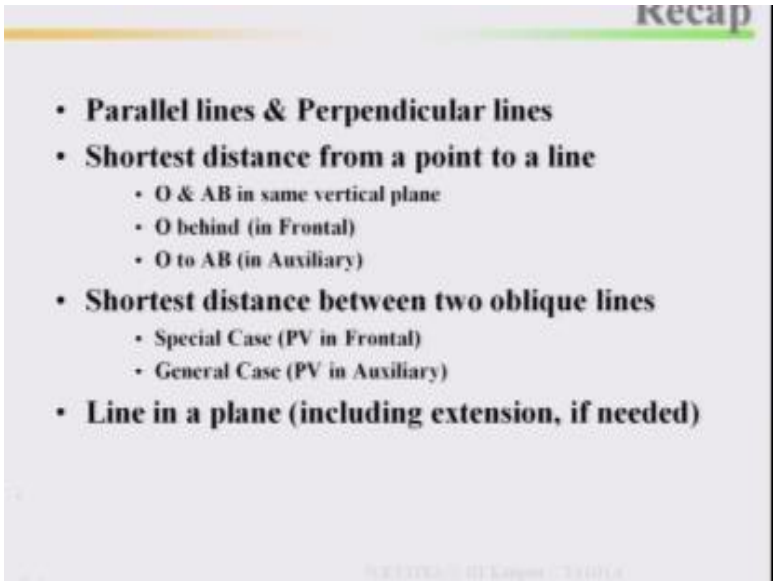
Indian Institute of Technology Kanpur
National Programme on Technology Enhanced Learning (NPTEL)
Course Title
Engineering Graphics

Lecture – 29
Relationship between Lines and Planes-2
&
Relationship between Plane and Plane

by
Prof. Nihar Ranjan Patra
Department of Civil engineering, IIT Kanpur

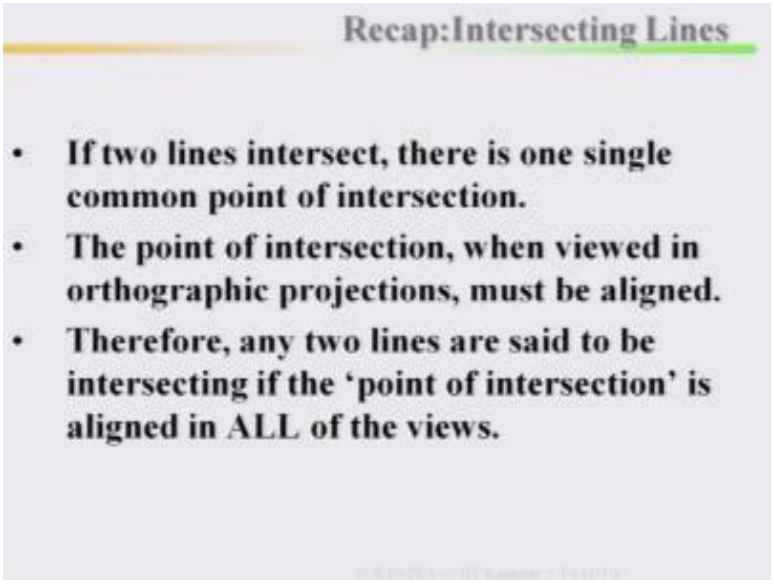
So we have finished till now parallel lines, perpendicular lines

(Refer Slide Time: 00:20)



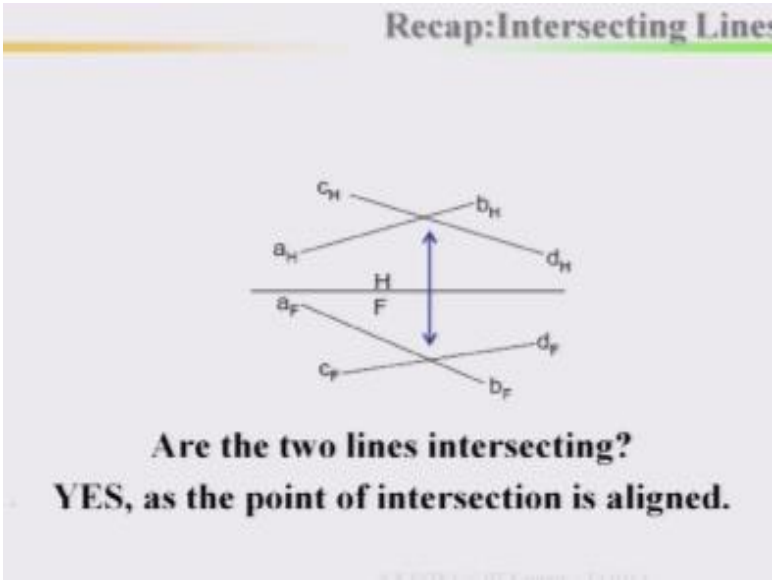
Shortest distance from a point to a line O and AB in the same and vertical plane, O behind that means in frontal plane, O to AB in auxiliary, shortest distance between two oblique lines, up to this we have to finished, then special case point view in frontal general case, point view in auxiliary, lines in a plane including extension if needed, lines parallel to a plane

(Refer Slide Time: 00:54)



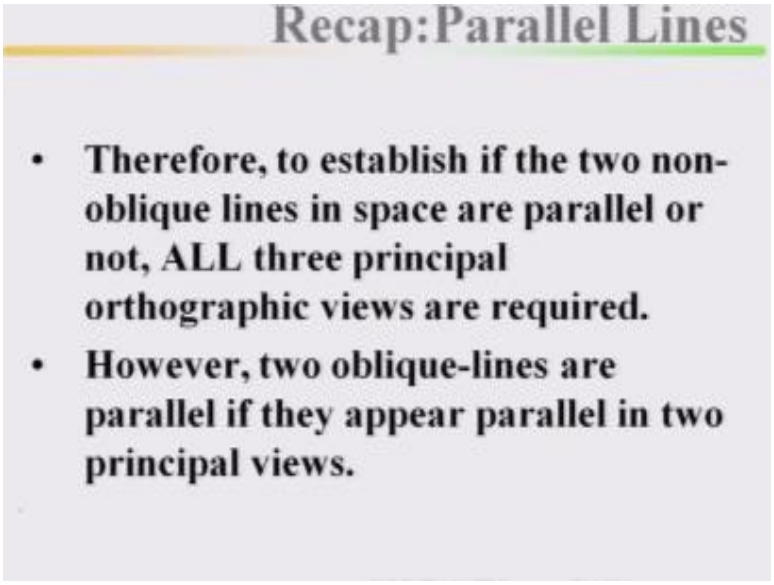
So intersecting of the lines, if two lines intersect there is one single common point of intersections. The point of intersection when viewed in orthographic projections must be aligned. Therefore, any two lines are said to be intersecting if the point of intersection is aligned in all of the views.

