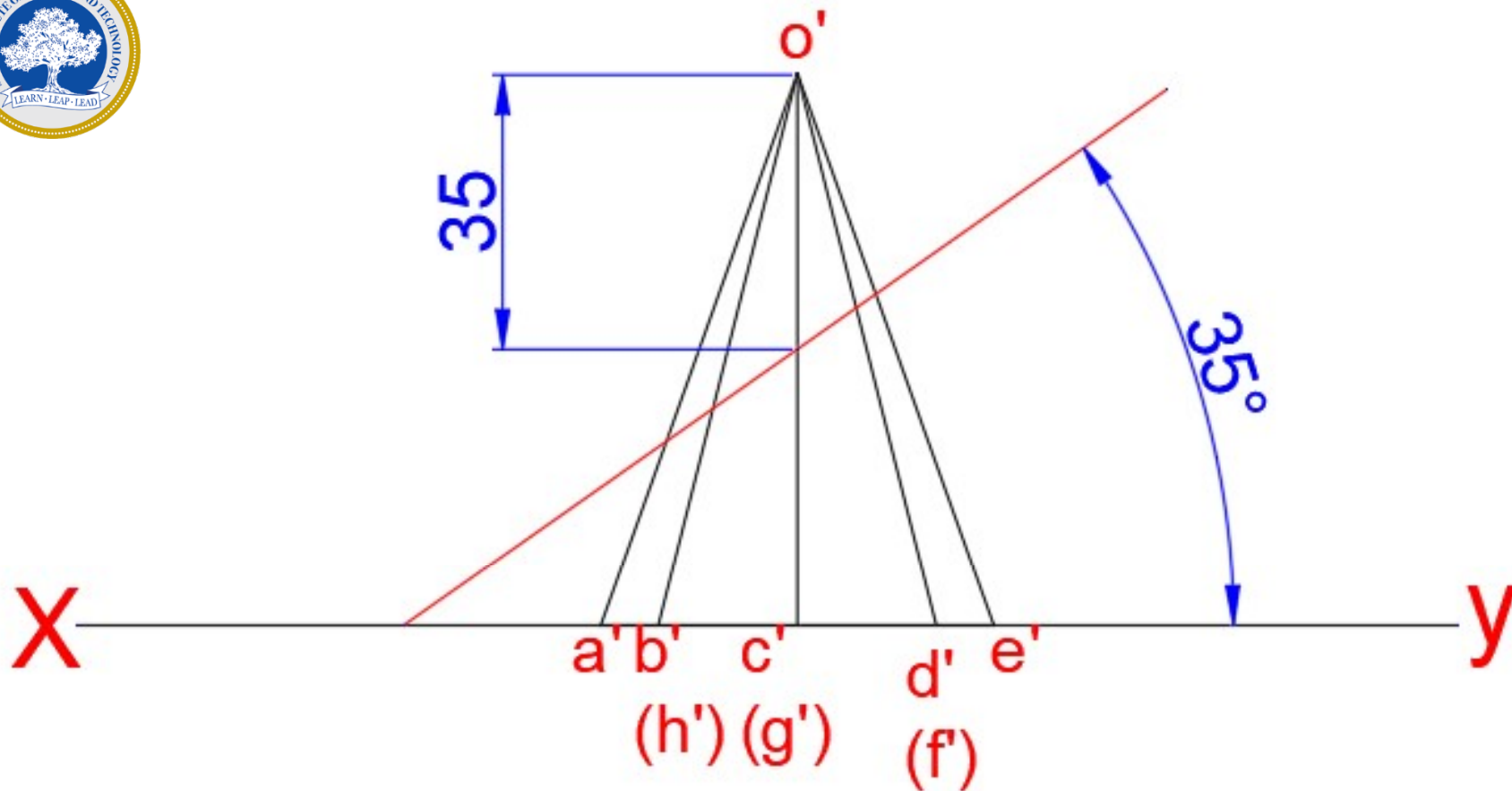
➤ Use the **LINE** command & complete the **Front view** of the Cone for the given height **70 mm** & name the bottom base points as **a', b' (h'), c' (g'), d' (f'), & e'**, & name the Apex point as **o'**.



- Use the **LINE** command & draw a Horizontal line on the Apex of the front view for a length more than the base width of the front view.



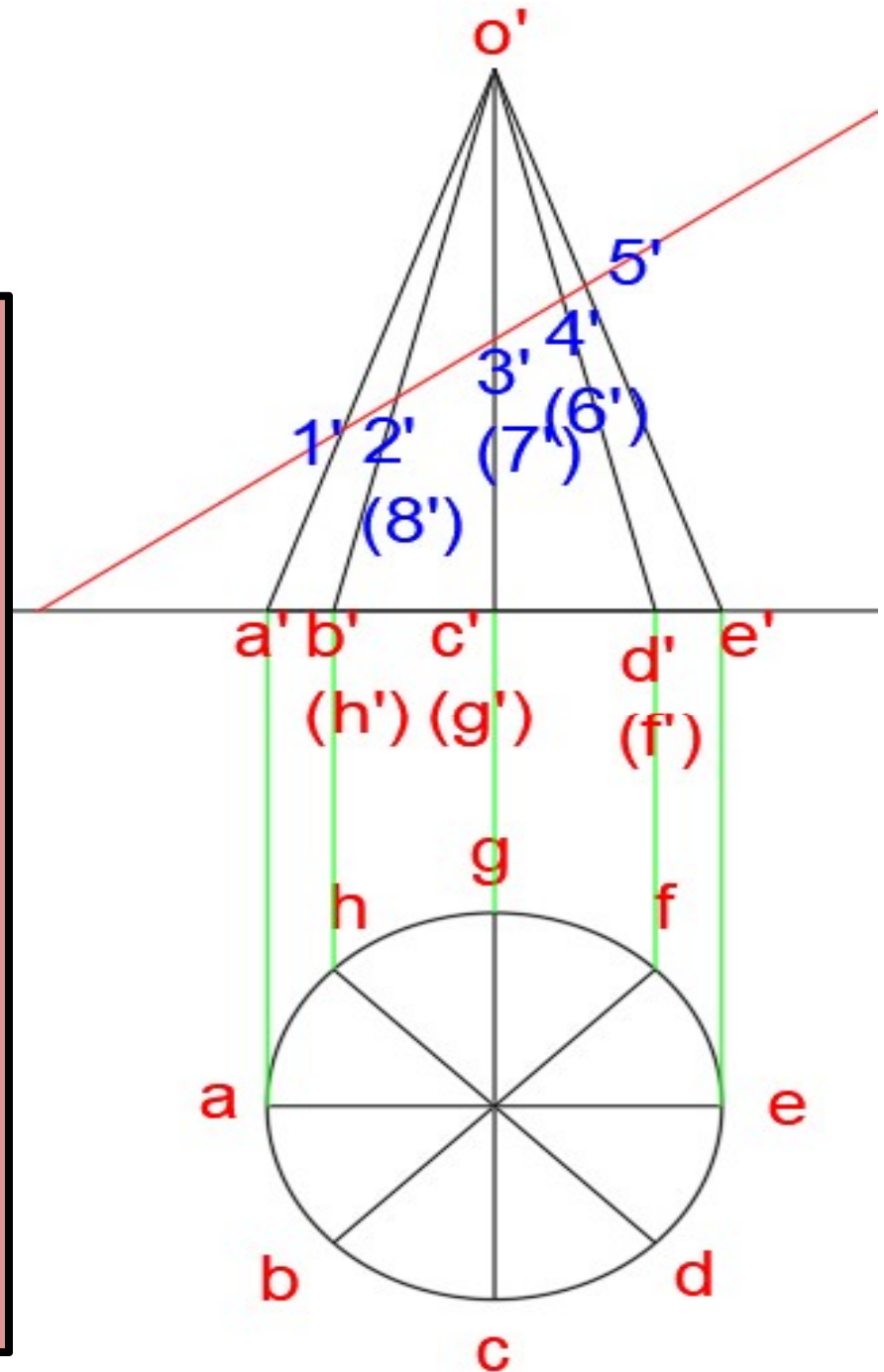
- Use the **ROTATE** command from **MODIFY** tool bar & Rotate the Horizontal line for the given angle **35°** with respect to **HP**.



- Use the **MOVE** command from **MODIFY** tool bar & move (**ORTHO ON**) the horizontal line linearly downward direction for given **35** mm.



- The Rotated line is the representation of **SECTION** plane cutting the Cone at **35°** with respect to **HP** as given in the problem.
- Name the points on the intersection of the section line with the solid as **1', 2'(8'), 3'(7')**, **4'(6')** & **5'**





➤ Calculate the Subtended Angle $\Theta = \left(\frac{r}{R}\right) \times 360^\circ$ of the Development

