ME 119
Lecture 9: Intersection of Surfaces
Vivek Sangwan

Based on slides by Prof. Salil S. Kulkarni

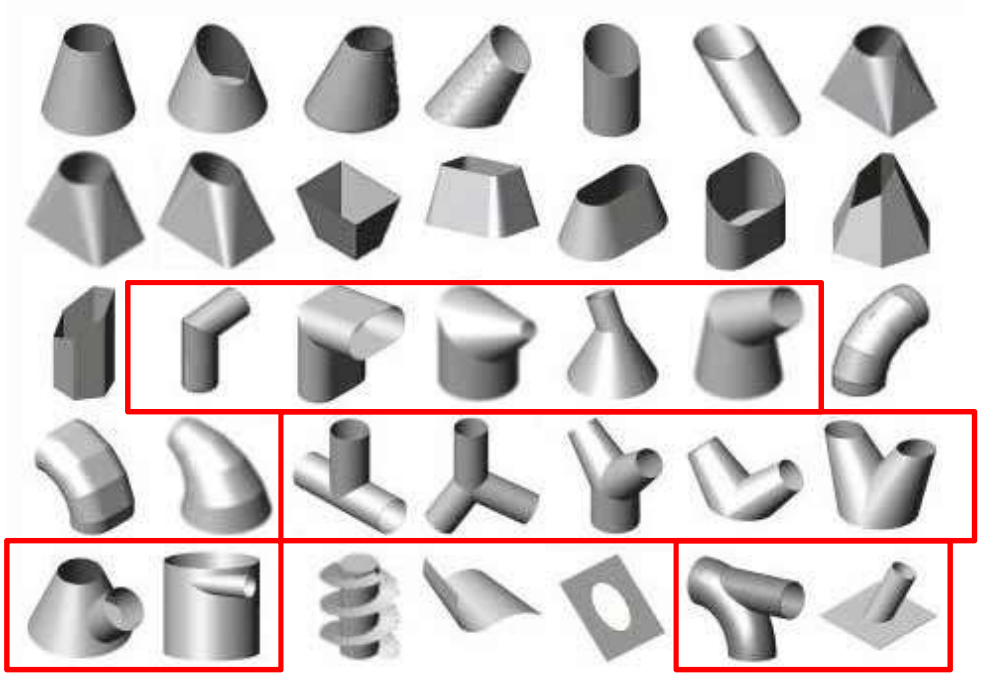
Motivation

- Practically every engineering product is composed of planes, lines or solids which intersect. Hence essential to understand the principles of intersection in order to design and analyze engineering products

- Essential in finding accurate developments of surfaces of intersecting geometric shapes

http://play-auto.net/wp-content/uploads/2010/01/half-of-wards-10-best-engines-2010-use-borgwarner-components-16019_1.jpg

http://www.3dmetalforming.com/news/3dmetal-forming-wins-the-innovation-challange-aero-structures/



http://metal.brightcookie.com/3_tem/tem_t2/htm/tem2_2_1.htm

Introduction

- **Aim** -Locate and determine the shape and size the **line of intersection** of the two intersecting surfaces

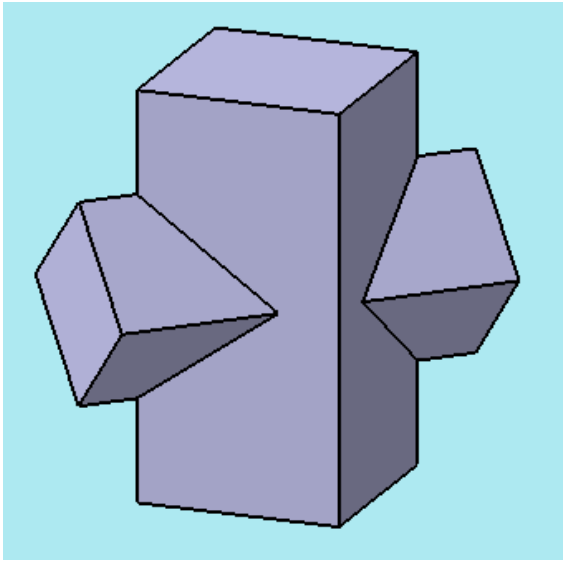
- Line of intersection of two surfaces is a line that is common to both surfaces

- The line of intersection is found by determining the number of points common to both surfaces and drawing line or lines through these points in correct order

- The line of intersection may be straight (Group A problems), curved (Group B problems)

Methods to Determine the Line of Intersection – Group A

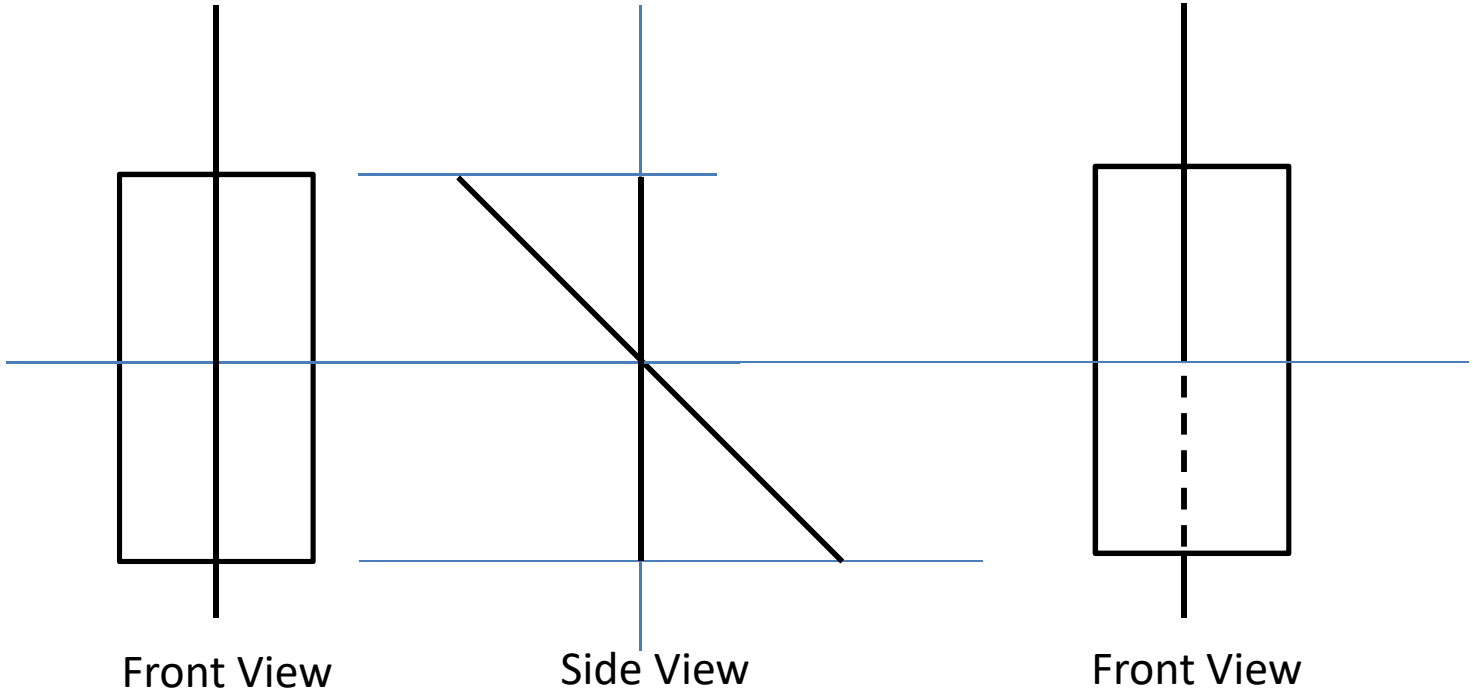
Group A - Both the surfaces are plane surfaces – prism and prism, pyramid and prism, pyramid and pyramid



- Locate the points through which the edges of one solid (I) pierces the surface of other the solid (II)
- These points are vertices of the line of intersection
- The vertices are located by using the view when the surface of solid II appears as an edge
- Join these vertices to obtain the line of intersection

To Find the Point of Intersection of a Line and a Plane

The front view a line equally inclined to both H.P. and the V.P. and a plane which lies along the VP is shown below. The line is intersecting the plane. Find the point of intersection and determine the visibility of the line.

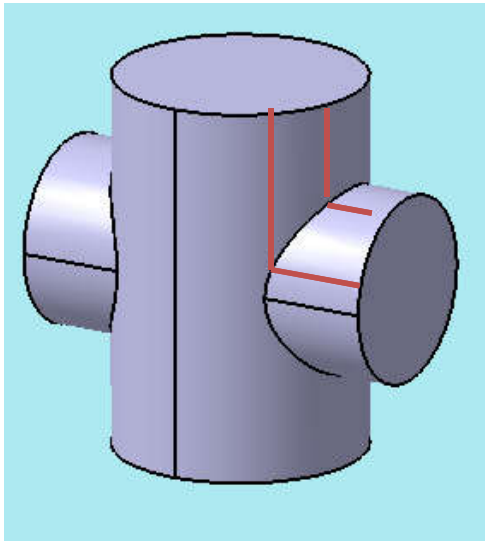


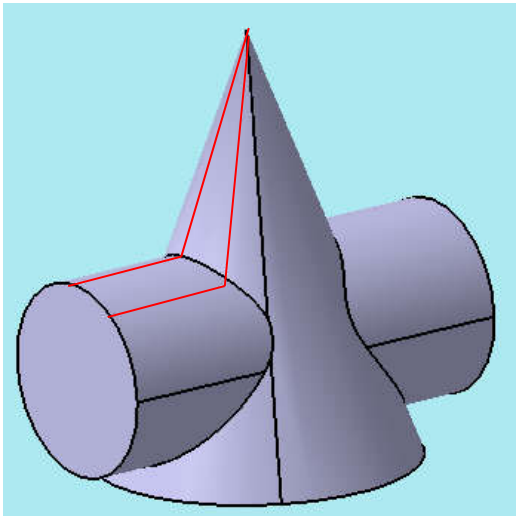
To find the point of intersection of the line with a plane, draw the edge view of the plane . Locate the point of intersection in the edge view.