(Refer Slide Time: 01:15)



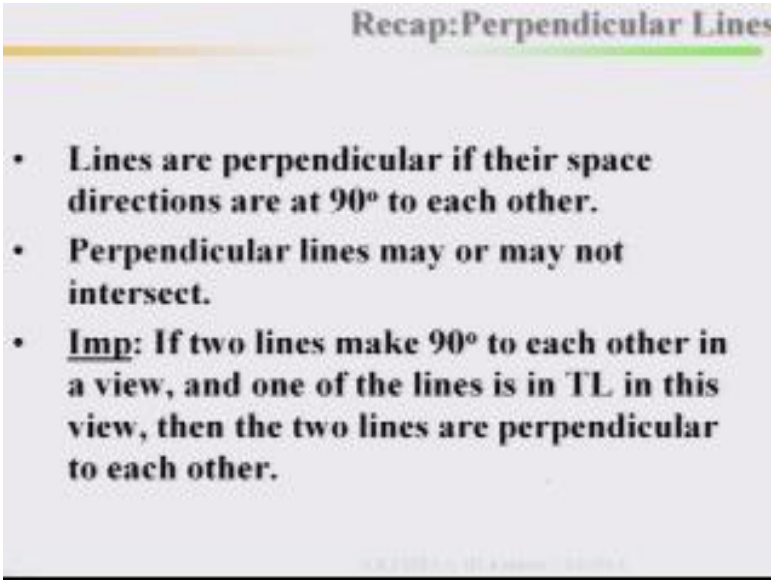
This is what we have covered, are these two lines are intersecting yes, as the point of intersection is aligned in the both the views

(Refer Slide Time: 01:26)



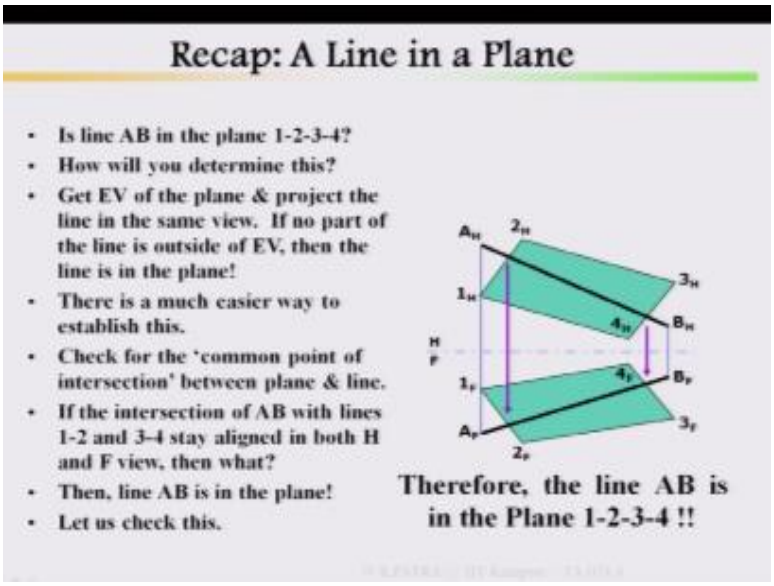
Then parallel lines to establish if the two non-oblique lines in space are parallel or not all three principal orthographic views are required. However two oblique-lines are parallel if they appear parallel in two principal views.

(Refer Slide Time: 01:42)



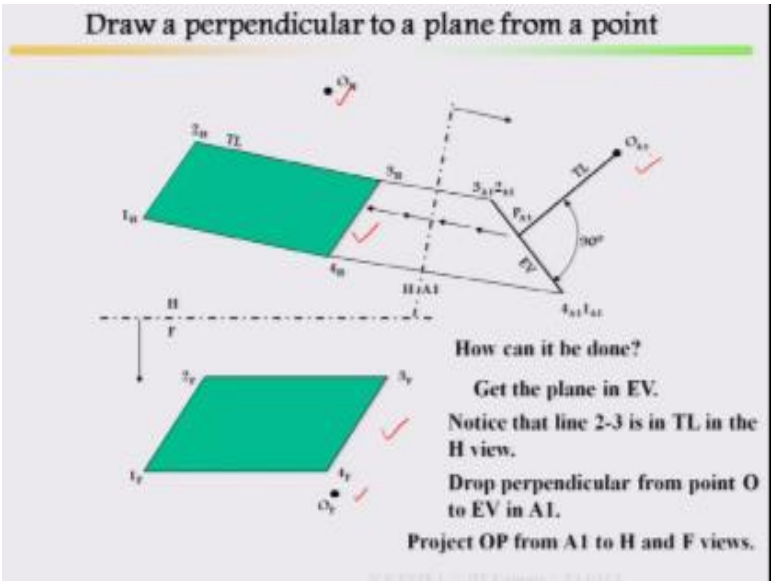
Then perpendicular lines, lines are perpendicular if their space directions are at 90 degree [to] each other. Perpendicular lines may or may not intersect. If two lines make 90 degree to each other in a view and one of the lines is in true length in this view then the two lines are perpendicular to each other. That means one of the lines should be in true length.

(Refer Slide Time: 02:07)



Then lines in a plane we have covered, this is what we have covered up to last class, lines in the plane, you can cross check with the opposite views and aligned it whether this lines in plane or not

(Refer Slide Time: 02:24)



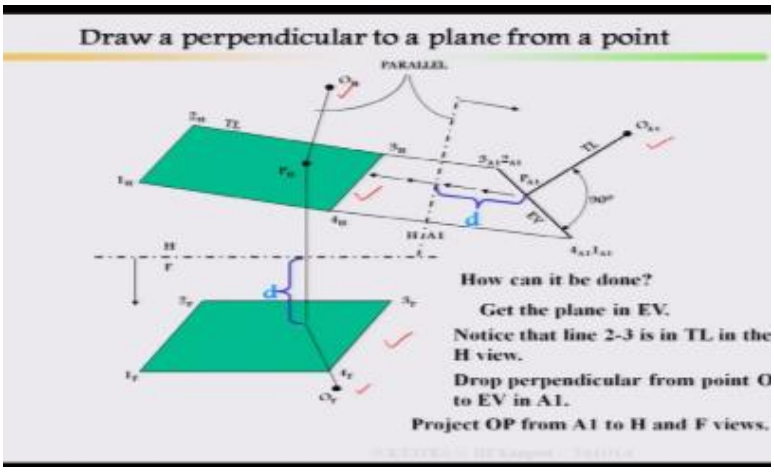
This is what we have covered, then draw a perpendicular to a plane from a point, draw a perpendicular plane from a point, how can it be done? This is your plane, this your plane and this is your point and this is your point, and ask these two three is parallel in an opposite view to hinge line so two, three line in the plane will be in true length. Notice that 2-3 is in true length in the horizontal view then consider your edge view, consider your auxiliary view, then measure the distance in the opposite view.