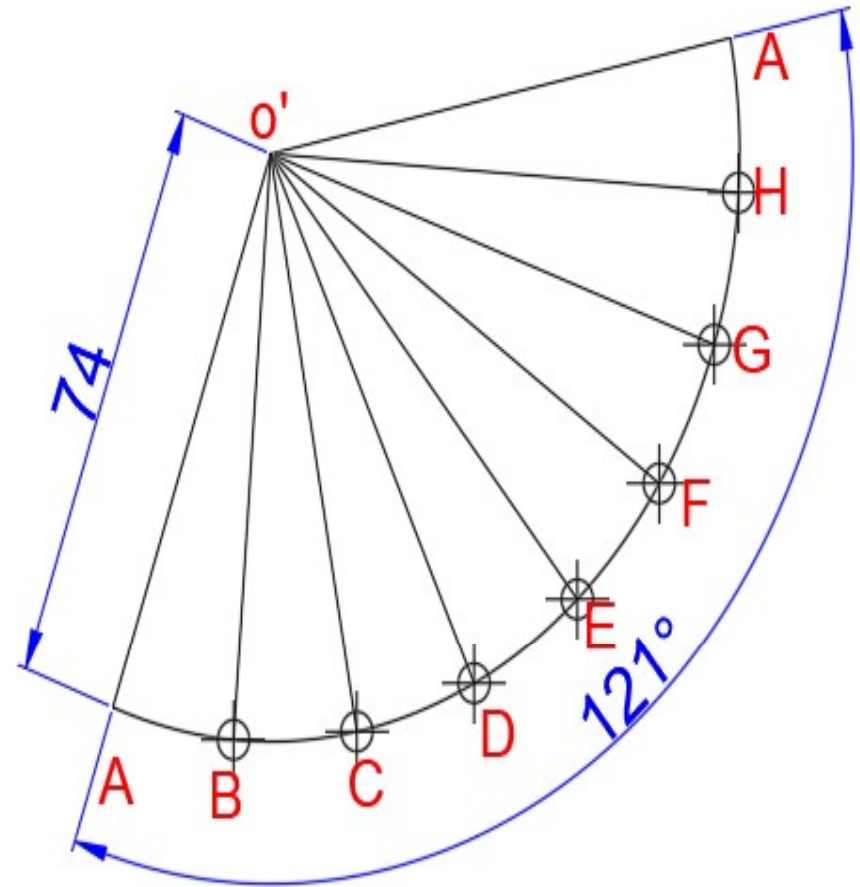
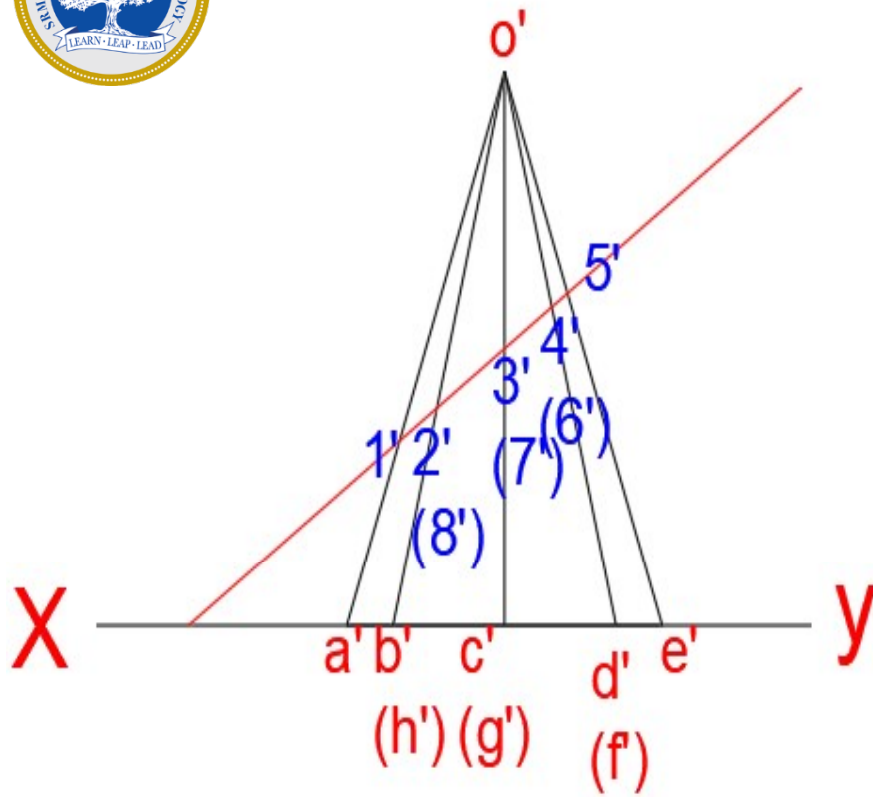
Where r = Base Circle Radius in mm

R = Slant Height of Generator in mm

$$\Theta = \left(\frac{25}{74.3}\right) \times 360^\circ = 121^\circ$$

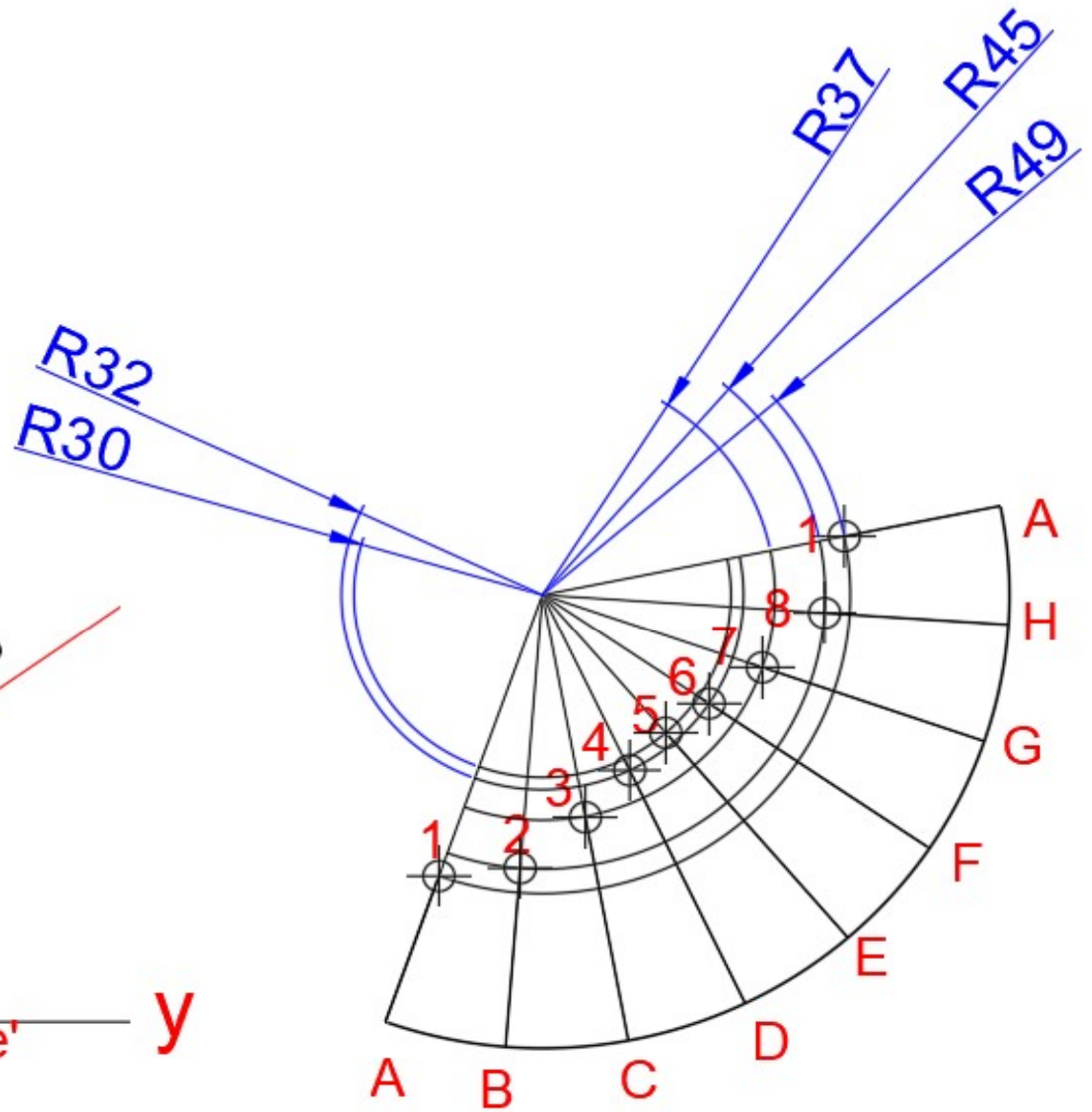
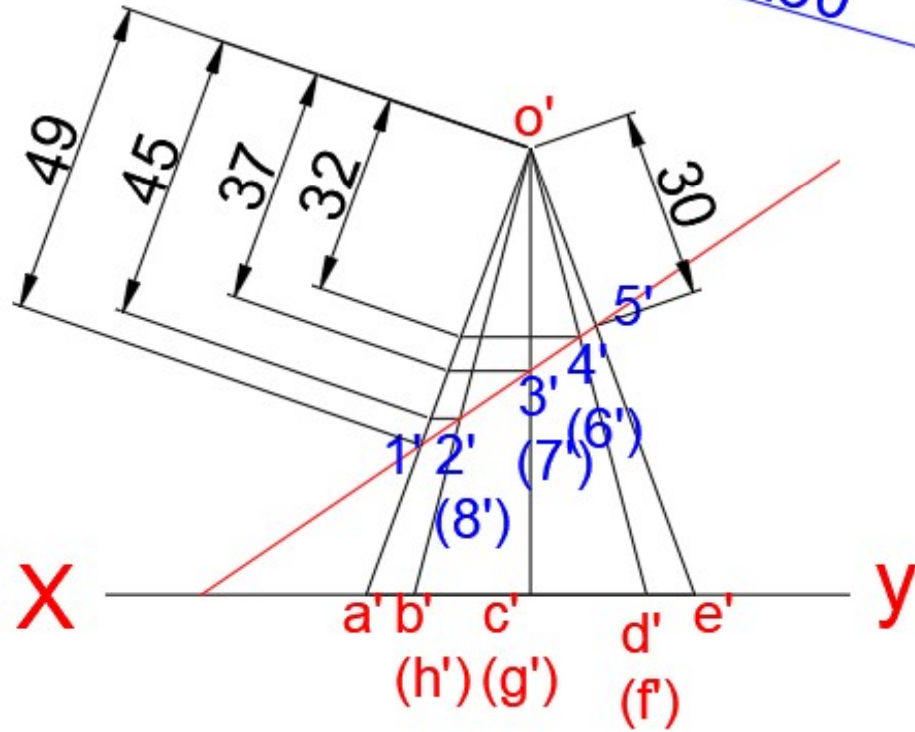


- To draw the Development Use the **LINE** command to draw the line for the measured **TRUE LENGTH** of the **Generator** of the Cone & name the ends as **O** & **A**
- Use **ARC (CENTER START ANGLE)** command from **DRAW** tool bar & fix the **CENTER** as **O** & **START** point as **A** & **ANGLE** as **121°** .
- Use **DIVIDE** command to Divide the Drawn **ARC** for **8** equal parts, & name the Divisions as **B** , **C** , **D** , **E** , **F** , **G** , **H** & **A**