Methods to Determine the Line of Intersection – Group B

Group B - Either one or both the surfaces are singly or doubly curved

Methods of Lines
Cutting Plane Method

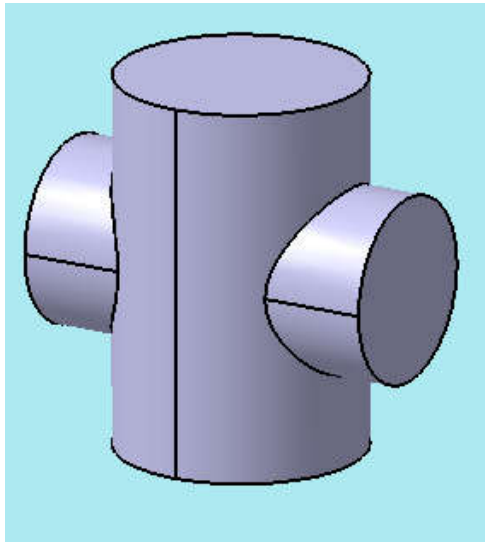


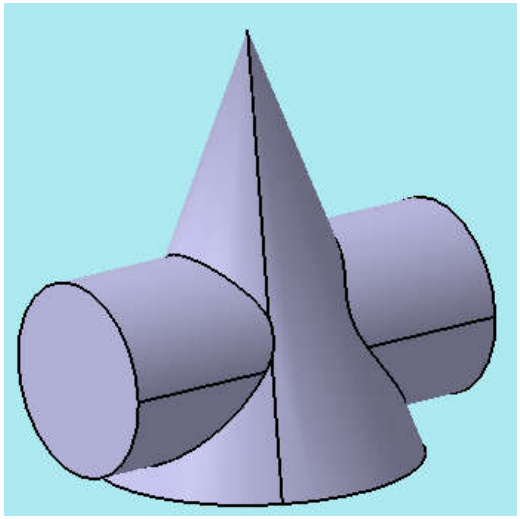


Method of Lines

- Number of lines are drawn on the lateral surface of the solids
- Points of intersection of these lines are then located
- These points lie on the line of intersection
- The curve passing through these points gives the line of intersection
- Points of intersection are easy to locate if the lateral surface of one of the solids appears edgewise

Methods to Determine the Line of Intersection – Group B



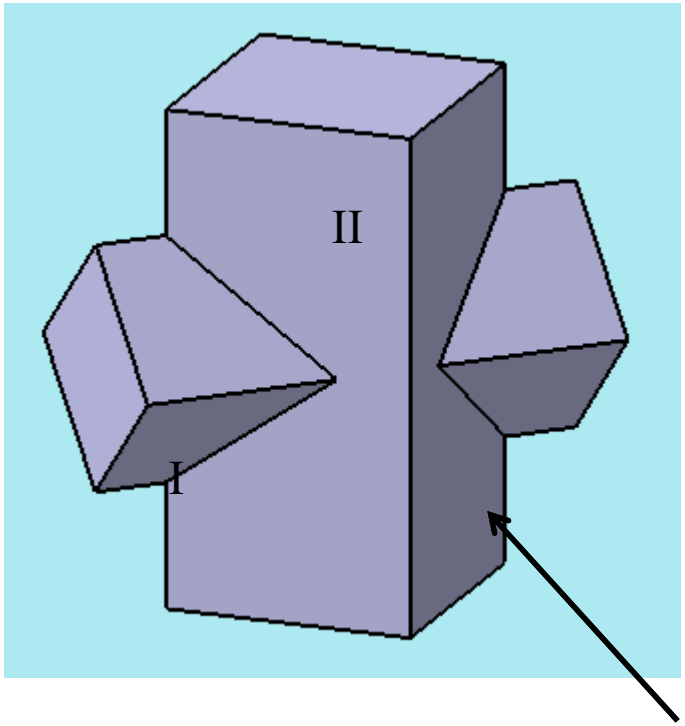


Cutting Plane Method

- The two solids are assumed to be cut by a series of cutting planes
- The position of the cutting planes is so chosen so that the shape of the section of each of the solid can be imagined and drawn in at least one of the views
- Draw the shapes of the two solids in the view where it is convenient and locate the points of intersection of these shapes
- Project these points on the cutting plane line and join them in the correct order to obtain the line of intersection

Intersection of Two Prisms

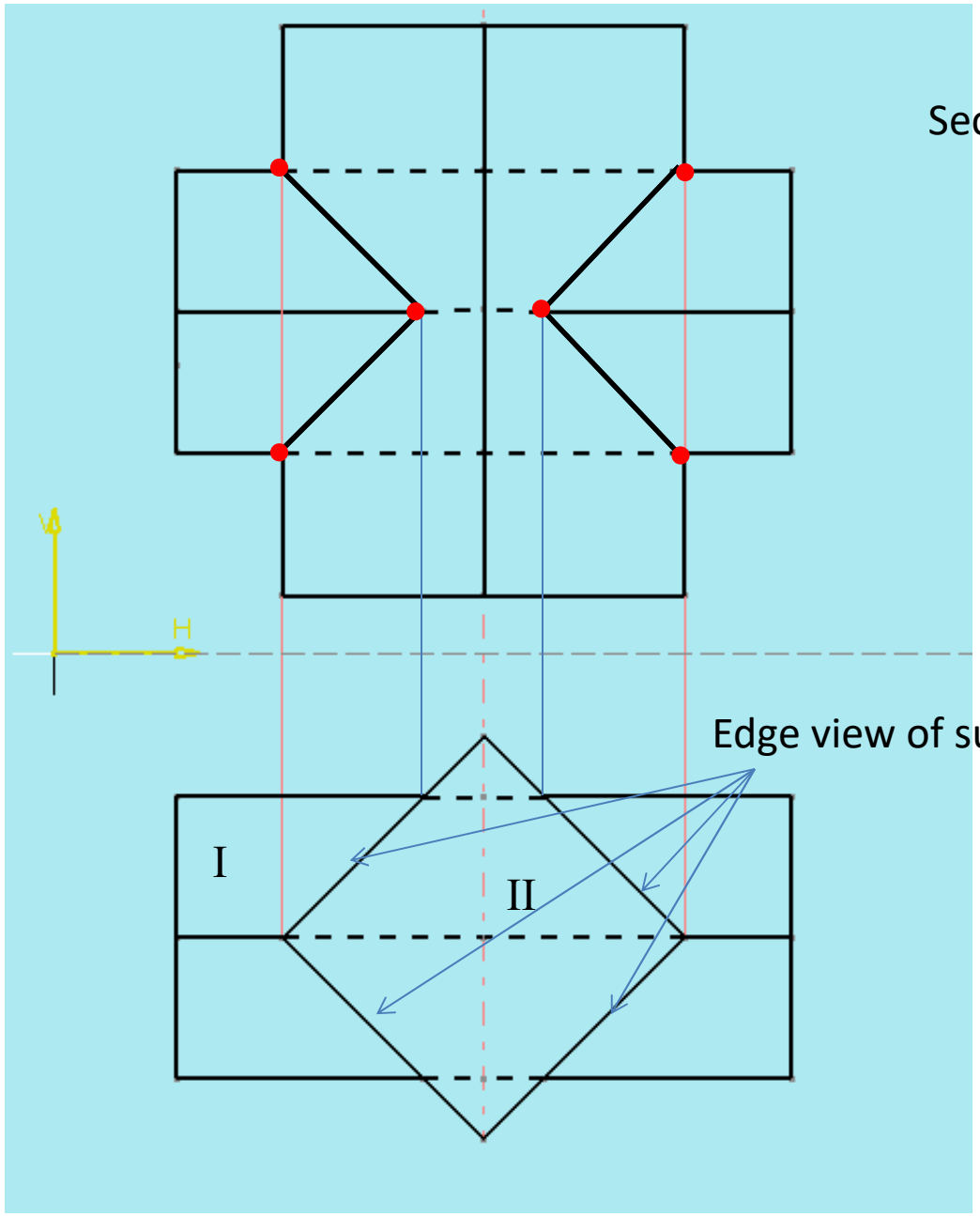
Group A problem



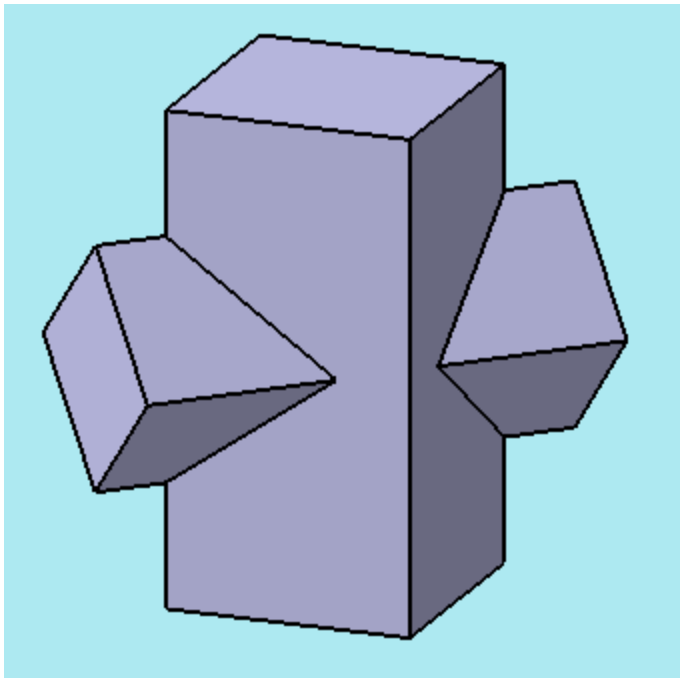
Problem 16-1. (fig. 16-1): *A vertical square prism, base 50 mm side, is completely penetrated by a horizontal square prism, base 35 mm side, so that their axes intersect. The axis of the horizontal prism is parallel to the V.P., while the faces of the two prisms are equally inclined to the V.P. Draw the projections of the solids, showing lines of intersection. (Assume suitable lengths for the prisms.)*