Then considering the true length find it out your edge view of the plane, then once you get edge view of the planes similarly you take out this point the point where it is there, this point you take out extend it in your auxiliary view, then from the point drop a perpendicular from point O to edge view then in auxiliary plane 1 A1, and this is in your true length then this is 90 degree, then project OP from A1 to H and F view. That means we are looking at point of intersections, so point of intersection.

What is the methodology, that means any of the line in that plane we are making it true length then going to the edge view considering that true length we are getting the edge view of the plane, then that point has been projected to that in that auxiliary plane, then from the point to

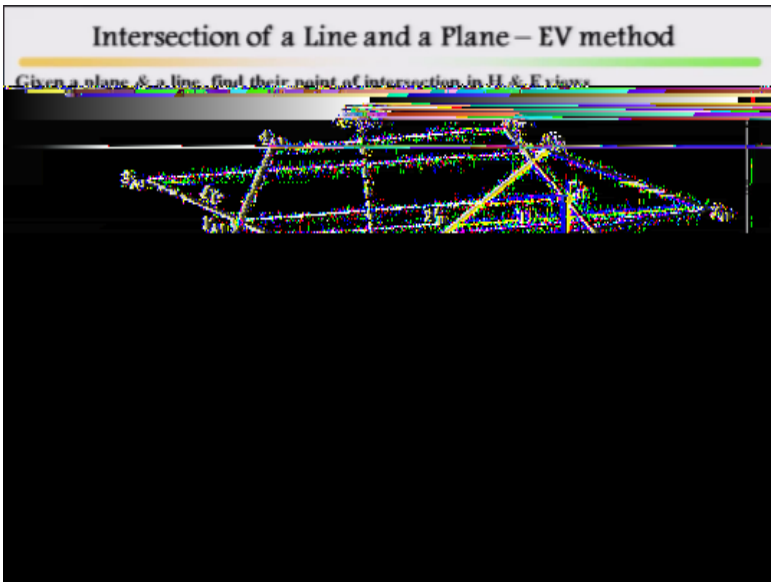
edge view draw the perpendicular, then where it intersect that is your point of intersection that point of intersection has been traced back, backward so how it has

(Refer Slide Time: 04:19)



Been traced back, this is your point of intersection, then similarly it has been traced back to your opposite view that means your frontal view this distance d, remember once I am taking distance from here to here that means this is the distance in your opposite view

(Refer Slide Time: 04:38)



Intersection of a line and a plane edge view method. Given a plane and a line find their point of intersection in horizontal as well as front view, so get the plane in edge view as I said, project the lint in auxiliary plane, so here if you look at the plane look at the plane none of the lines are in true length that is means I3 or I2 or 23 none of the lines in the plane are in true length so basically any of the point you take in parallel line to hinge line so that you will get opposite view is your true length.

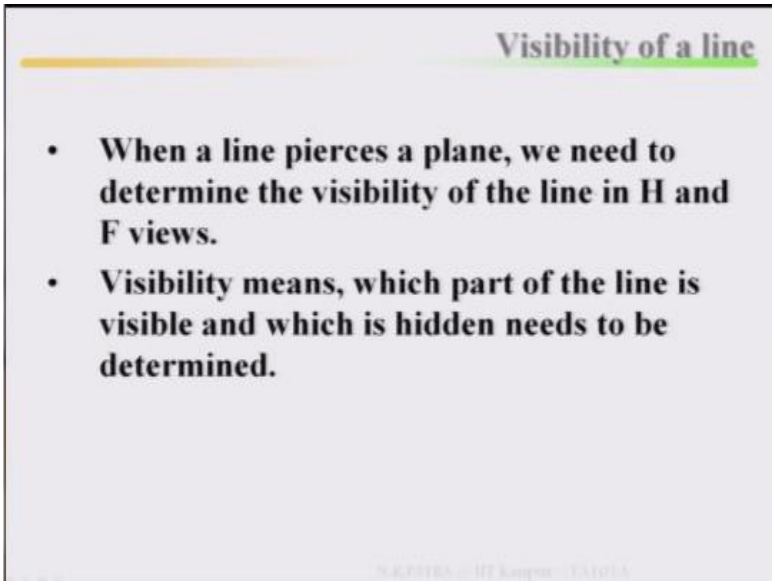
So that means this is your true length, with respect to true length then consider your auxiliary view, then once you get the auxiliary plane, auxiliary plane at any distance from here at any distance you will get the auxiliary view then project it back, project it back, basically you are converting edge view of the plane to a line then this line has been projected back then you will find it out two lines as if they are intersecting two lines are intersecting, so that means this is a intersection between the line and plane.

This is your edge view of the plane, once you get the intersection point from that intersection point you project it back opposite to your opposite view that means in your top view as well as in the front view so you project it back. This is your point of intersections then project it back, this

is your point of intersection in front view, this is your point of intersection in top view. Once you get it now the question comes here visibility, visibility means as this is a plane in the space and there is a line going through this and there is a point of intersections that means whether this, this line is piercing backward or this line is piercing from the top.

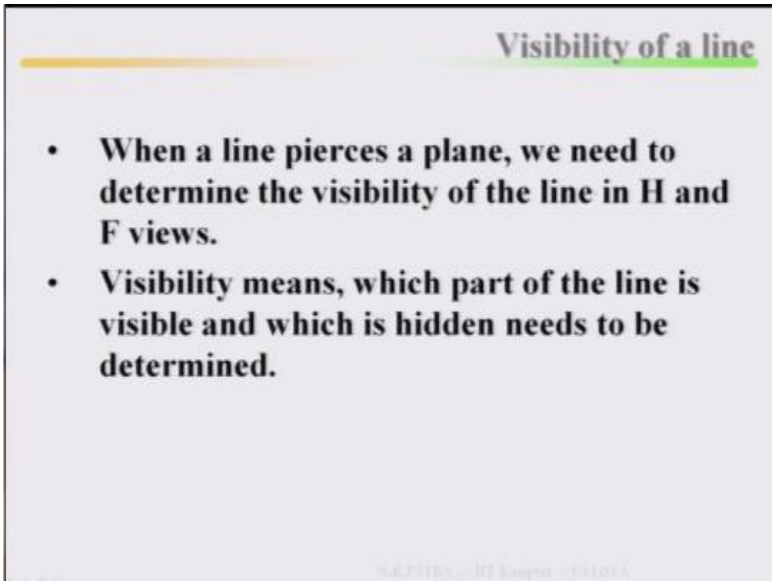
That is your point visibility how it intersect, how it intersects, in the front and in the backward a in the both view all views you have to show the visibility.