- Use the **LINE** command to draw the lines from **O** to all divisions **B , C , D , E , F , G , H , A**
- Use the **LINE** command to draw the lines from (Section Line intersection with the Generators) **2'(8') , 3'(7') , 4'(6') & 5' on the** to the **TRUE SLANT EDGE** of **o' a'**
- Measure the distance from **o'** to **1'** , **o'** to **2'(8')** , **o'** to **3'(7')** , **o'** to **4'(6')** & **o'** to **5'** on the **TRUE SLANT EDGE** & mark the measured distances on the Development at **OA , OB , OC , OD , OE , OF , OG , OH & OA** & name it as **1, 2, 3, 4, 5, 6, 7, 8 & 1**

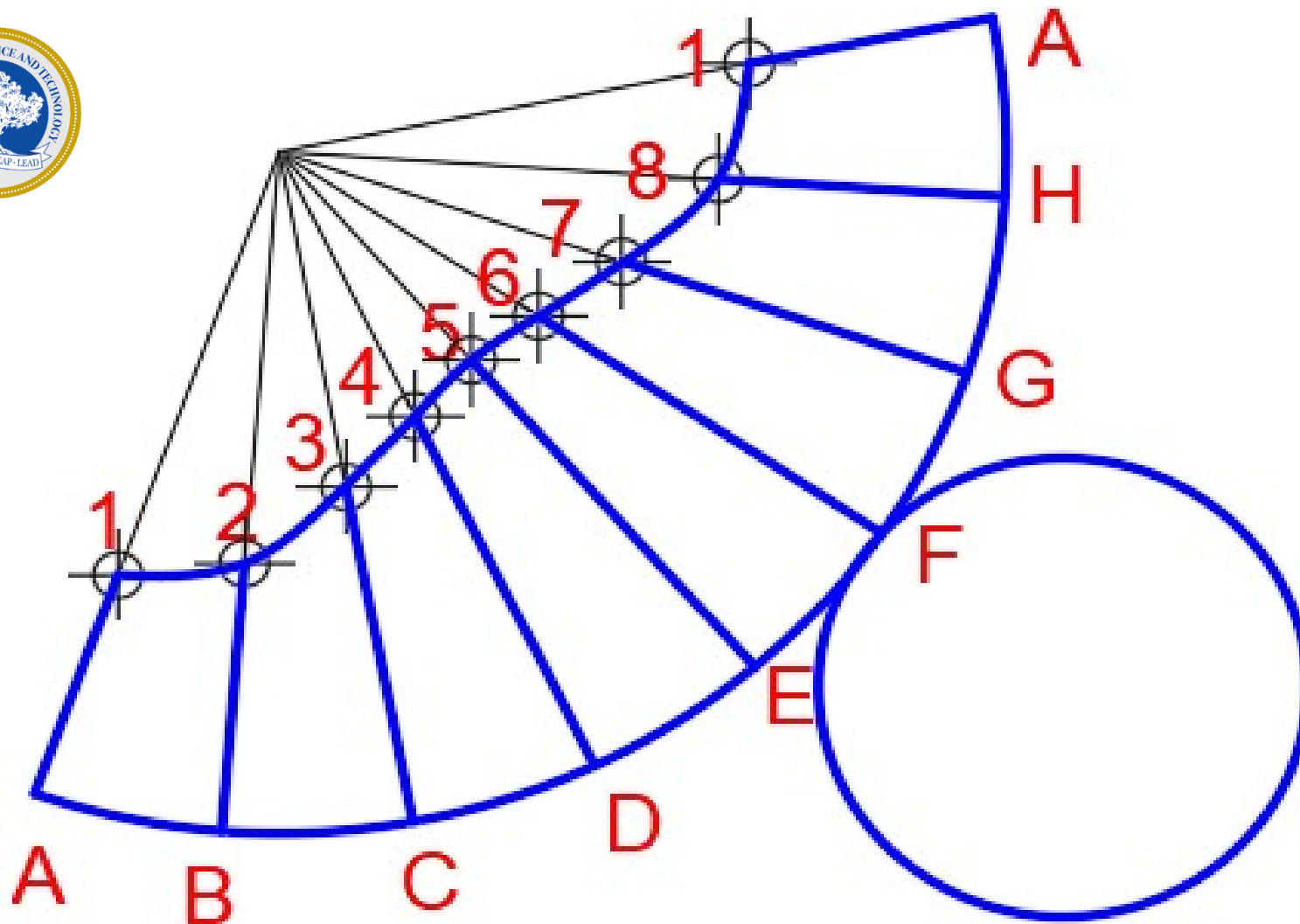




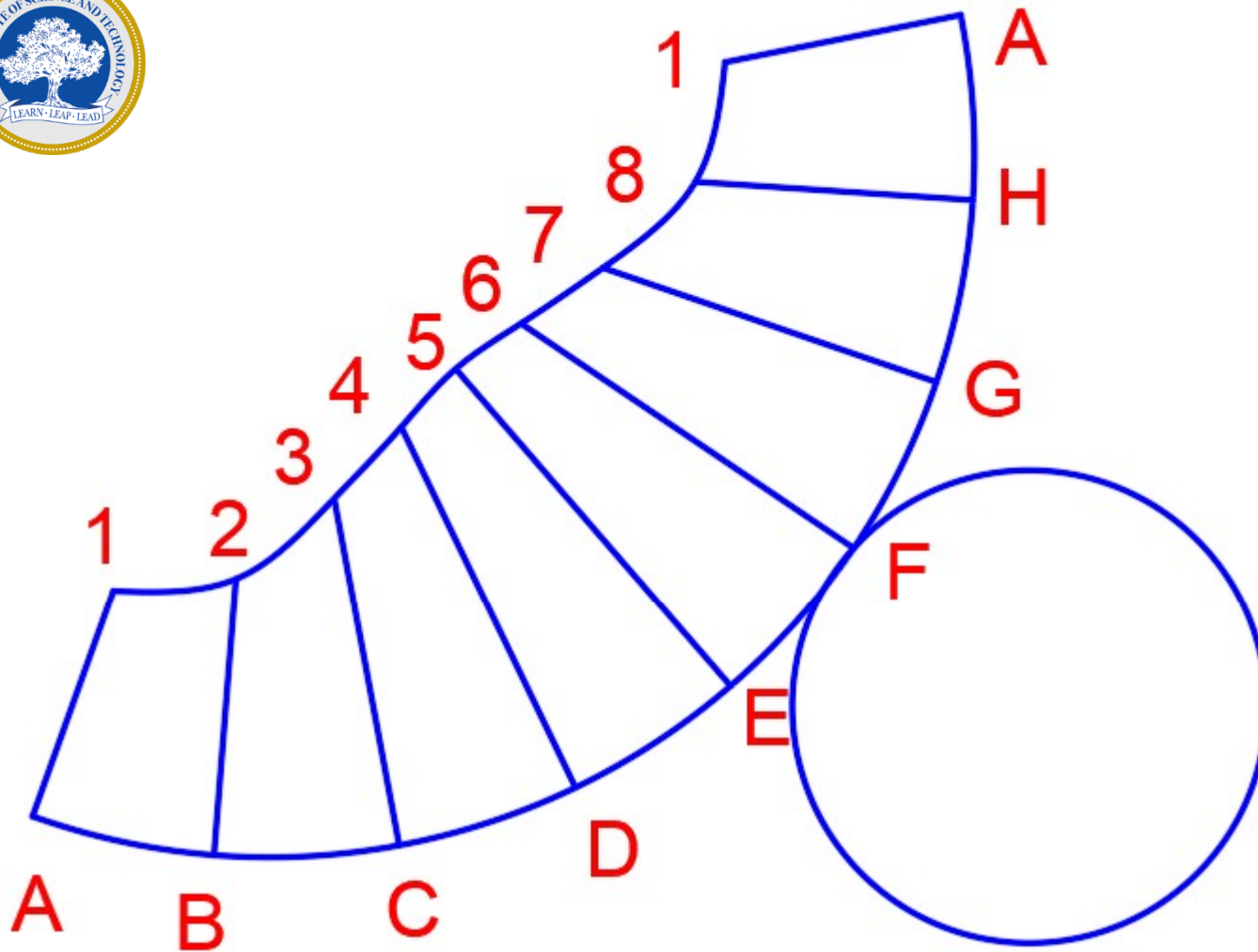
➤ Use **SPLINE FIT** command to

Draw the curve from **1 to 2 , 2 to 3 , 3 to 4 , 4 to 5 , 5 to 6 , 6 to 7 , 7 to 8 & 8 to 1**

➤ And join the vertical lines **1 to A , 2 to B , 3 to C , 4 to D , 5 to E , 6 to F , 7 to G , 8 to H & 1 to A**



- Use **CIRCLE** command from **DRAW** tool bar & create the **CIRCLE** on any point on the Sectioned Cone Circumference of the base drawn in the **DEVELOPMENT** to show the bottom base of the **CONE**.