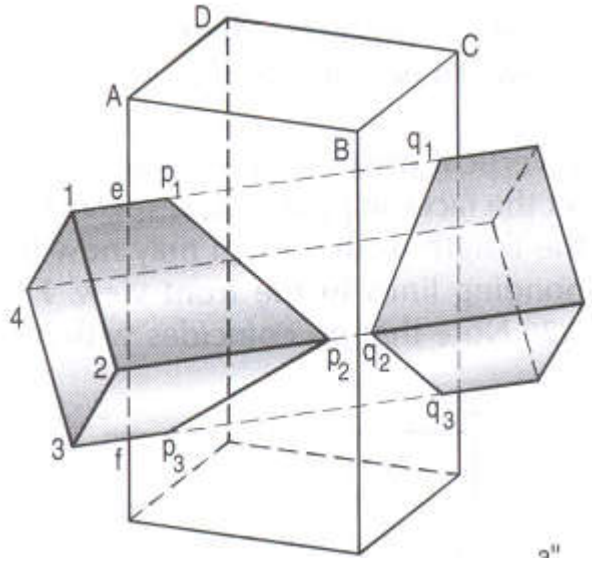
Intersection of Two Prisms

Section 16-3, pg. 382, N. D. Bhatt, 50th edition



Edge view of surface

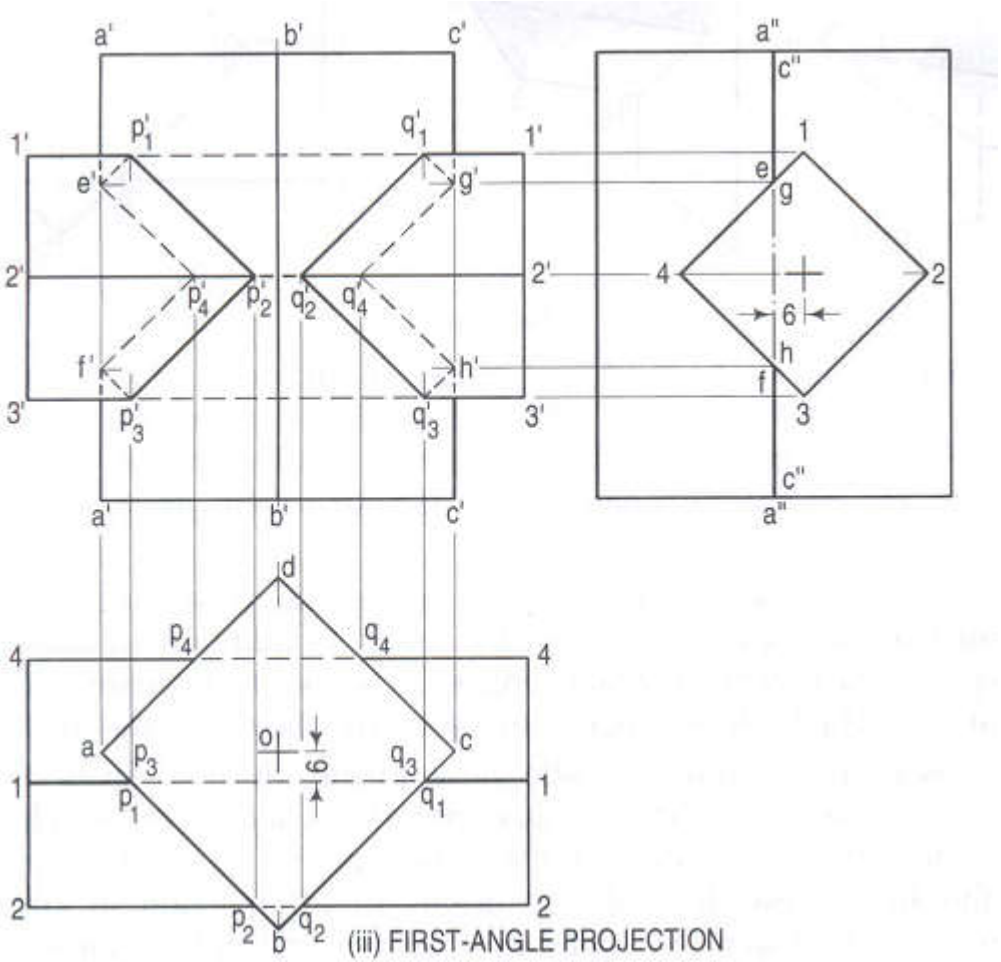


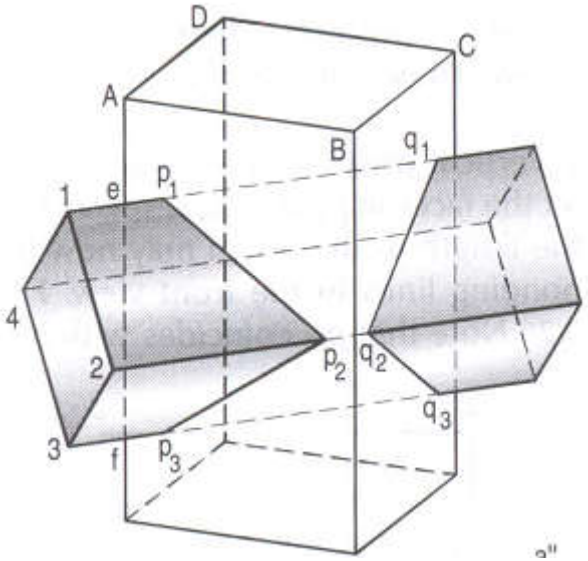


Problem 16-2. (fig. 16-2): *A vertical square prism, base 50 mm side is completely penetrated by a horizontal square prism, base 35 mm side so that their axes are 6 mm apart. The axis of the horizontal prism is parallel to the V.P., while the faces of both prisms are equally inclined to the V.P. Draw the projections of the prisms showing lines of intersection.*

Intersection of Two Prisms

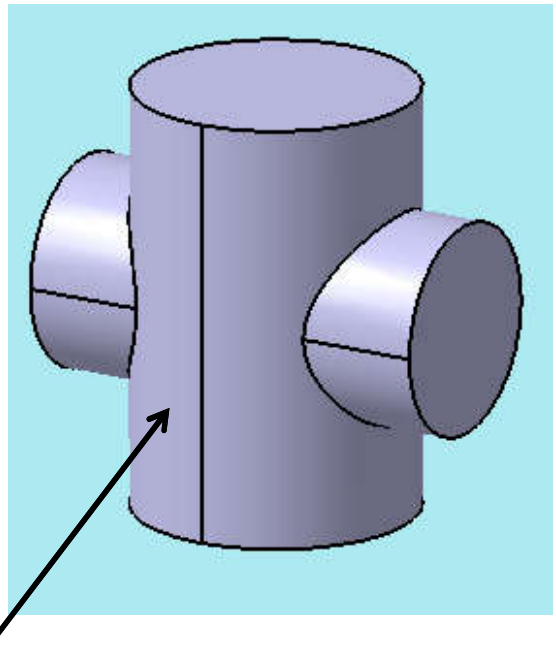
Section 16-3, pg. 384, N. D. Bhatt, 50th edition