(Refer Slide Time: 06:50)



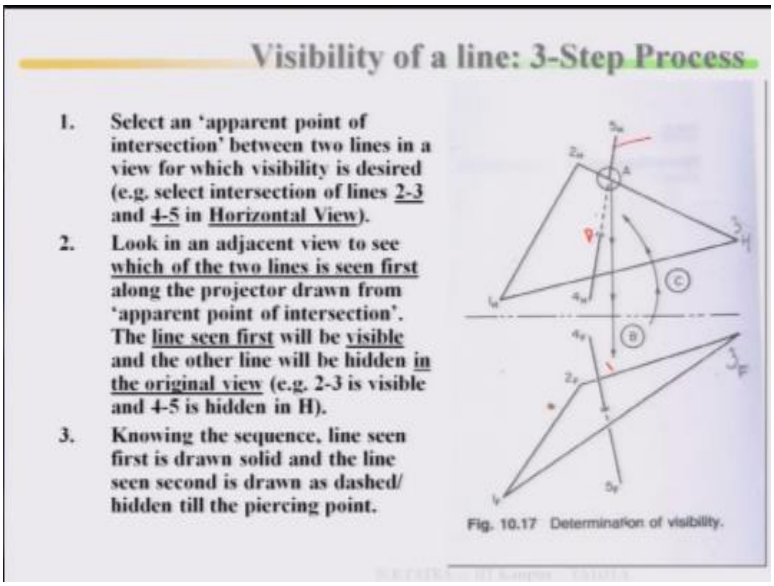
So when a line pierces a plane we need to determine the visibility of line in horizontal as well as in front view that is what I have said, then visibility means which part of the line is visible, which part of the line is visible which is hidden, need to be determined, that means the line which is visible that has to be determined which is passing through the plane, definitely it is not going to be visible that means that is hidden, this is called visible.

(Refer Slide Time: 07:22)



Visibility a 3 step procedure is normally used to determine the visibility of a line piercing a plane.

(Refer Slide Time: 07:30)



Now visibility of a line 3 step procedure now, so determination of visibility if you look at here step 1, look at here this is a plane in this plane there is a line is piercing, line is piercing and this is your point of intersection, again in the front view in the top view this is the plane and line is piercing this is your point of intersections, whether this line intersecting backward or from the front which part of the line will be visible that has to be carry forward, so first number one select an upper end point of intersection between the two lines in a view for which visibility is determined, that means select intersection of line 2-3.

The plane you consider as a 1 by 1, in the plane this edge there is a line 2-3 and 4-5 where this, where in the plane 2-3 and 4-5 where line is penetrating so you consider in both horizontal view as well in the horizontal view consider one is 2-3 and other is your 4-5. 4-5 is your line, 2-3 is your line on the plane, then look in the adjacent view, look in the adjacent view, this is your top view look in the adjacent view.

Adjacent view is your front view to see which of the two lines is in the past along the projector drawn from the upper end point of intersections if I look at this, this is the line piercing in the plane in the plane I am taking this is the line that means this point if I am taking then, if I am

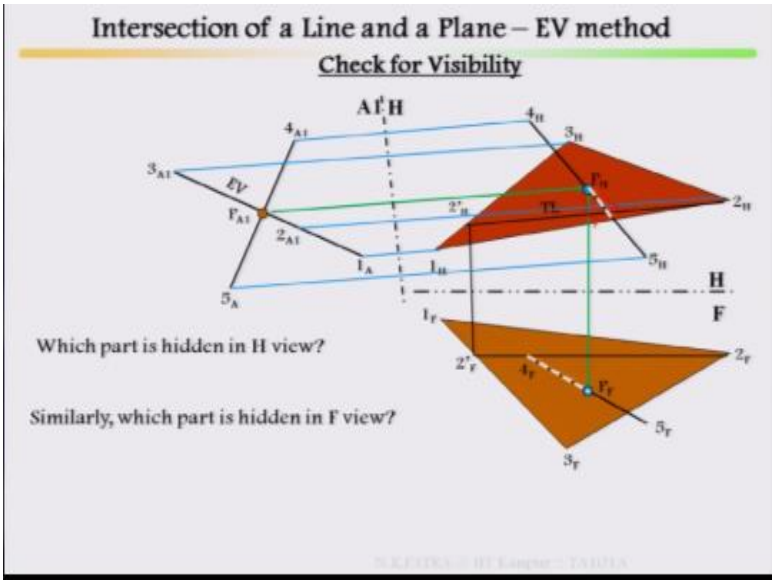
taking the projecting back from this point of interaction I am projecting back then I look in the opposite view or adjacent view.

Which line comes first whether 5-4 comes first or 2-3 comes first, if you come back here it is coming back 2-3 is coming, coming first then your line that means if 2-3 is coming first that means 2-3 of the line plane will be visible, this line will be visible that means it will penetrate, it will pierce backward back directions, that is the reason why that is the reason, then here it has been shown dotted line that means it is the line is not above the plane line is below the plane penetrating, so this is your point of intersections.

So that is why this is your dotted line, so this is the procedure to find it out visibility knowing the sequence line is in line, line seen in first is drawn solid and the line seen second is drawn dust so this 2-3 line in the plane seen first that is why it is drawn solid and 5-4 line is seen second that is why here it is a dotted line here, similar procedure can be adapted for the frontal view.

So that you can find it out both the views, both the views what is your visibility, this is your 3 step procedure.