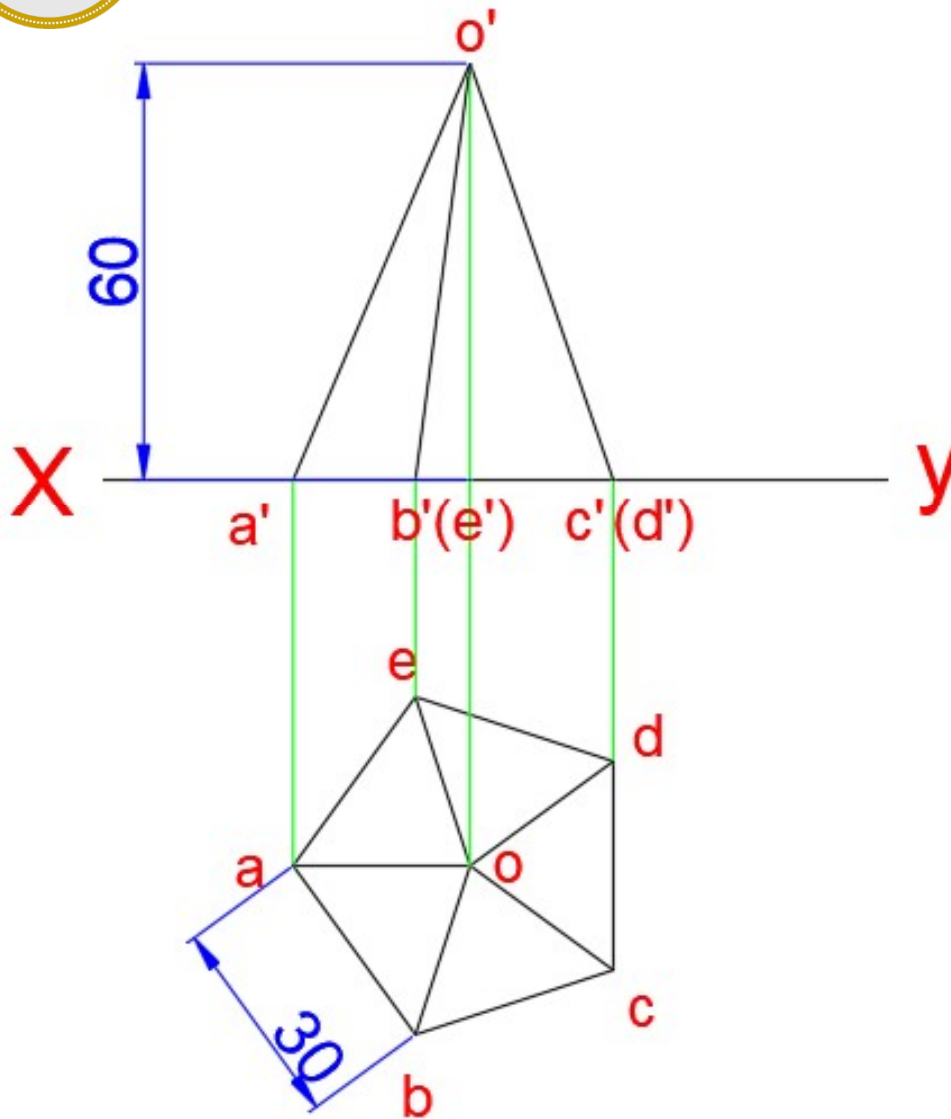


➤ Development of the **SECTIONED CONE** using **Radial Line Method**.



A pentagonal pyramid of base side **30** mm & axis length **60** mm is resting on HP on its base with a side of base perpendicular to VP . It is cut by a section plane perpendicular to wall and inclined at **35°** to the ground & meets the axis at a distance **25** mm from the vertex. Draw the development of the remaining portion of the pyramid.

- Set the **UNITS & LIMITS** in **Drafting & Annotation Mode**
- Use the **LINE** command from **DRAW** tool bar & draw the Reference line **XY**.



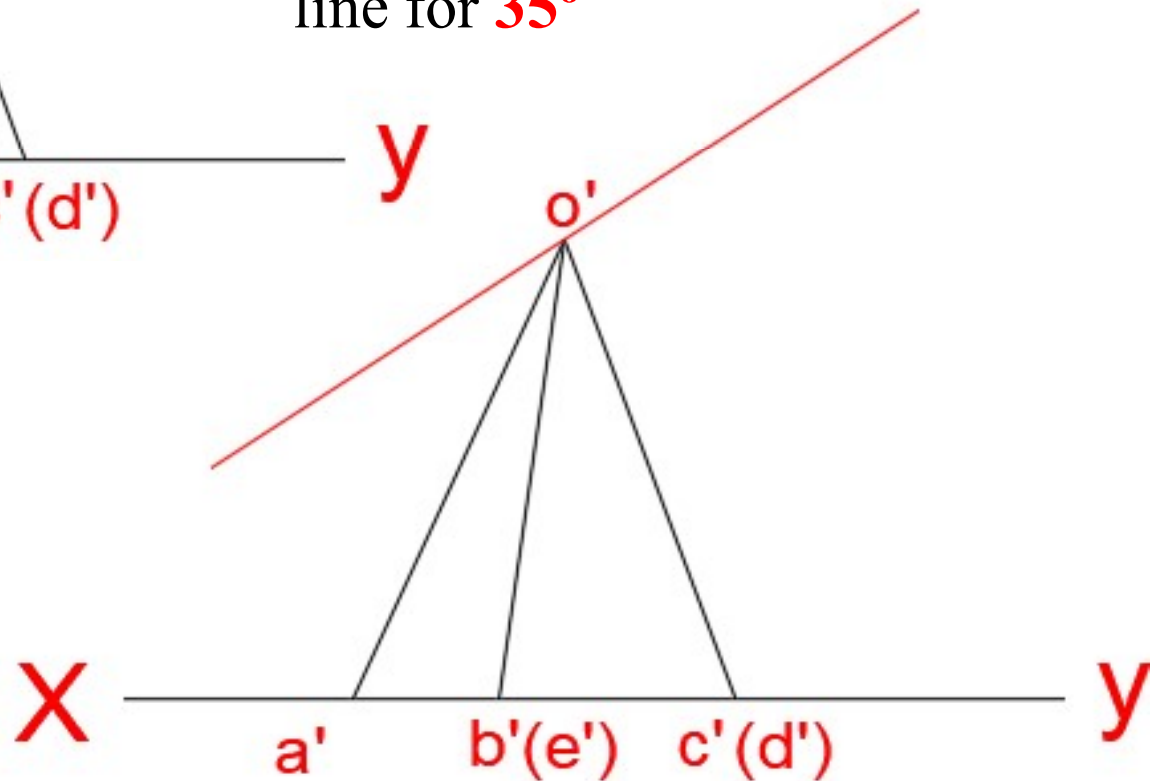
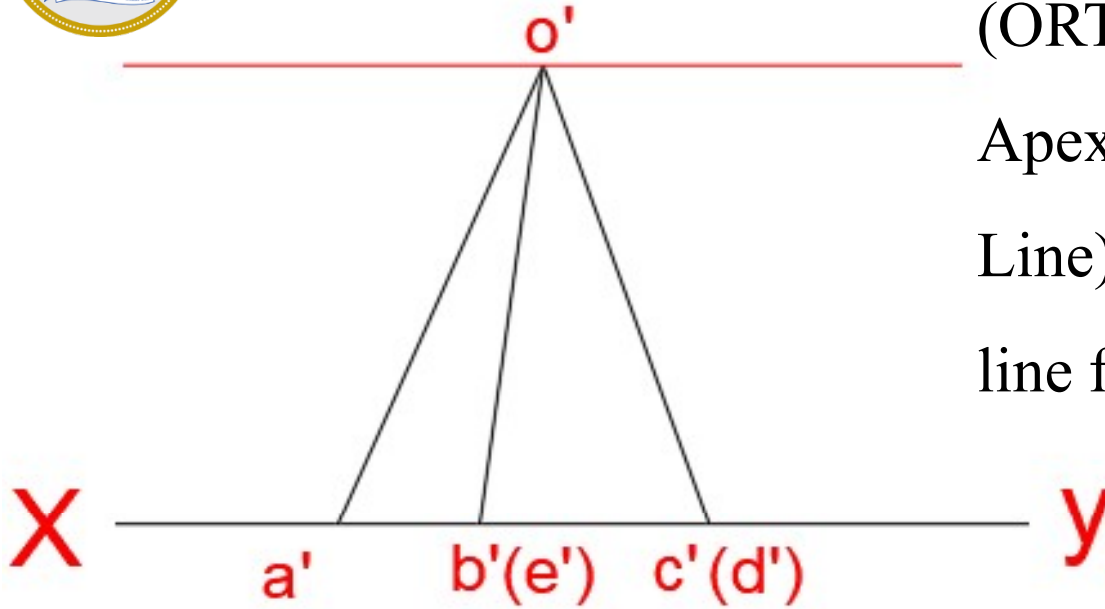
- Use **POLYGON** command from **DRAW** tool bar & create the **PENTAGON (ORTHO ON)** for the given base side length as **30** mm By dragging the mouse **UP** or **DOWN** in order to satisfy the given condition that with a side of base perpendicular to **VP**.



- Use the **TEXT** command & Name the corner for the vertex as **o** & the bottom visible corners as **a, b, c, d, & e**.
- Use the **LINE** command & project the lines from top view **a, e, d** & **o** upto Reference line **XY**.
- Use the **LINE** command & complete the **Front view** of the Pyramid for the given height **60** mm & name the vertex as **o'** & bottom base corners as **a', b' (e') & c' (d')**