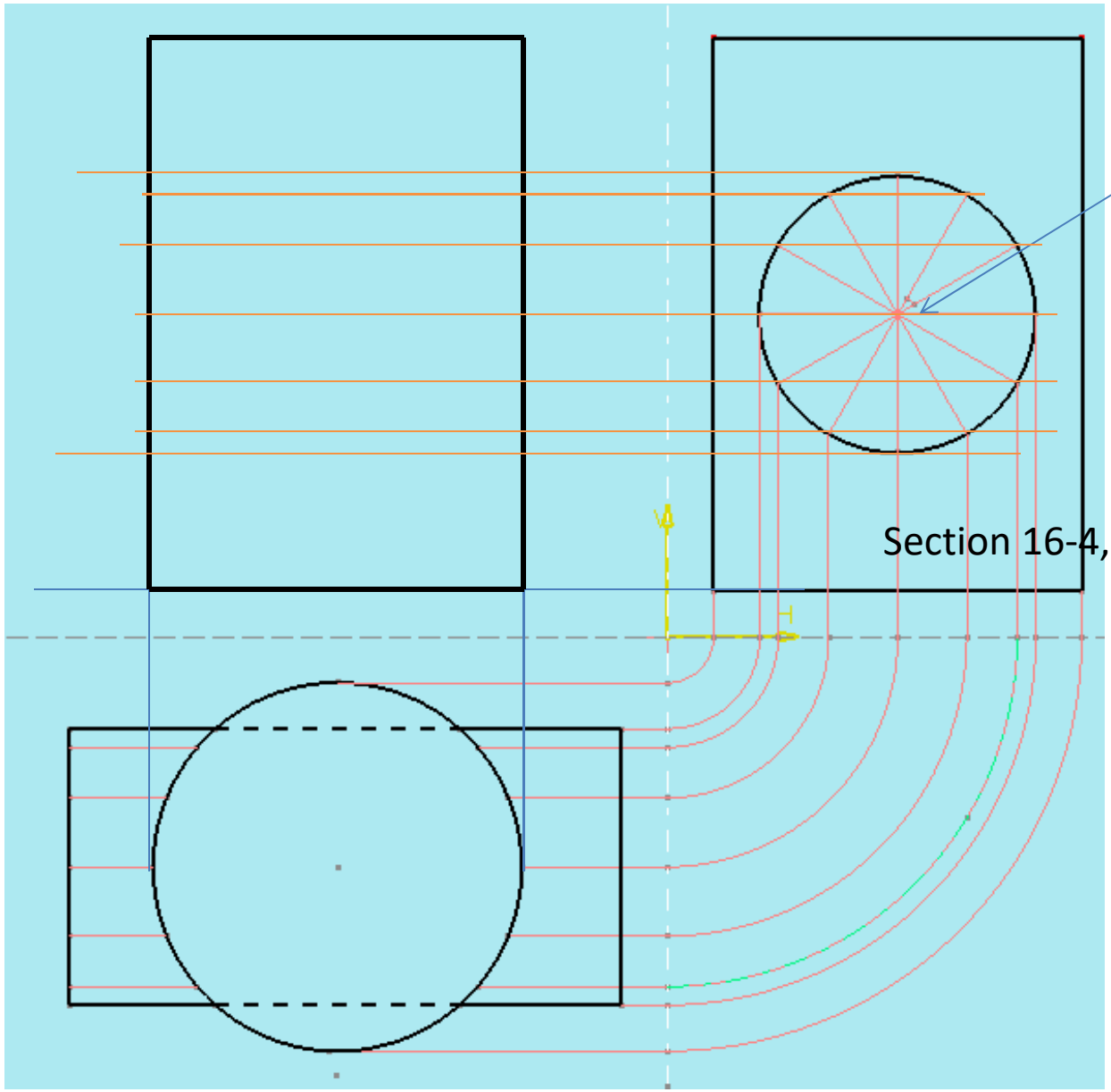
Intersection of Cylinder and Cylinder

Group B problem



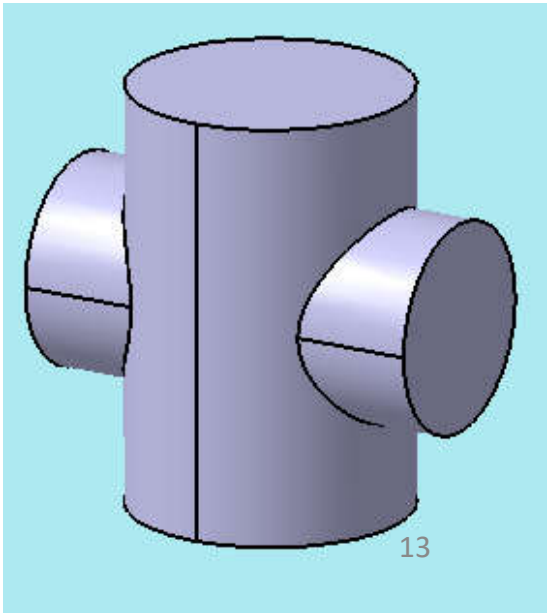
Problem 16-8. (fig. 16-8): *A vertical cylinder of 80 mm diameter is completely penetrated by another cylinder of 60 mm diameter, their axes bisecting each other at right angles. Draw their projections showing curves of penetration, assuming the axis of the penetrating cylinder to be parallel to the V.P.*

Intersection of Cylinder and Cylinder – Method of Lines

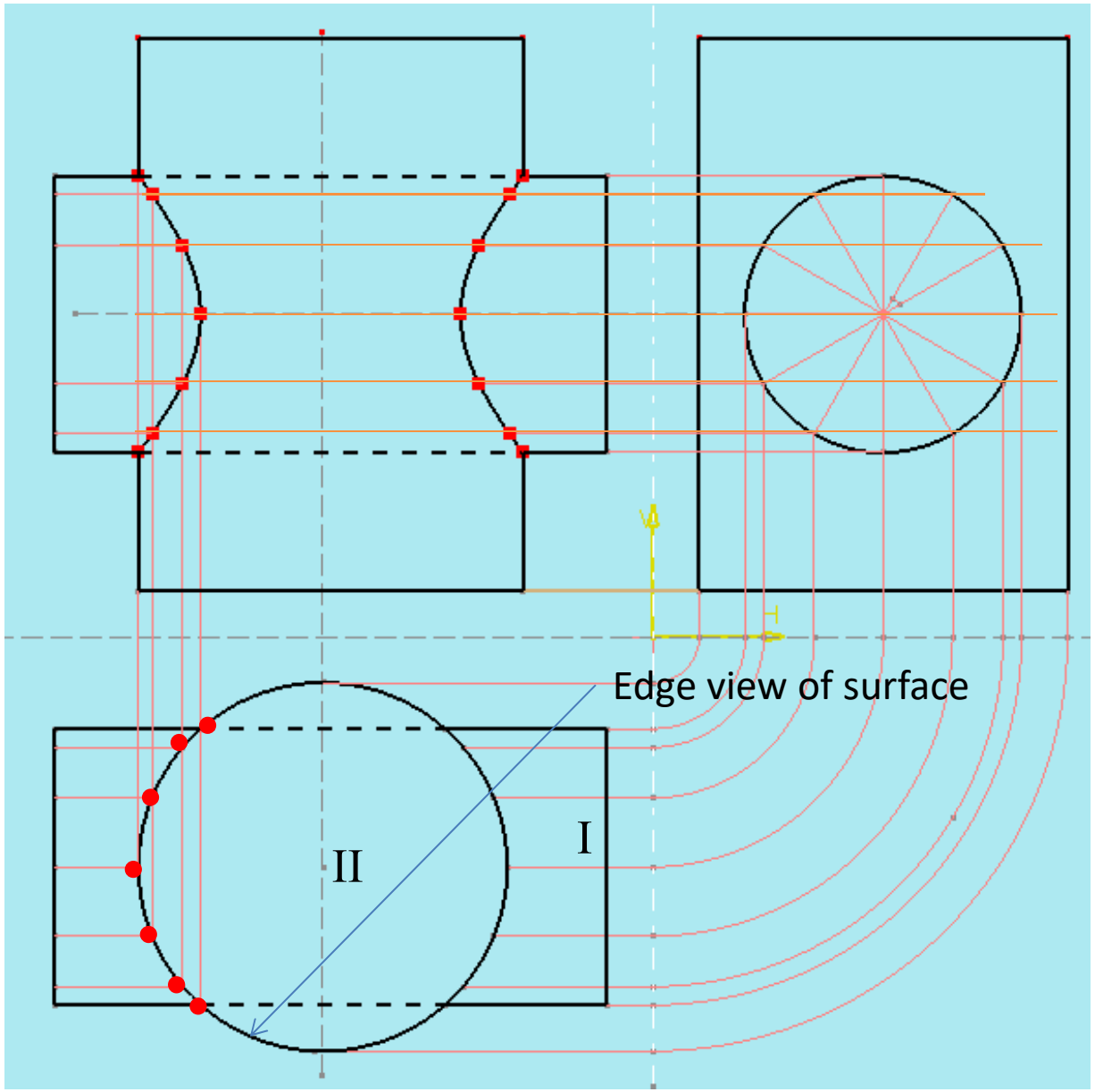


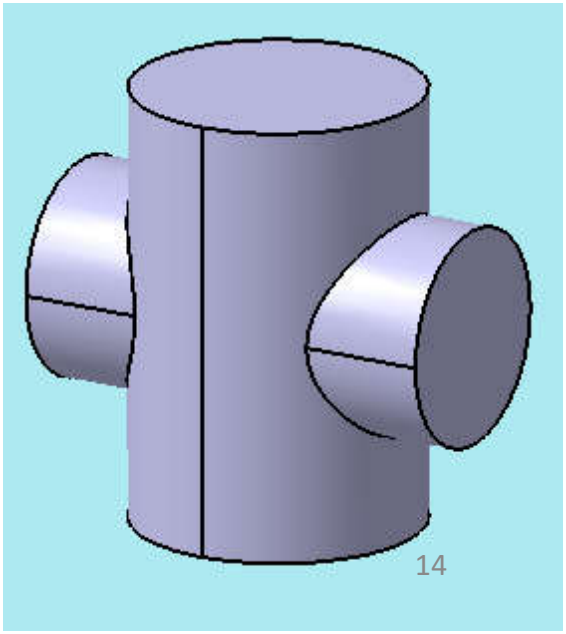
Construction used to draw lines on its lateral surface