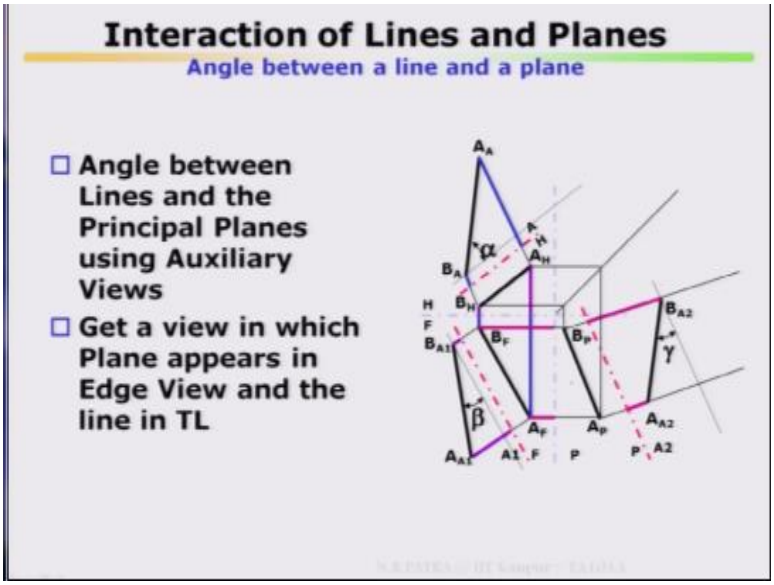
(Refer Slide Time: 10:42)



Now intersection of a line and plane edge view method, now find it out check the visibility, now which part is hidden in the horizontal view that means in the top view that means this line is piercing inside the plane this is your point of intersections, so now this part we can calculate we can find it out based on the 3 steps has been given so it is entering from the top and this part is going inside so this that is why this is your dotted line. Similarly which part hidden in the front view if you look at here this part is hidden, that means that is your backside of the plane.

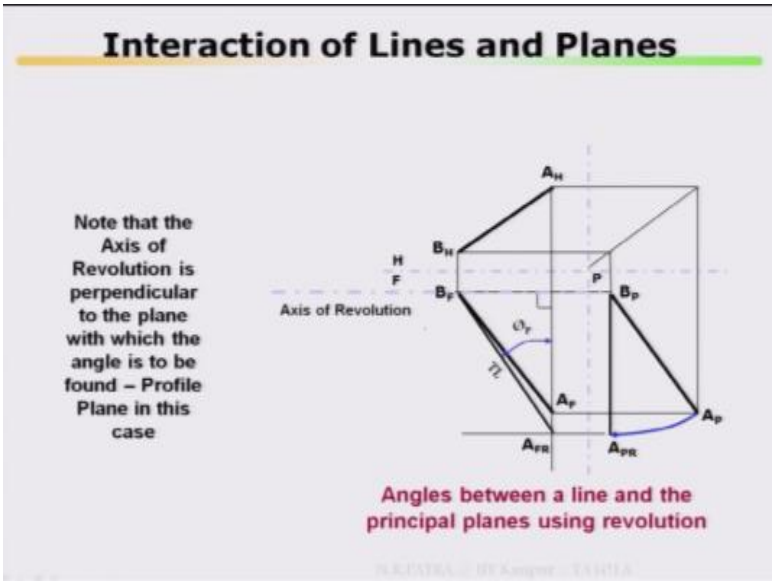
So visibility is most important phase or important factor while doing the intersection of lines, plane, planes, plane or solid, solid.

(Refer Slide Time: 11:32)



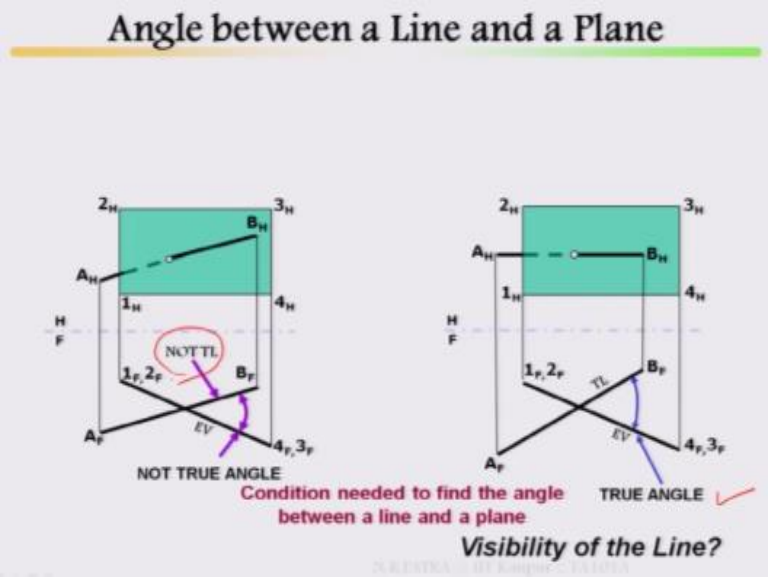
Now interaction of lines and plane, angle between a line and plane, angle between line and principle plane using auxiliary view how to get angle between a line and plane, you can do it by means of a auxiliary view as I said or by means of a edge view where the line will be taken as a true length, if you look at here

(Refer Slide Time: 11:55)



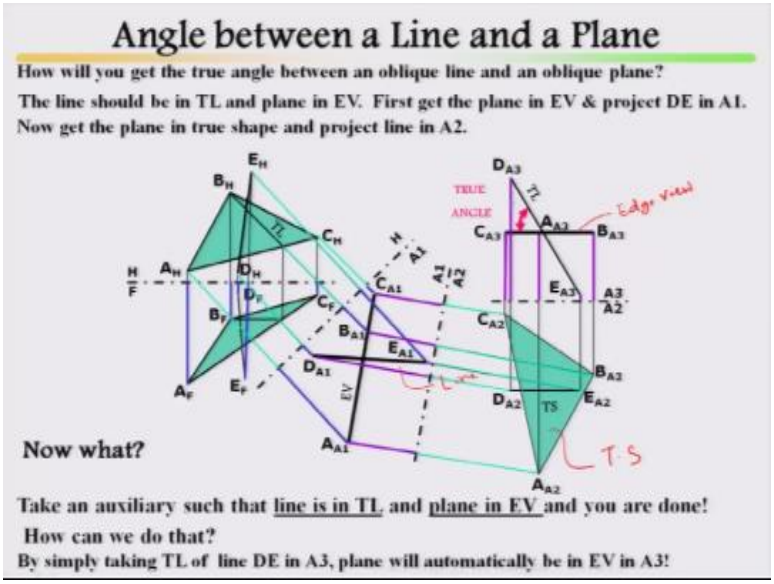
Intersection of lines and plane, note that the axes of revolution is perpendicular to the plane with which the angle is to be found horizontal plane in this case. Now if you look at here angle between a line and the principle plane using by means of revolution this is the by means of revolutions, then similarly interaction of lines and planes, angle between the line and the principal using by means of method of evolutions' you have to find it out true length, once you get the true length then you can find it out what is the angle. Similarly the axes of the revolution is perpendicular.