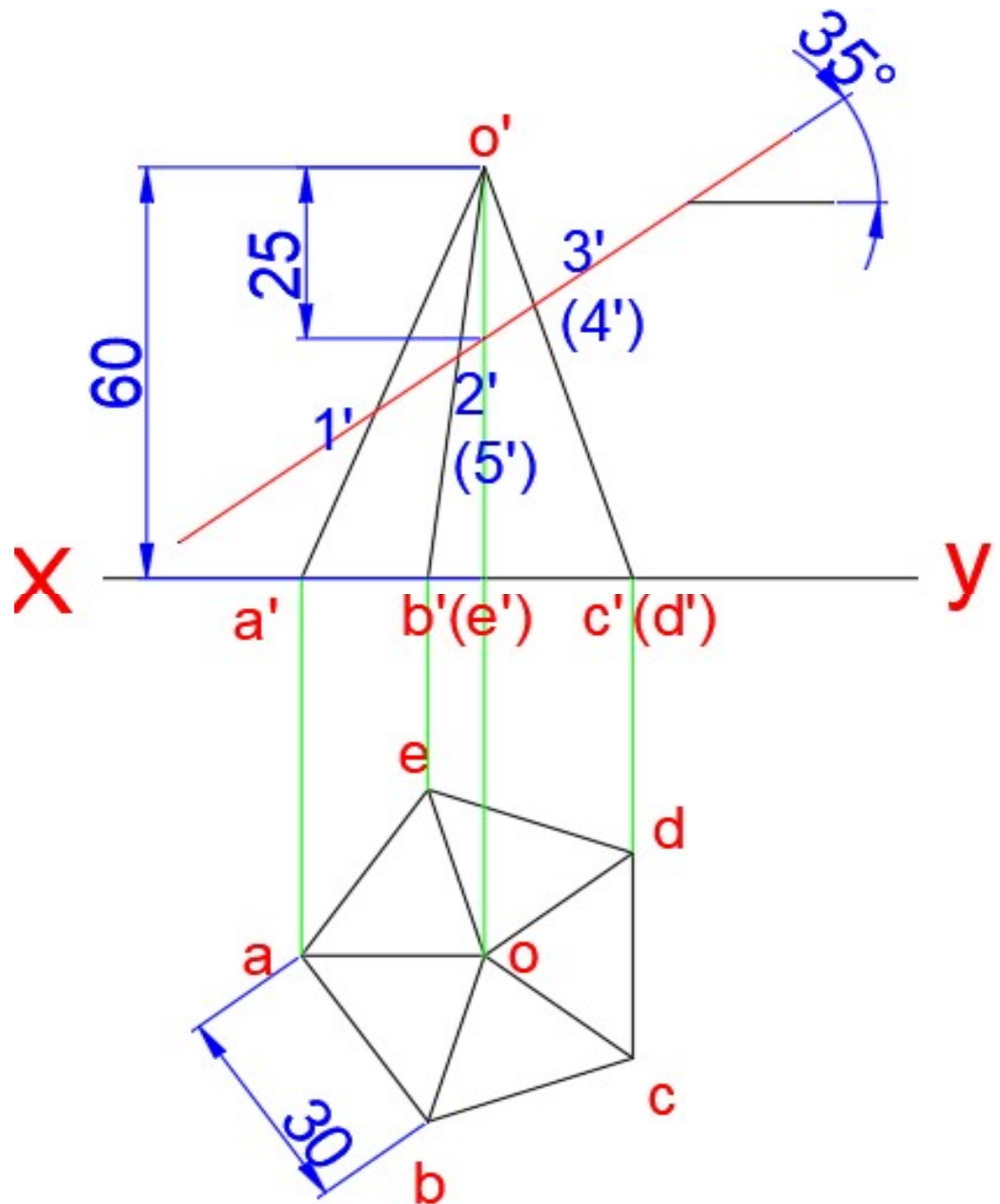


- Draw a Horizontal line
(ORTHO ON) on the top of the
Apex (Representation of Section
Line) & Rotate the Horizontal
line for 35°



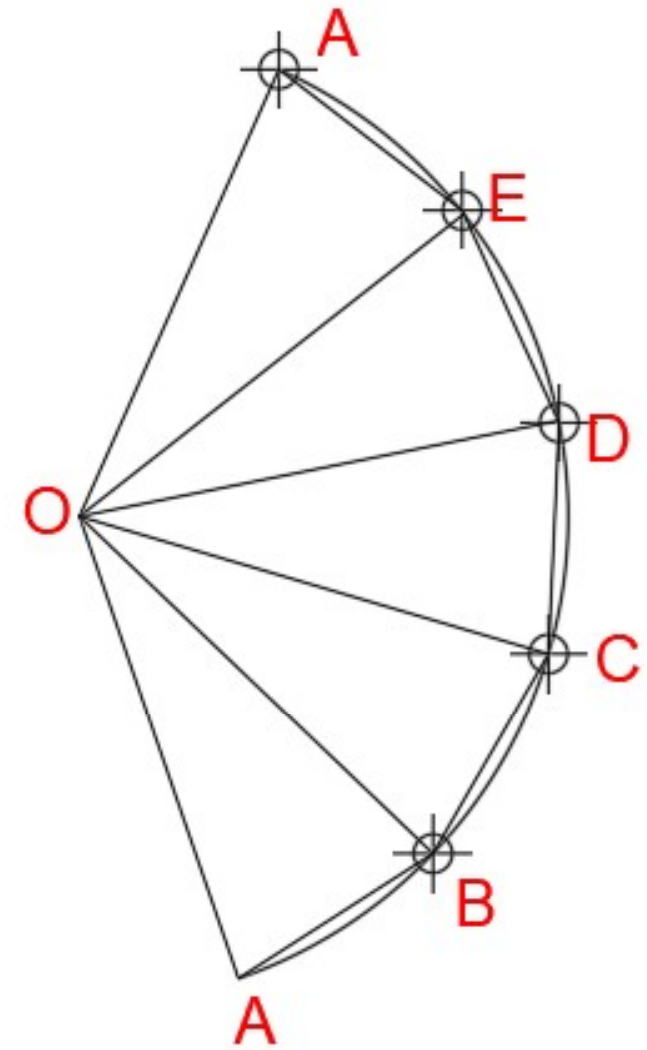
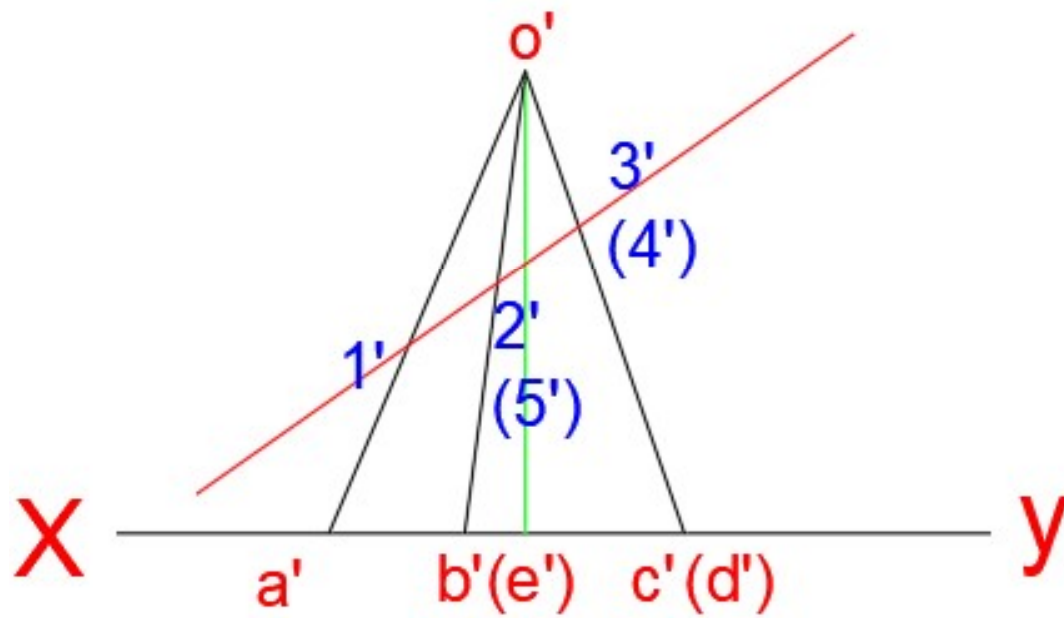


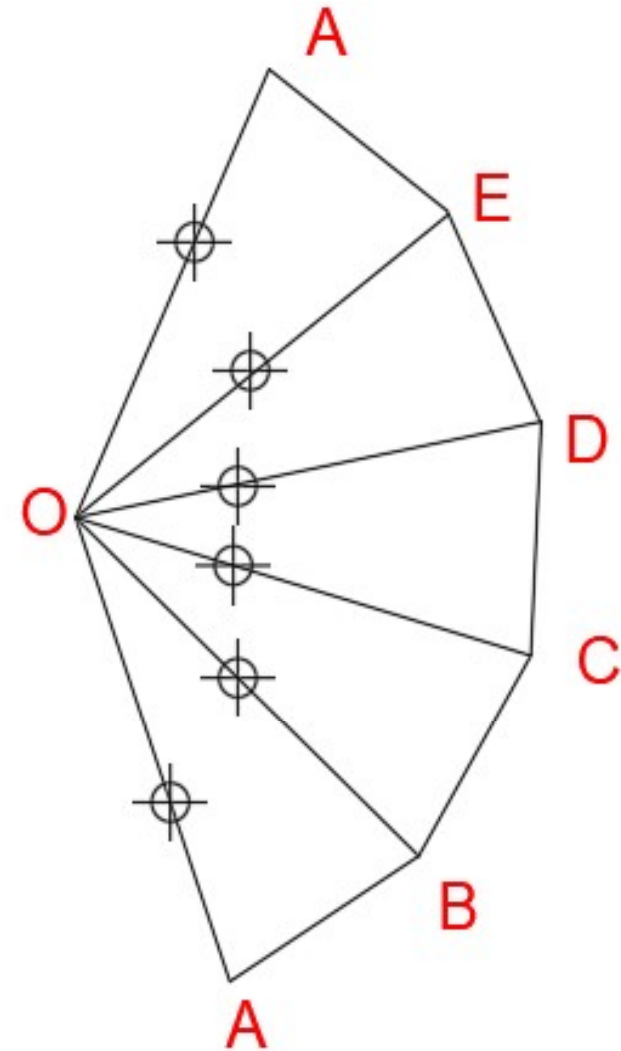
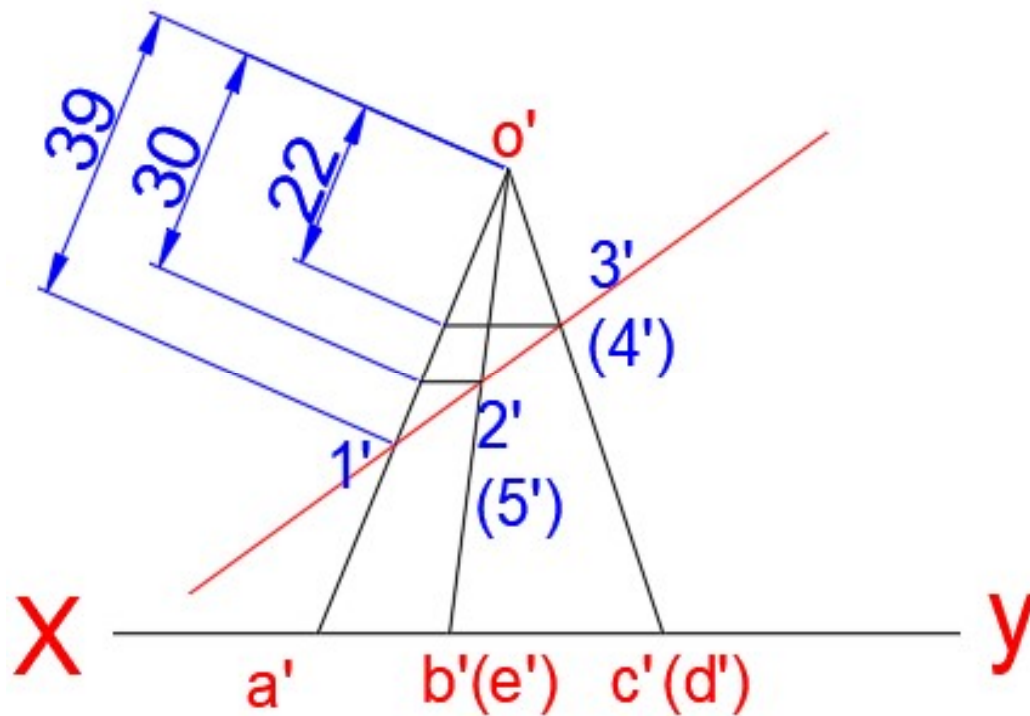
- Move Down the section line for **25 mm** from the Apex
- Name the points on the intersection of the section line with the solid as **1'**, **2' (5')** & **3' (4')**