Section 16-4, pg. 390, N. D. Bhatt, 50th edition

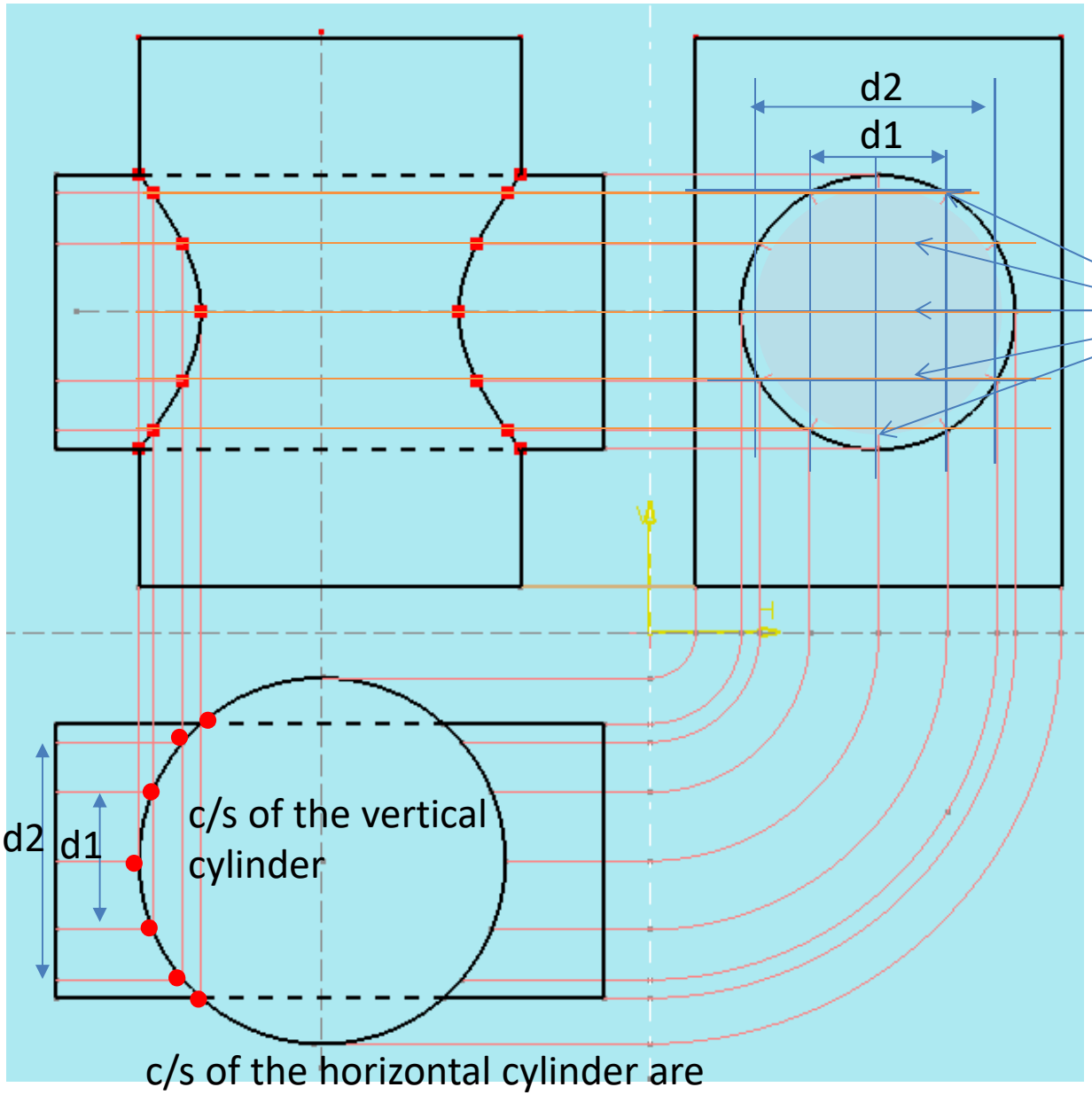


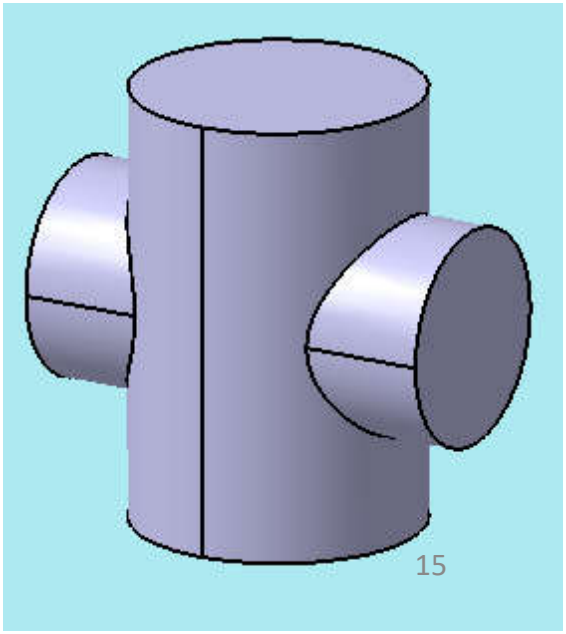
Intersection of Cylinder and Cylinder – Method of Lines





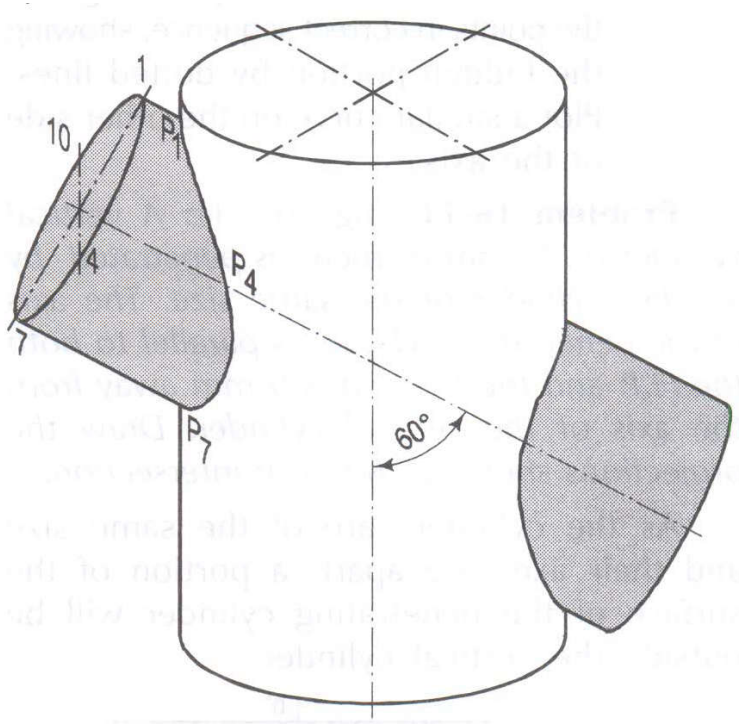
Intersection of Cylinder with Cylinder – Method of Planes



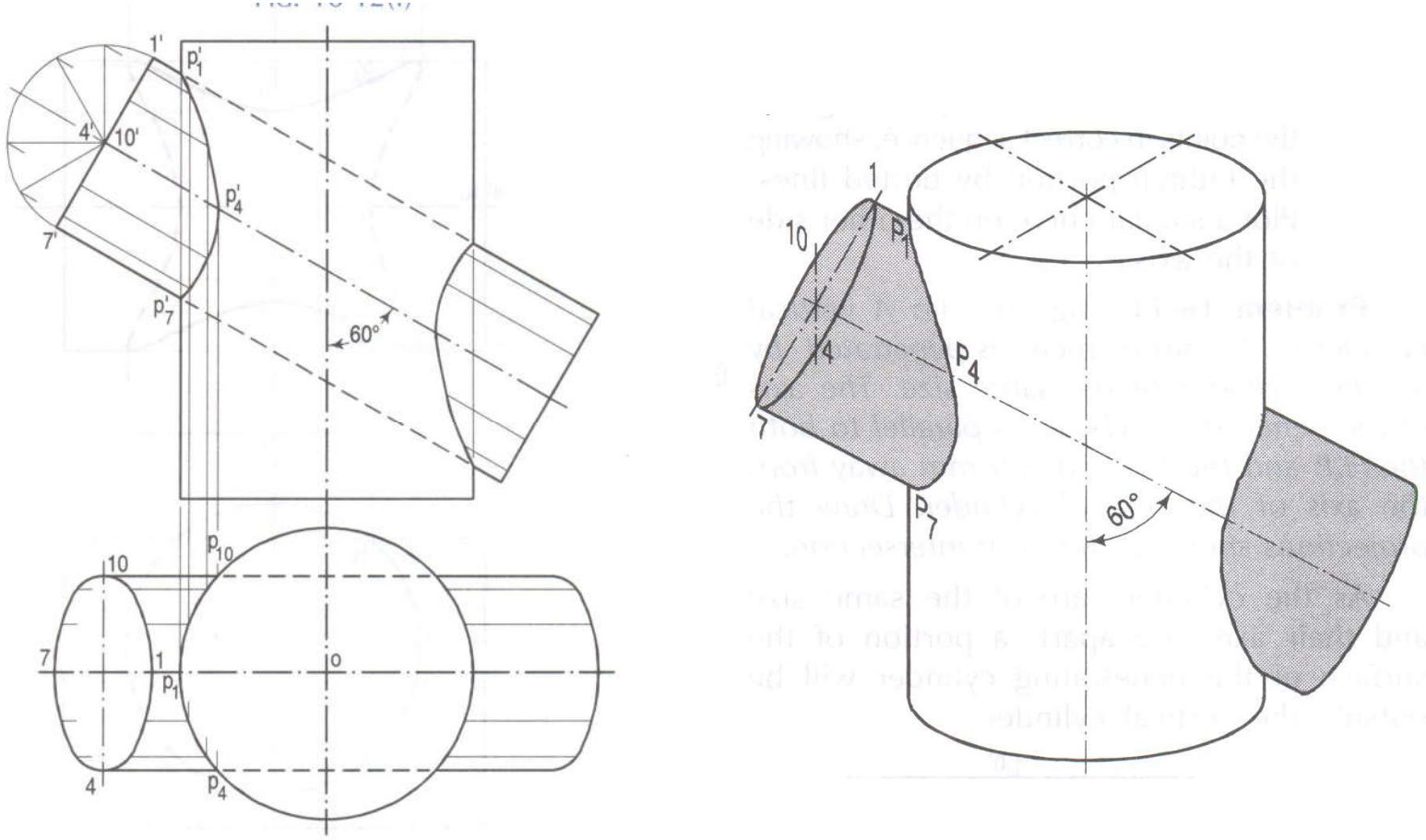


Intersection of Two Cylinder Oblique to Each Other

Problem 16-12. (fig. 16-12): *A cylinder of 60 mm diameter, having its axis vertical is penetrated by another cylinder of 40 mm diameter. The axis of the penetrating cylinder is parallel to the V.P. and bisects the axis of the vertical cylinder, making an angle of 60° with it. Draw the projections showing curves of intersection.*