(Refer Slide Time: 12:37)



Particularly here the axes of the revolution is perpendicular to plane with which the angle is to be found, frontal plane in this case, in this case it is a frontal plane, in this case it is a profile plane, earlier in this case it is a horizontal plane, three cases. Now angle between a line and the plane look at here, this is your line this is your plane, how to find it out angle between line and plane, so that means the line you have to convert into a true length, true length of the line, then you take the plane, you take the plane as a edge view then find it out what is the angle and this is your angle this is your true angle, if this line AB is not in true length, is not in true length that means you are not about to get the true angle, condition needed to find the angle between a line and plane that is your true length has to find it out, visibility of a, of the line.

(Refer Slide Time: 13:39)



Angle between a line and plane let us go and do it, this is your plane in your top view, this is your plane in your front view, and there is a line if you look at here there is a line de there is a line if you look at here, this is your de in the front as well as down, how you will get the true angle between the between an oblique line and an oblique plane?

In this case lines and planes are oblique how do get it? Now next step is the line should be in true length and plane should be in edge view, first get the plane in edge view, project DE that means line in A1 in that auxiliary plane, that means look at here to get the edge view one of the one of the line you join B to these parallel to your inside the plane parallel to your hinge line so that you will get the true length, this is your true length inside the plane, inside the line, then considering the true length I have with respect to true length.

I have taken one auxiliary plane then with this auxiliary plane you project it back, project it back both plane both the lines, then find it out this is your line, this is your line and this is your edge view of the plane, now this is your edge view of the plane and this is your line, now get the plane in true shape and project line in A2, once you are getting edge view get the plane in the true

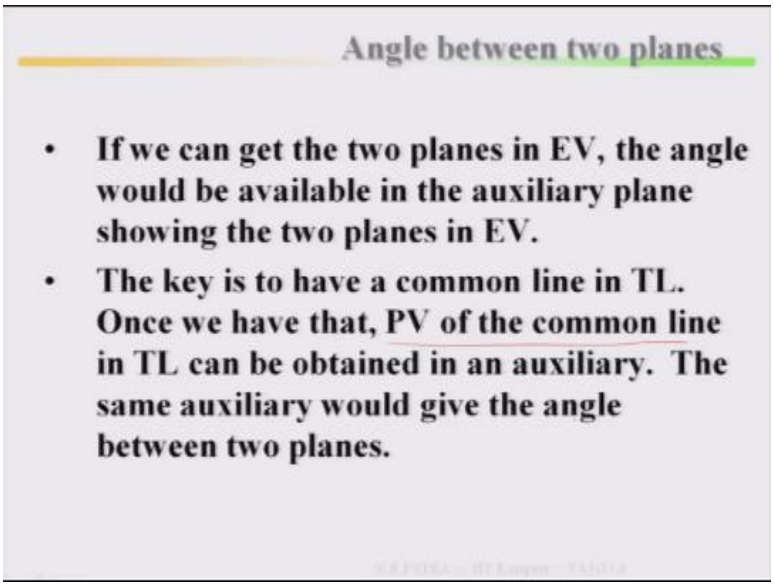
shape that means second you will look at here this is your line, this is your line then you consider another auxiliary plane parallel to your edge view.

Auxiliary plane 2 then from there you project it back both line as well as both line as well as the edge view of the plane, so then you make it so this plane, this plane is in true shape, this is in true shape, then draw the line then take this line, then now what take an auxiliary such that line is in true length, you have to convert line is in true length and plane in edge view so you are done. Now what can you do by simply taking true length of a line DE in A3, plane will be automatically be edge view in A3.

Now it is your true shape now, these are oblique planes I covert these oblique plane to edge view, then same line has been projected back, then from edge view of the plane we got the true shape of the plane, then same line has been projected back now next step is we have to find it out true length of this line, true length of the line then again we project it back considering a auxiliary plane.

A3, then you consider line of sight, take it in this case what you are supposed to get it, look at here DE3 this is your line in true length, line in true length and this plane true shape of the line is in edge view, this is in edge view considering true shape. Now basically you convert line to a true length, then plane to edge view, then true shape from true shapes to again edge view so this is your true angle between the line and the plane, this is your angle between line and plane, next step is coming angle between two planes, what is the angle between two planes?

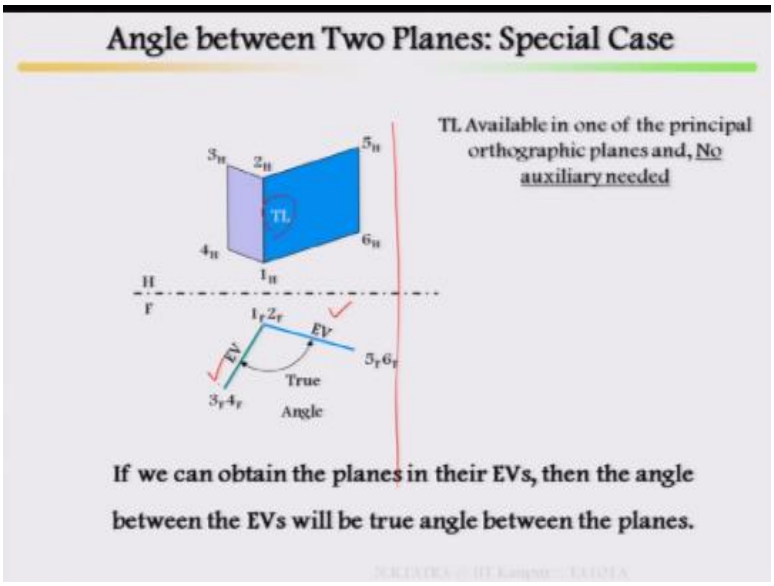
(Refer Slide Time: 17:44)



If we can get two planes in edge view how to get it, if we can get two planes in edge view the angle would be available in the auxiliary plane showing two planes in edge view. The key is to have a common line in true length, once we have that point view of the common line in true length can be obtained in our auxiliary, this same auxiliary would give the angle between the two planes, basically we are converting two plane to edge view and one of the edge view we are making it into two true length.

Then from there are we are making the angle so that particularly we are converting two planes to two lines, the lines to 1 is point 1 is the true length then from there we are making the angle, the key is to have a common line in true length, common line in the true length, once we have that point view, point view of a common line in true length can be obtained in an auxiliary and the same auxiliary would give the angle between the two planes.