- Copy the line **o' a'** & place Right side of the Front View & name it as **O** , **A** to draw the Development of the Pyramid using Radial Line method
- Draw an Arc (Center, Start ,End) with **O** as center & **A** as the Start point
- Mark the Base Edge length **30** mm on the Arc Using circle command & name the Points as **B** , **C** , **D** , **E** & **A**
- Connect all the point to the Apex point **O**

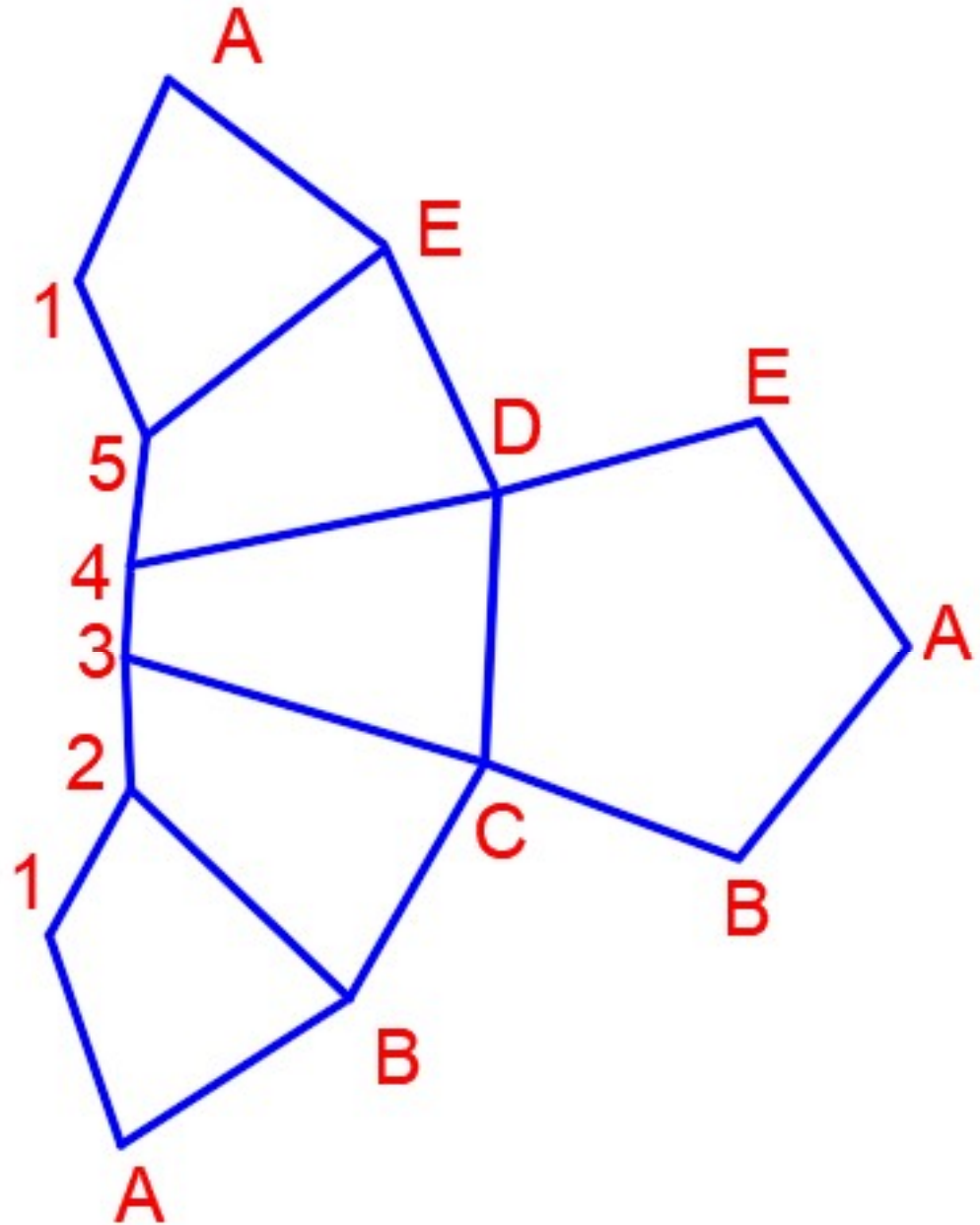




- Draw Horizontal lines from **2** & **3** (the intersection of the section line along **o' b'** & **o' c'**) to meet **o' a'**
- Measure the distances & mark on the development using circle command.



- Connect all the points & name the points as shown
- The required Development of a Sectioned Pentagonal pyramid using **Radial Line Method**