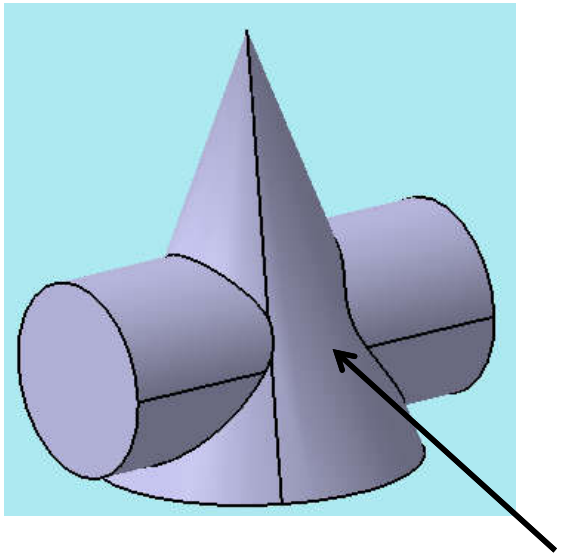


Intersection of Two Cylinder Oblique to Each Other - Method of Lines



Section 16-4, pg. 394, N. D. Bhatt, 50th edition

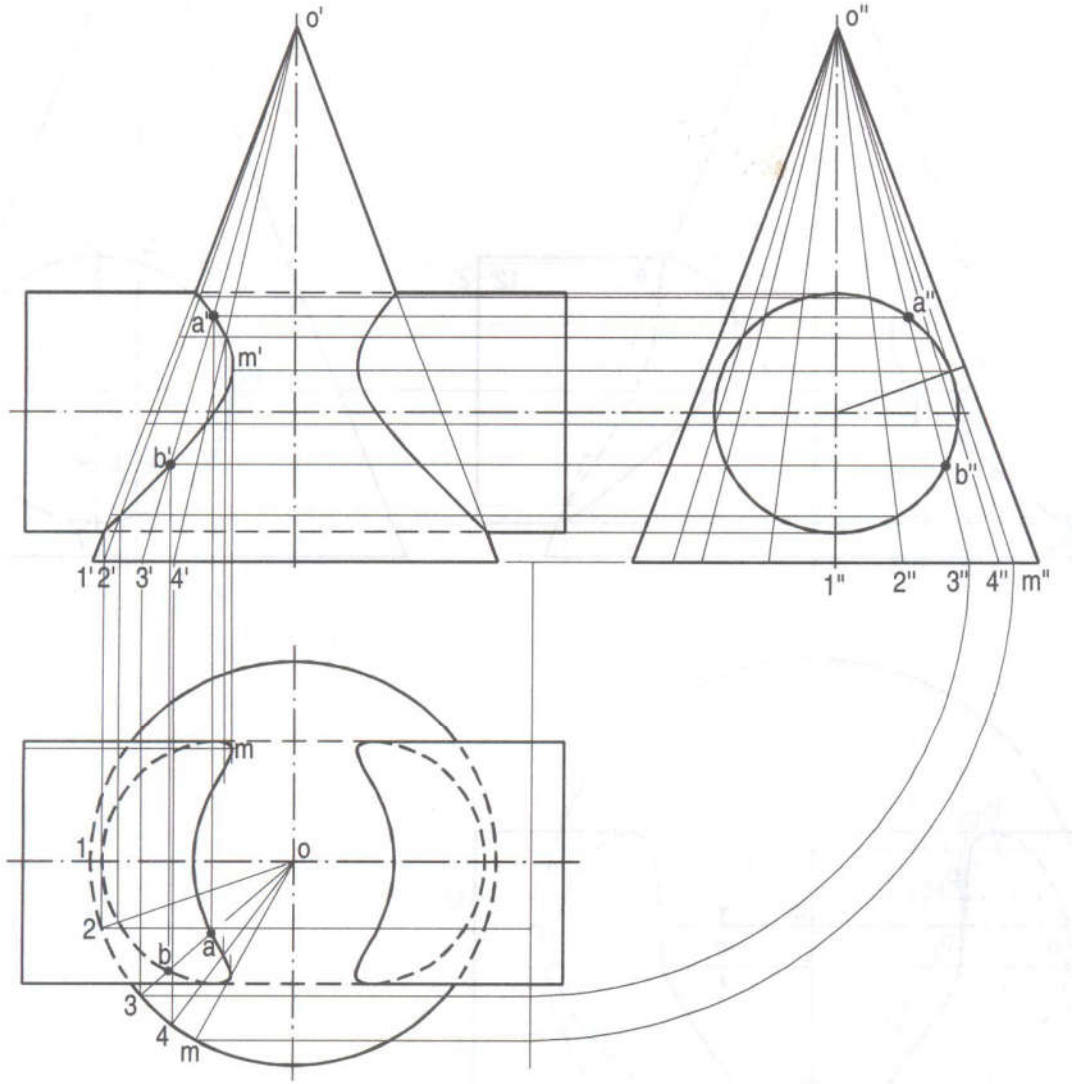
Intersection of Cone and Cylinder

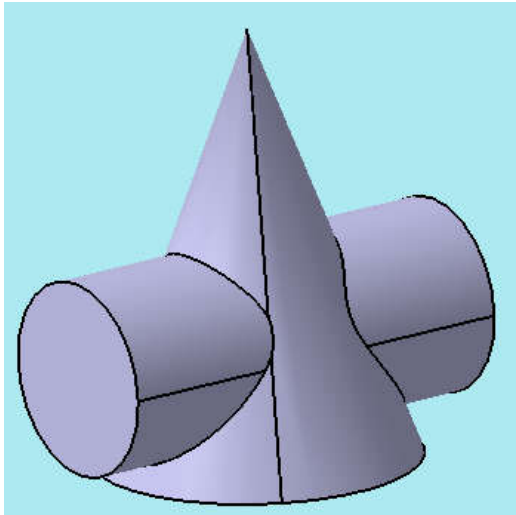


Problem 16-22. *A vertical cone, diameter of base 75 mm and axis 100 mm long, is completely penetrated by a cylinder of 45 mm diameter. The axis of the cylinder is parallel to the H.P. and the V.P. and intersects the axis of the cone at a point 28 mm above the base. Draw the projections of the solids showing curves of intersection.*

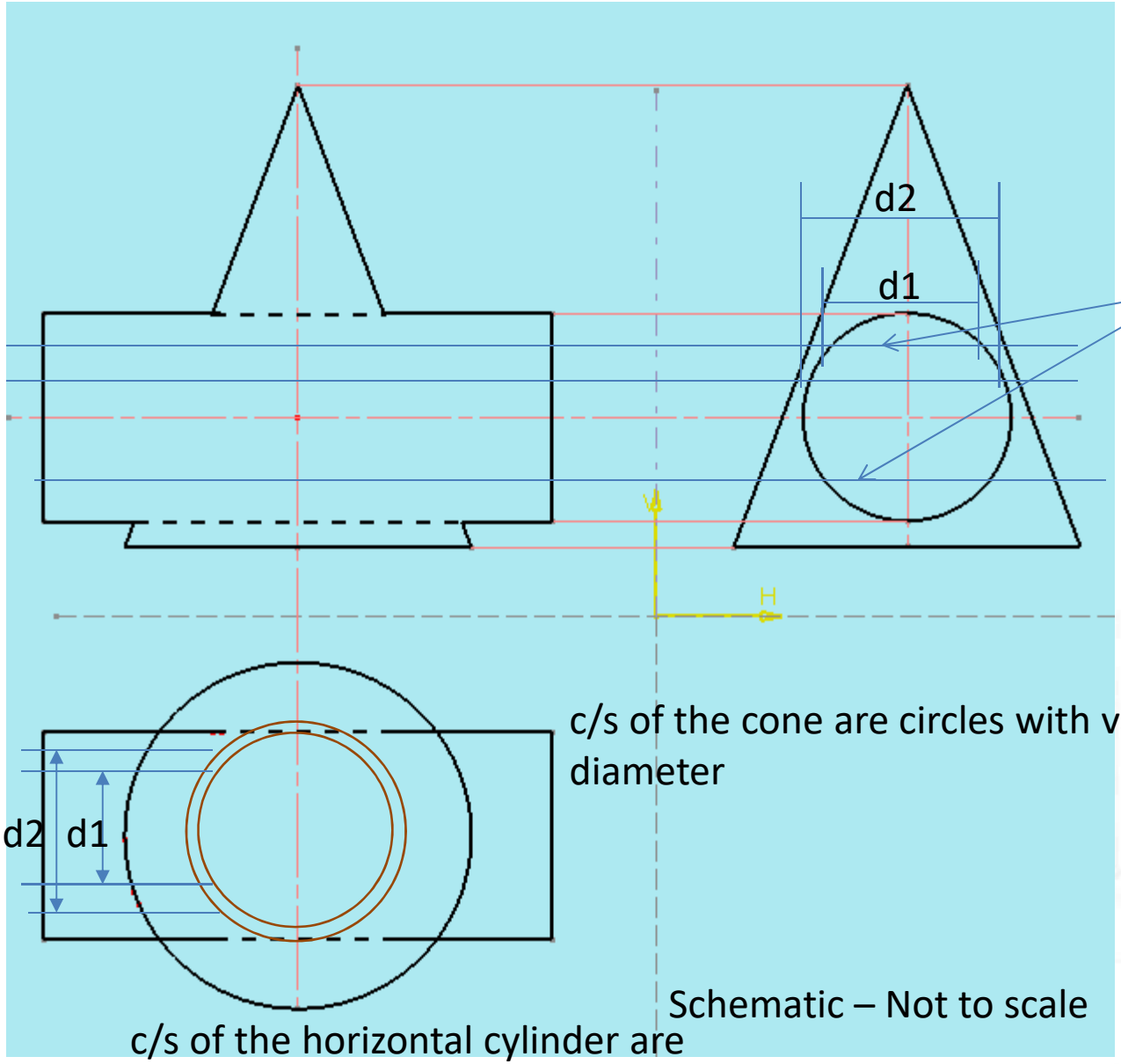
Intersection of Cone and Cylinder – Method of Lines