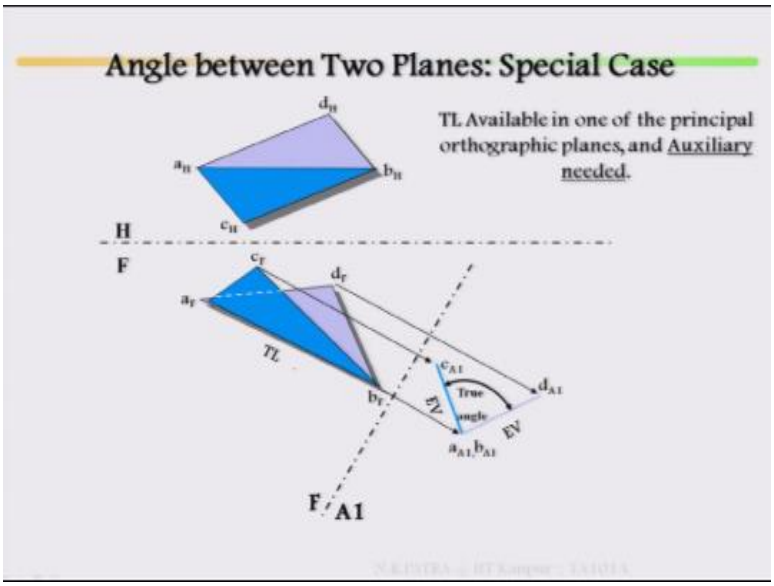
(Refer Slide Time: 18:51)



Let us look at here, angle between two planes special case, available in one of the principal orthographic planes no auxiliaries needed, look at here it is available. Now it in this case it will be very easy because true length true, length is available in one of the principal orthographic plane, this line will be parallel to this hinge line so that is why this is a true length so that means there is a true length is available any of the auxiliary or any of the principal orthographic planes so that means in that case.

No auxiliary is needed, no auxiliary view is needed, so in this case what will happen? Once both the planes one of the edge is in true length so that means you project it back, this is your edge view and this is your edge view particularly this plane this is your edge view and this plane this is your edge view then this is your true angle, this is your true angle this is case 1, case 1 in this case true length available in one of the principal orthographic planes, no auxiliaries required so if we can obtain the planes in their edge views then the angle between edge view will be true angle between the planes.

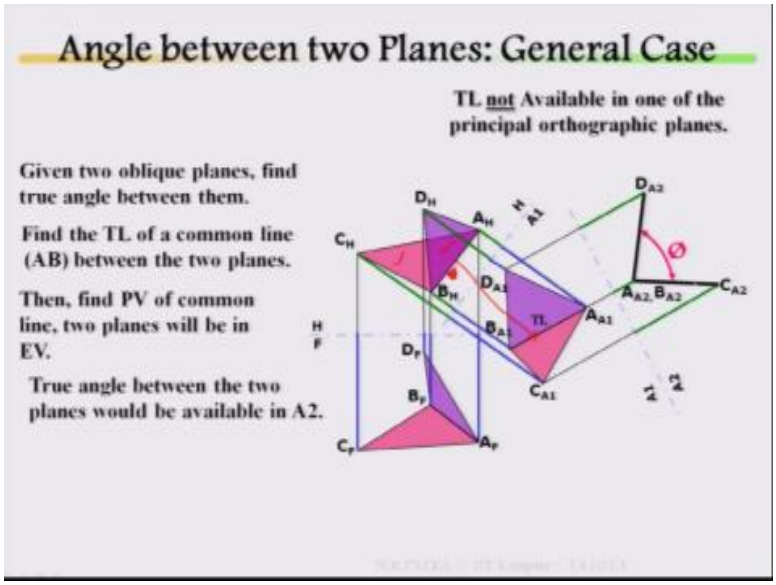
(Refer Slide Time: 20:20)



Come to the, these are the special case second case, true length available in one of the principal orthographic planes but auxiliaries required. See two planes as if they are touching to each other in one of the view that means this line is parallel, this line is parallel to this what does it mean, ABH, ABH is parallel to your hinge line so in this case AF, BF in the opposite view this is in true length so then in that case what you are supposed to do take the edge view, sorry take the auxiliary plane.

Auxiliary view then take the edge view, then once you take the edge view then this is your true angle.

(Refer Slide Time: 21:13)



Then come to the angle between two planes general case, true length not available, none of the edge or none of the any line inside this plane or inside this edge is in true length in one of the principal orthographic planes, in that case this is one plane this is other plane look at there is another plane one is ABC this is your in top view, ABC it is in front view, another is ABD so there is no true length, so these are the two planes, this is a general case so in that case what you are supposed to do given to oblique planes in this case this two planes are oblique planes.

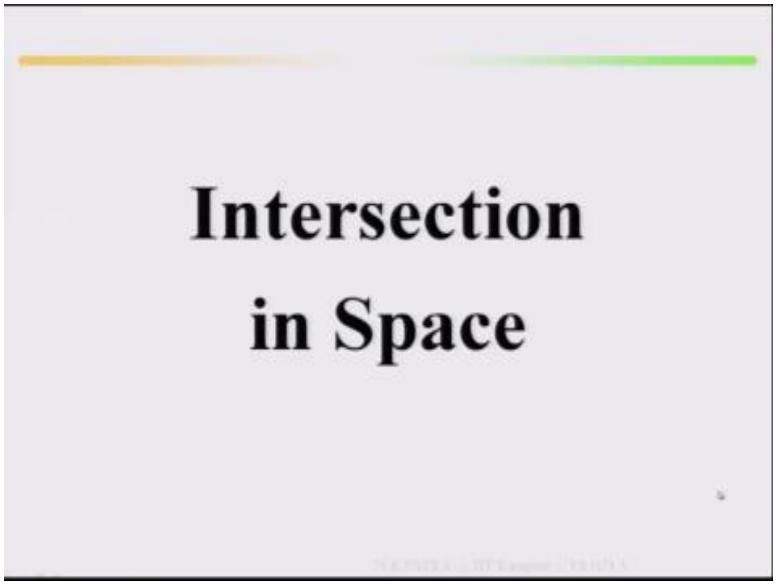
Find true angle between them, now in this case find true length of a common line AB between the two planes, that means if I consider plane 1 this is the plane 2, AB is your common line between the two planes. Now take one auxiliary plane from there measure the distance in the opposite view then project it back, you are getting one plane and another plane, then this line particularly you are converting this line AB 2A true length, so this line AB is in true length, next step find point view of common line two planes will be in edge view, if I consider this is a point view then obviously what will happen two planes will be in edge view.

Now considering the true length consider another auxiliary plane that is your A2. So considering this auxiliary plane then respective distance you take it. So it becomes, this line become a point.

So this plane will be one edge view, this plane will be another edge view. Now this is your true angle.