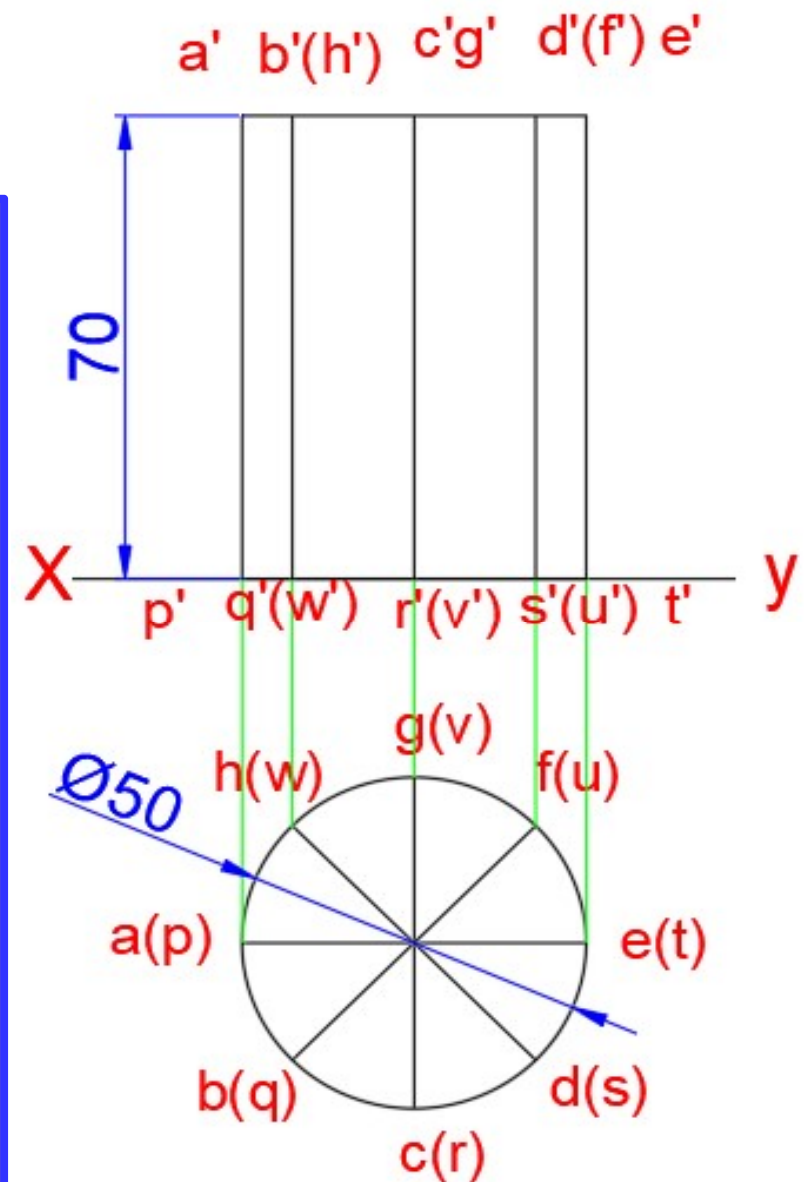


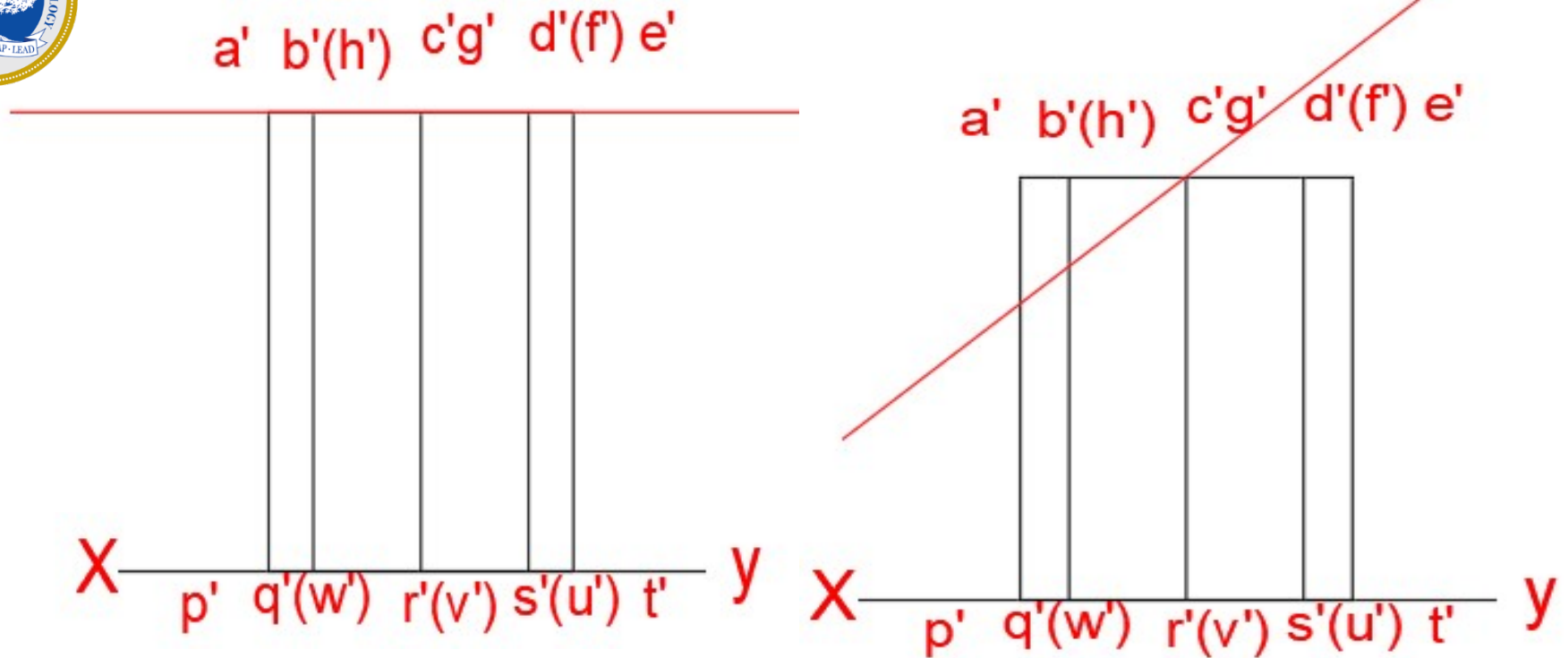
Draw the development of lateral surface of a cylinder of diameter **50** mm and axis **70** mm when sectioned by a plane inclined at **40°** to HP and perpendicular to VP and bisecting the axis.

- Set the **UNITS & LIMITS** in **Drafting & Annotation Mode**
- Use the **LINE** command from **DRAW** tool bar & draw the Reference line **XY**.
- Start with Top view & create the **CIRCLE** for the given base diameter **50** mm.

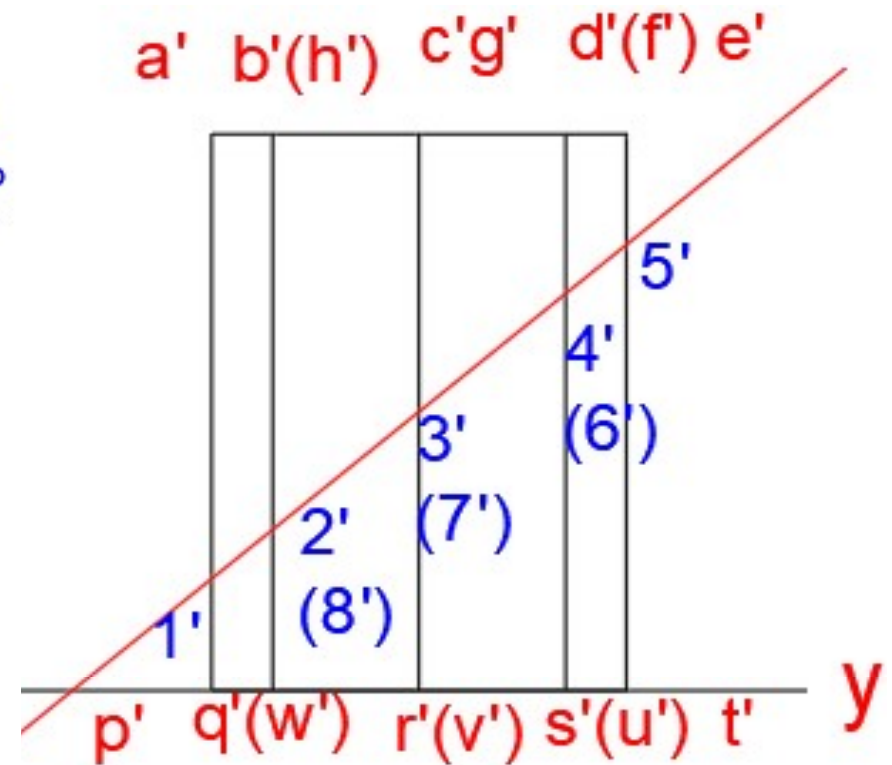
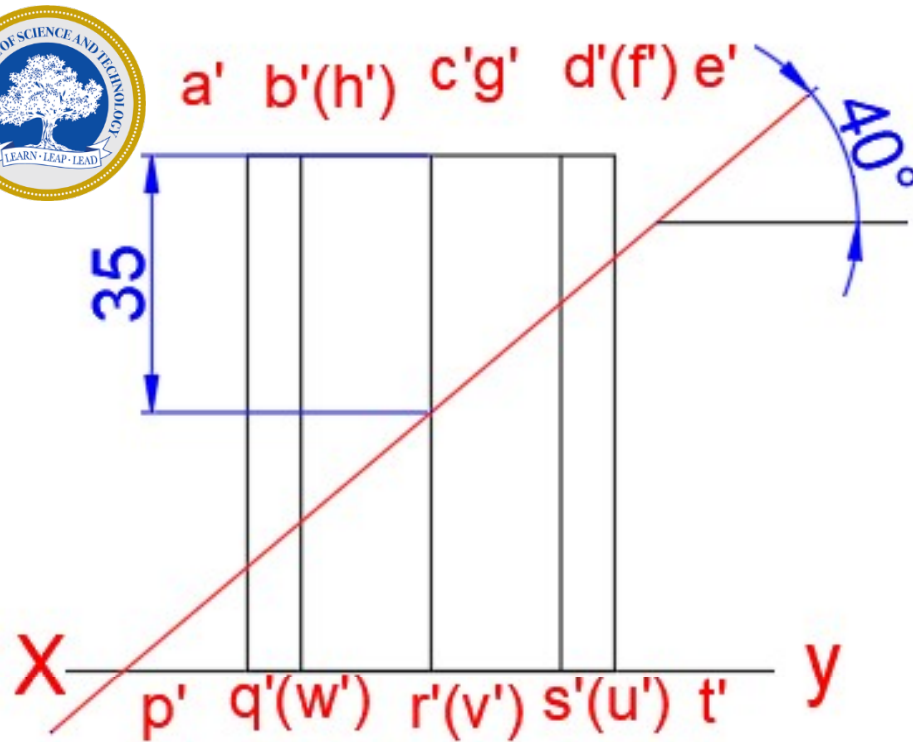


- Use **DIVIDE** command to divide the circle into 8 equal number of parts
- Use the **TEXT** command & Name it as **a, b, c, d, e, f, g, & h** for **Top base** and **p, q, r, s, t, u, v, & w** for **Bottom base**.
- Project lines from **Top view** & complete the **Front View** with namings