Section 16-6, pg. 403, N. D. Bhatt, 50th edition





Intersection of Cone and Cylinder – Method of Planes

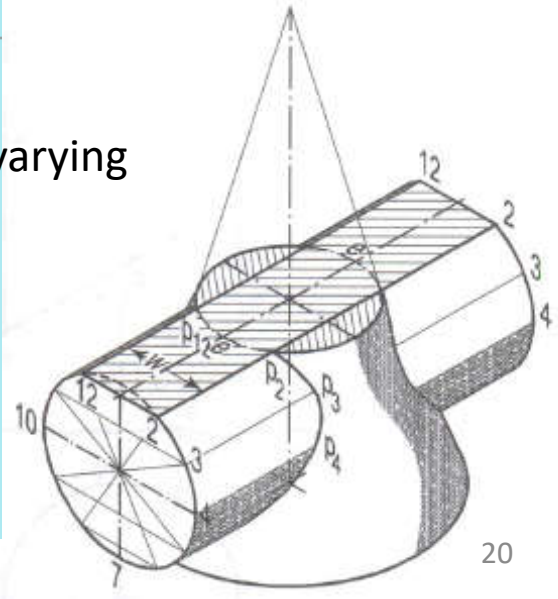


Horizontal cutting planes

c/s of the cone are circles with varying diameter

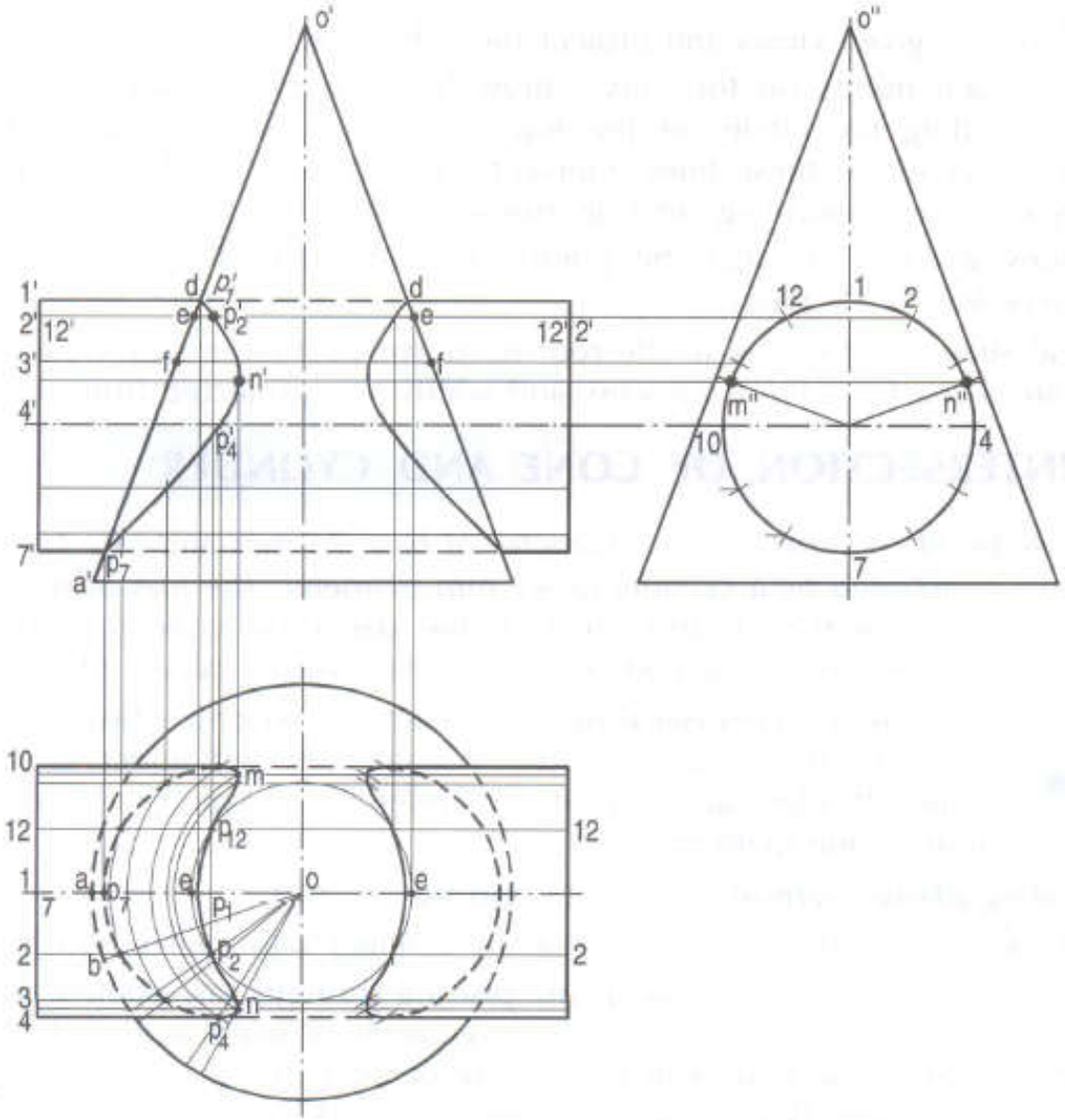
Schematic – Not to scale

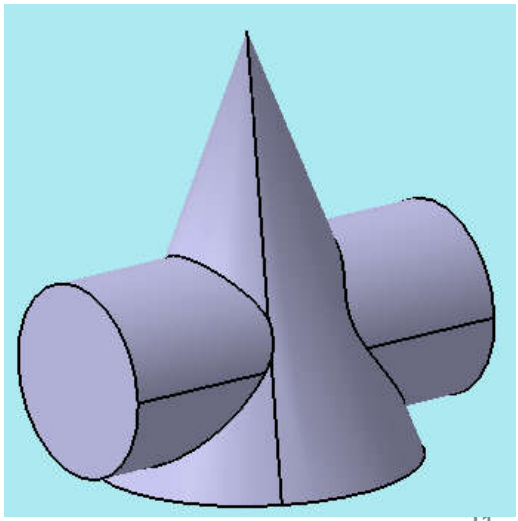
c/s of the horizontal cylinder are rectangles with width d1, d2, etc



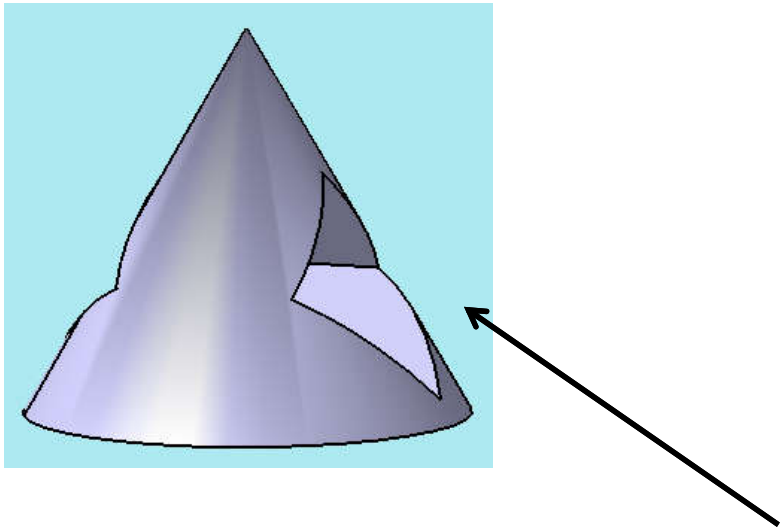
Intersection of Cone and Cylinder – Method of Planes

Section 16-6, pg. 401, N. D. Bhatt, 50th edition



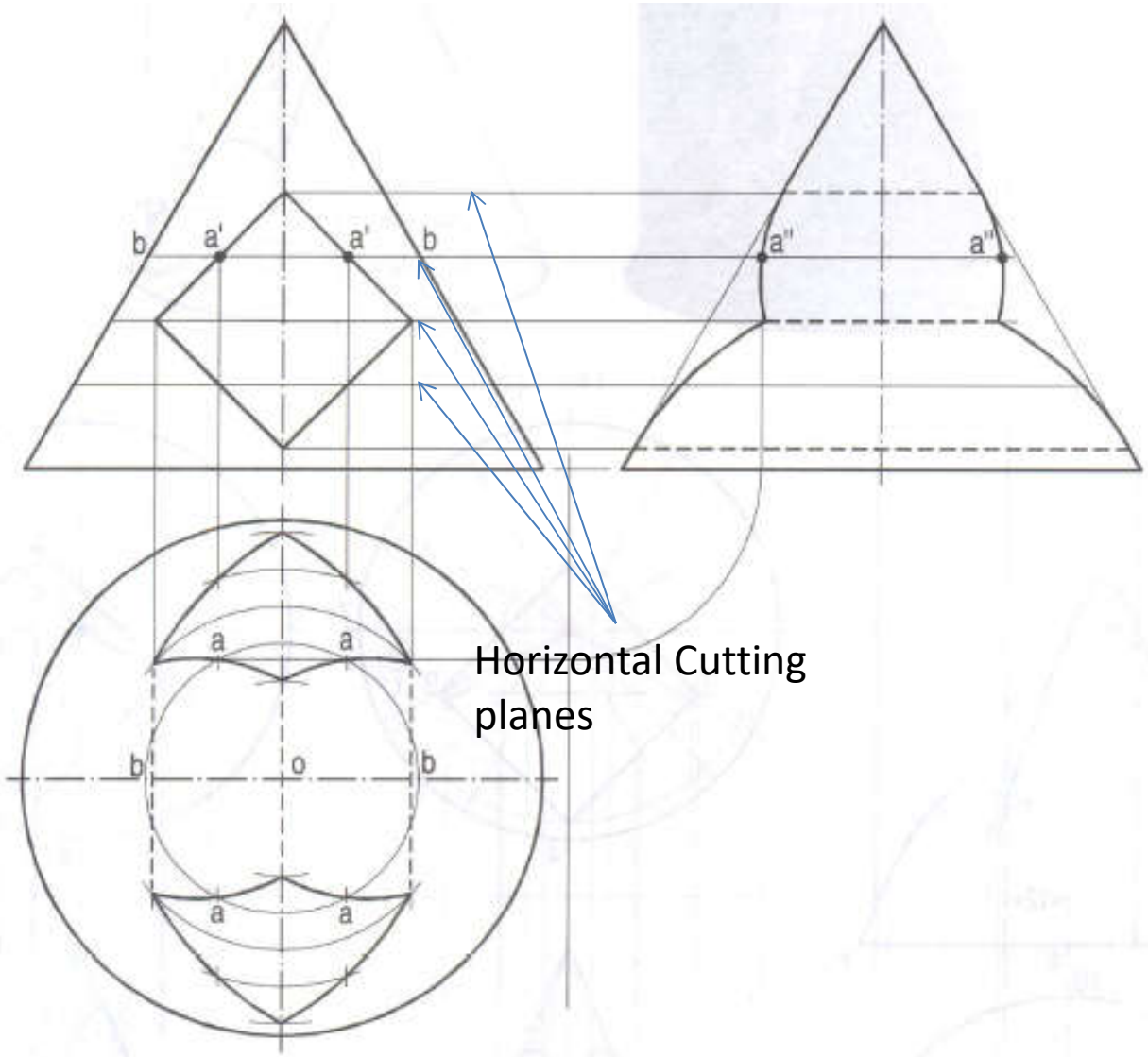


Intersection of Prism with Cone

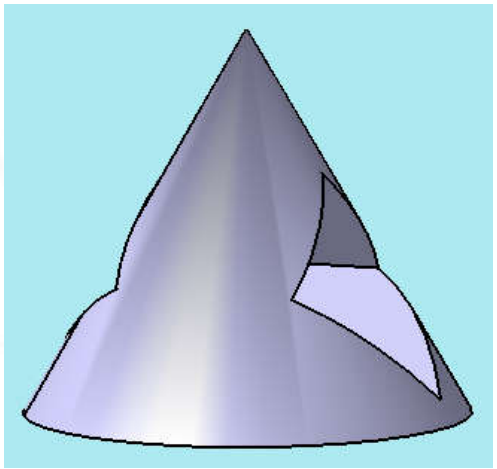


Problem 16-29. (fig. 16-33): *Draw an equilateral triangle of 100 mm side with one side horizontal. Draw a square of 35 mm side in its centre with its sides inclined at 45° to the base of the triangle. The figure shows the front view of a cone standing on its base on the ground and having a square hole cut through it. Draw three views of the cone.*

Intersection of Prism with Cone – Method of Planes



Horizontal Cutting planes

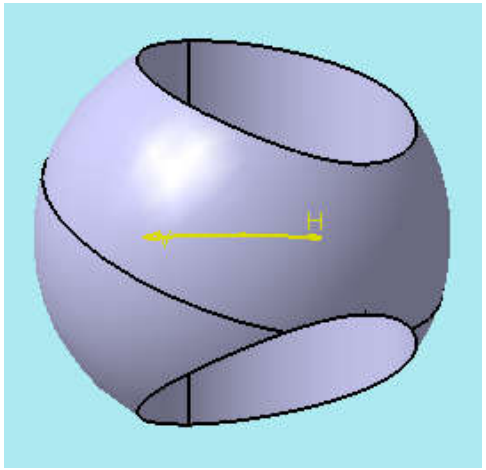


Section 16-7, pg. 409, N. D. Bhatt, 50th edition

Intersection of Prism with Cone – Method of Planes

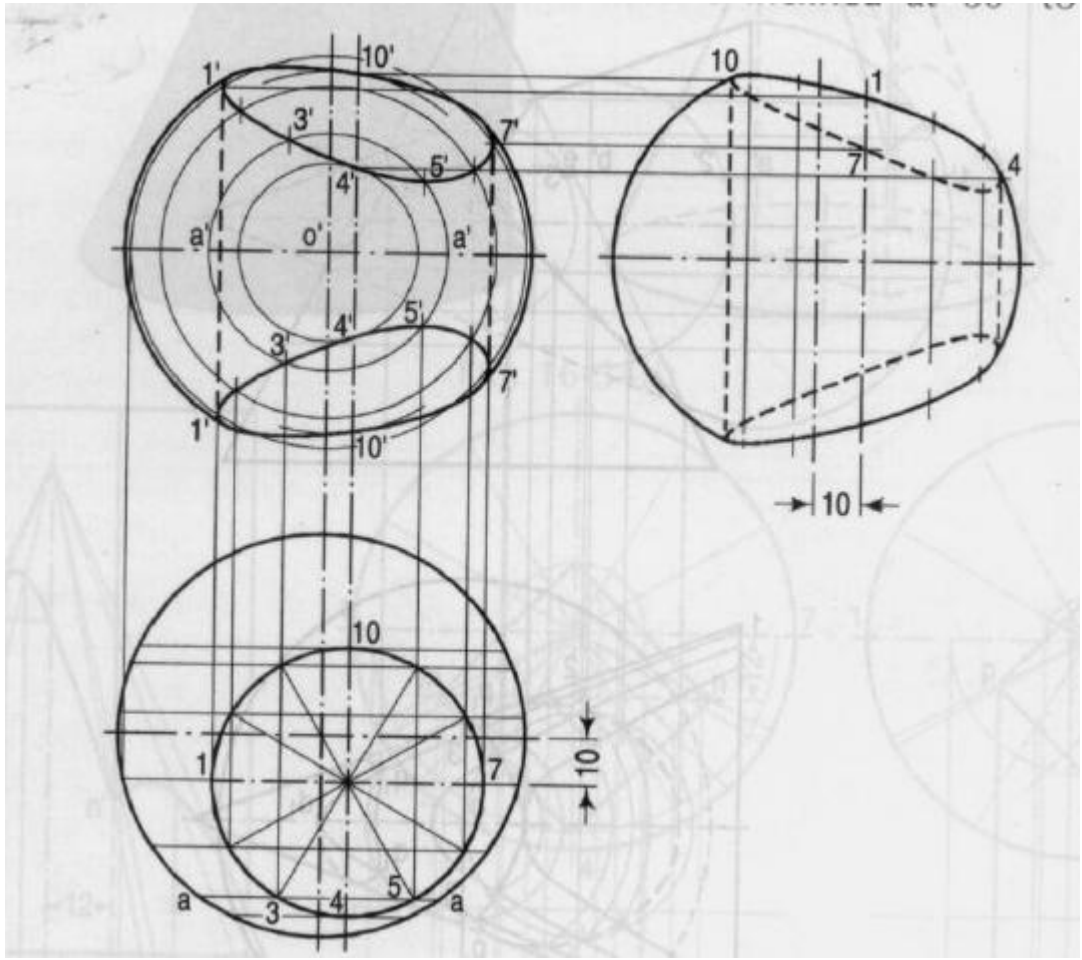
- Draw the front view and the side view of the cone and the prism.
- The cone appears as an isosceles triangle.
- The prism appears as a square in the front view. This is in fact the projection of the of the line of intersection in the front view
- Locate the critical points
- Take cutting planes parallel to the H.P. Make sure that a plane passes through each of the critical points (one plane for one critical point).
- In the top view the intersection of the planes with the cone appear as circles with increasing diameter.
- The point where the cutting planes intersect the front view of the prism are the required points of intersection
- Project these points on the top view to get the points of intersecting in the top view
- These points lie on the corresponding circles in the top view

Intersection of Cylinder with Sphere

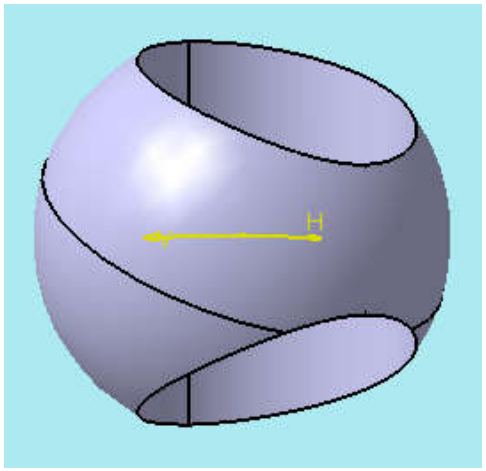


Problem 16-32. (fig. 16-38): *A hole of 50 mm diameter is drilled through a sphere of 75 mm diameter. The axis of the hole is 10 mm away from the centre of the sphere. Draw three views of the sphere when a vertical plane containing the centre of the sphere and the axis of the hole is inclined at 60° to the V.P.*

Intersection of Cylinder with Sphere – Method of Planes



Section 16-9, pg. 412, N. D. Bhatt, 50th edition



Intersection of Cylinder with Sphere – Method of Planes

- Draw the top view of the sphere and the cylinder. The circle representing the cylinder is the projection of the line of intersection in the top view.
- Locate critical points. Draw the front view of the sphere and the dotted lines representing the cylindrical hole.
- Draw cutting planes parallel to the V.P. Make sure that a plane passes through each of the critical points.
- The front view of the intersection of the cutting planes with the sphere are circles of different diameter
- Draw the circles in the front view. Project the points of intersection of the cutting planes with the circle representing the cylinder from the top view to the front view
- These points lie on the corresponding circles in the front view. Join the points in the correct order.

END