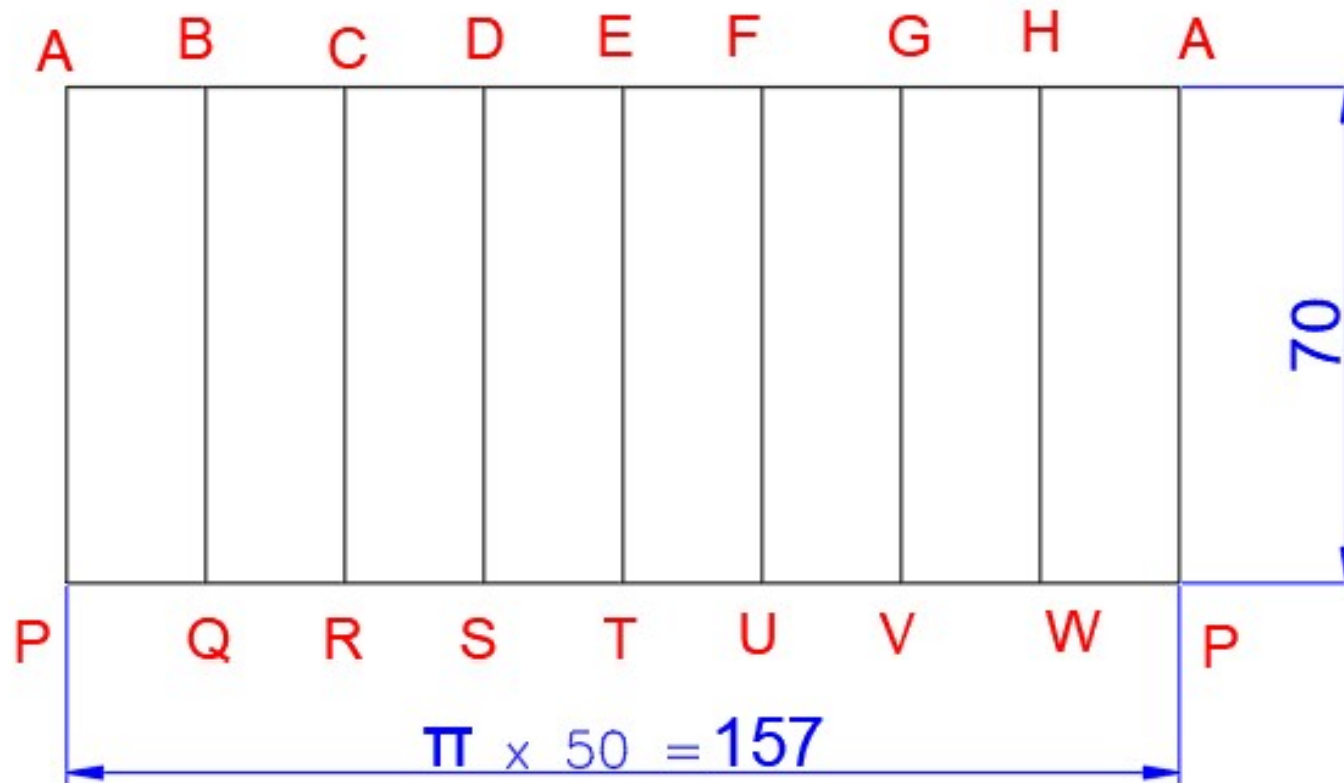




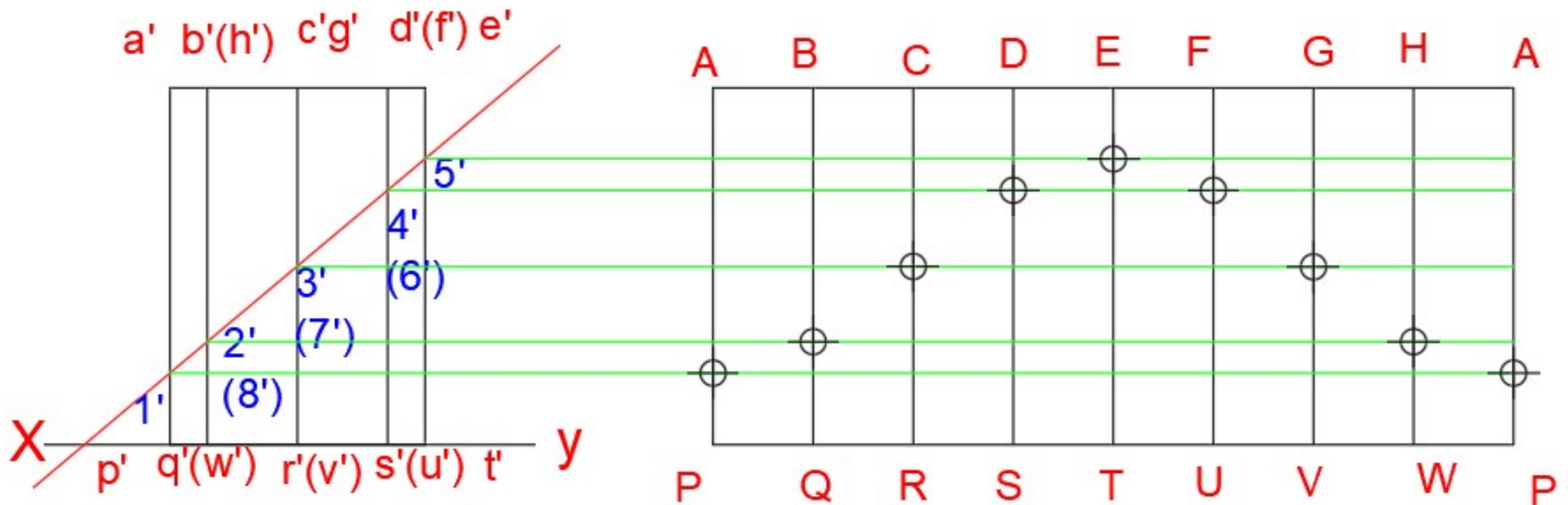
- Draw a Horizontal line on the top base of the front view for a length more than the width of the front view.
- **ROTATE** the Horizontal line for the given angle **40°** with respect to **HP**



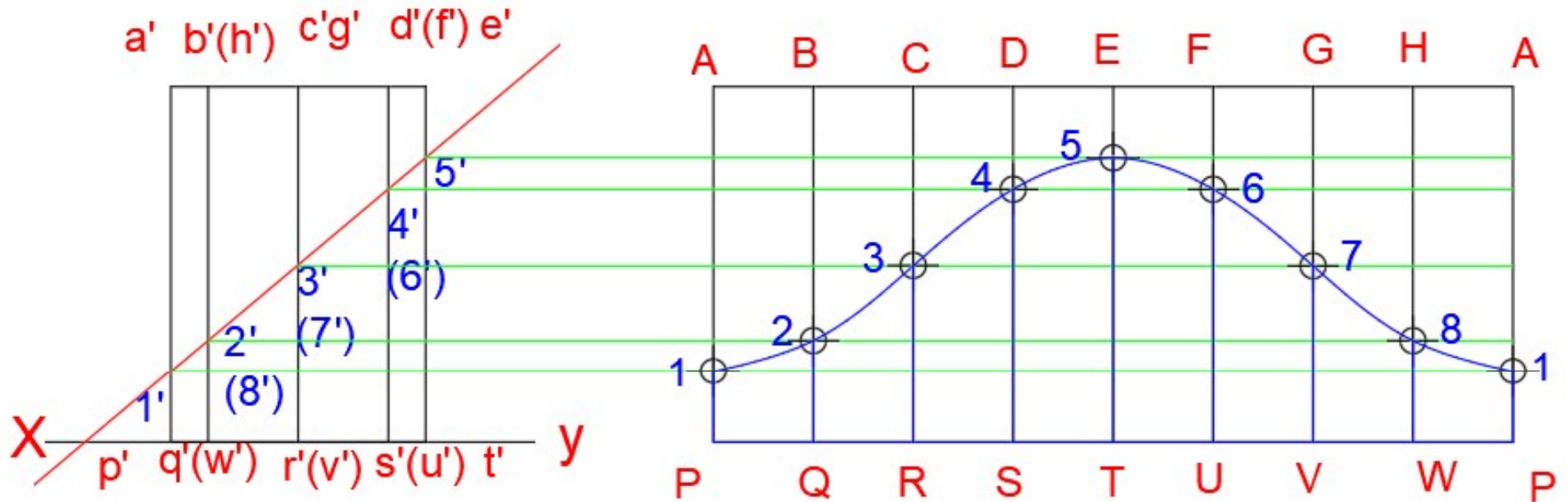
- **MOVE (ORTHO ON)** the horizontal line linearly downward direction for given **35** mm which represents the **SECTION** plane cutting the cylinder at **40°** with respect to **HP**
- Name the points on the intersection of the section line with the solid as **1'**, **2' (8')**, **3' (7')**, **4' (6')** & **5'**



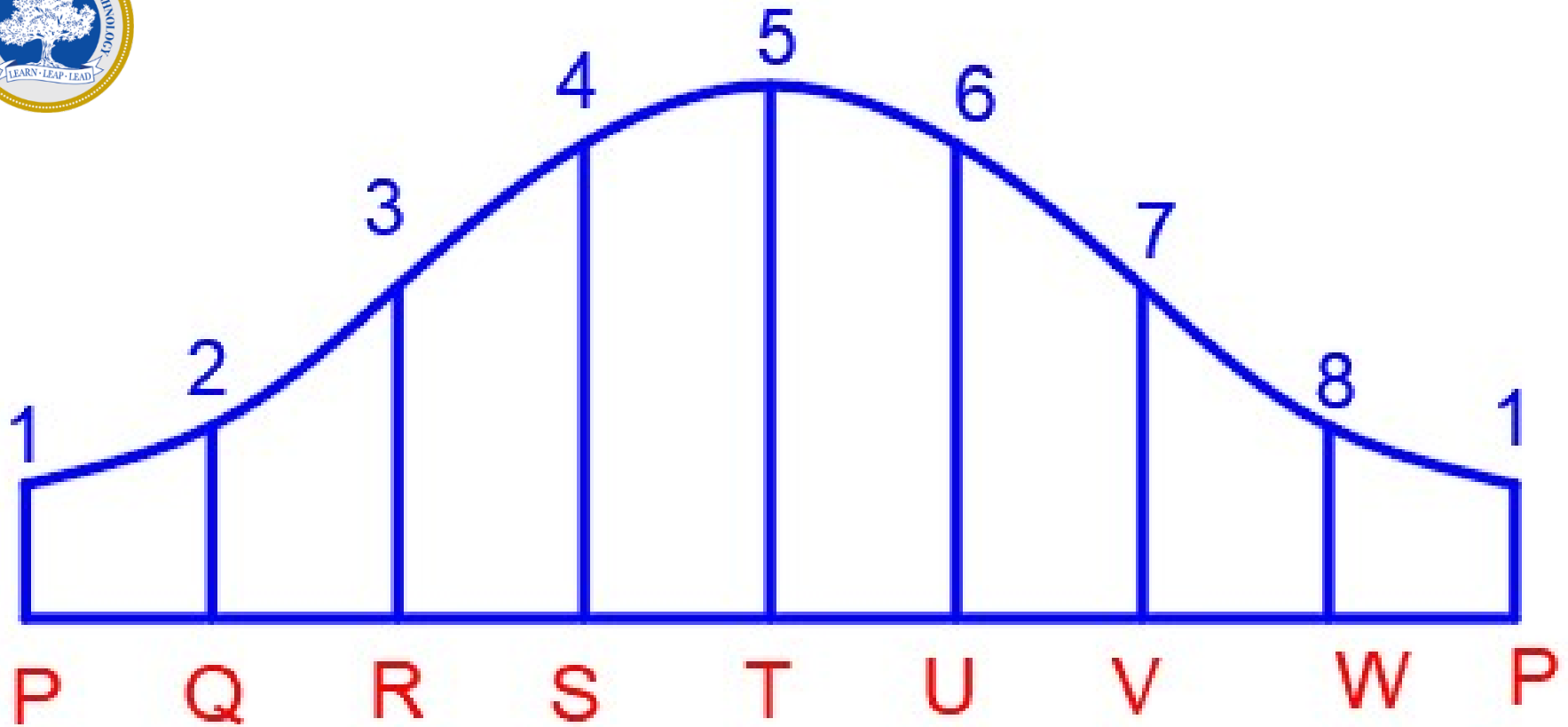
- Calculate the length of the Development (diameter multiply with π) & draw the development of the cylinder
- Divide the base line into 8 equal parts & name the points.



- Project the lines from the **Section line** cutting the front view of the cylinder to the Development diagram.
- Mark the points on the intersection.



➤ Use **SPLINE FIT** command to Draw the curve from **1 to 2** ,
2 to 3 , **3 to 4** , **4 to 5** , **5 to 6** , **6 to 7** , **7 to 8** & **8 to 1**



➤ The required Development of a Sectioned Cylinder using **Parallel Line Method**



REFERENCE BOOKS

- JEYAPOOVAN T, “ENGINEERING GRAPHICS AND DESIGN”, 2023, Vikas Publishing House Pvt Ltd,
- K.V.NATARAJAN, “Engineering Graphics”, 2015, Dhanalakshmi Publishers.