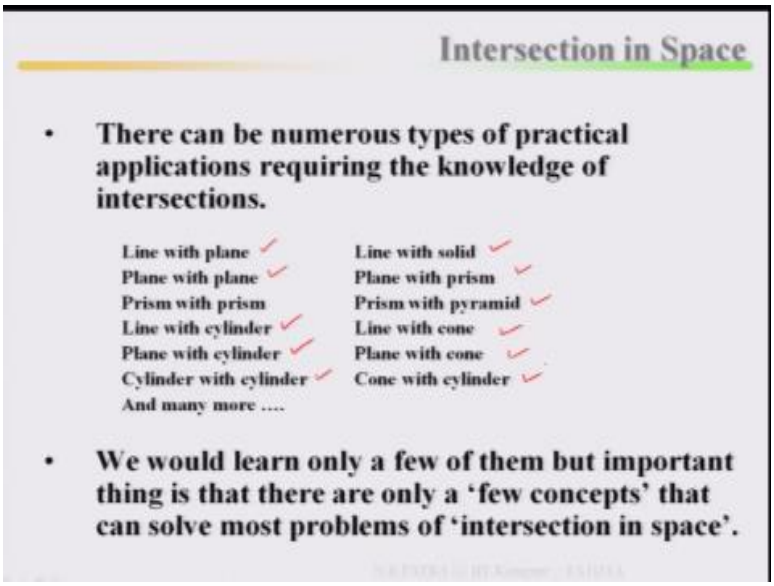
So now we have covered up to this angle between line and plane, angle between plane and plane different cases. Now I will start the next part of this, this is your general features or general principles of relationship between lines and planes, planes and planes.

(Refer Slide Time: 23:50)



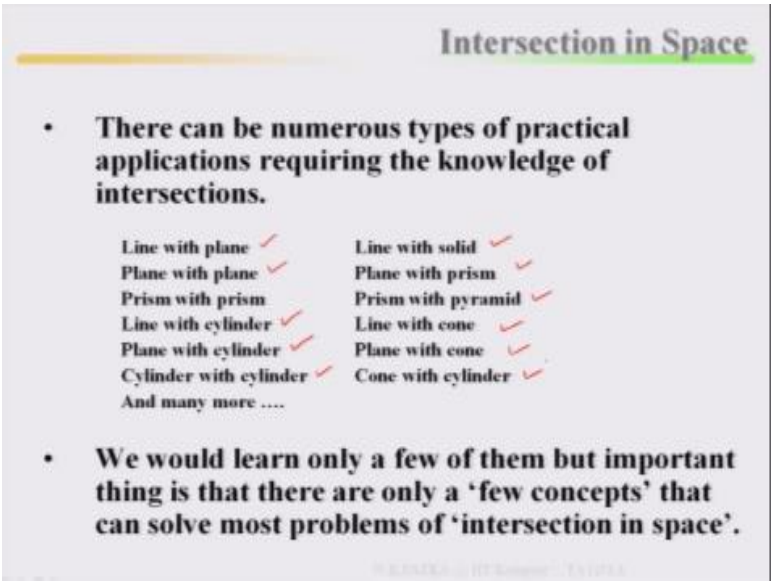
Now come to the next part, intersection in space.

(Refer Slide Time: 23:54)



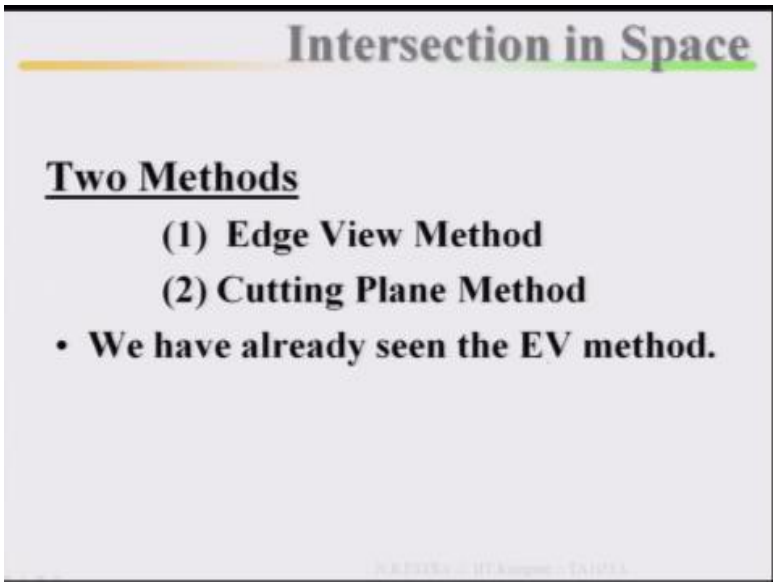
There can be numerous type of practical application required the knowledge of intersection, look at here, line with plane, plane with plane, line with plane, plane with plane, prism with prism, line with cylinder, plane with cylinder, cylinder with cylinder, line with solid, plane with prism, prism with pyramid, line with cone, plane with cone, cone with cylinder. There are many more, particularly intersection in the space. That is the reason we have finished basic features of intersection between lines and lines, lines and planes and planes and planes.

(Refer Slide Time: 24:39)



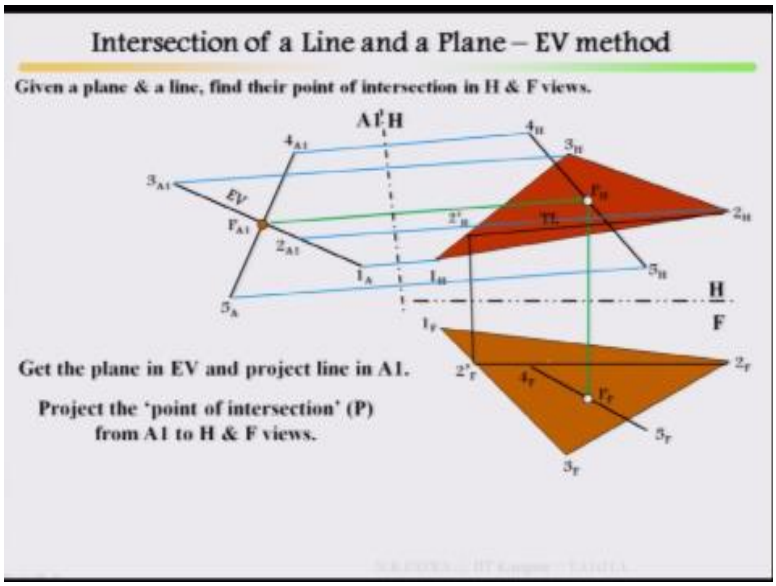
We would learn only a few of them but important thing is that there are only a few concept that can solve most problems of intersection in the space.

(Refer Slide Time: 24:50)



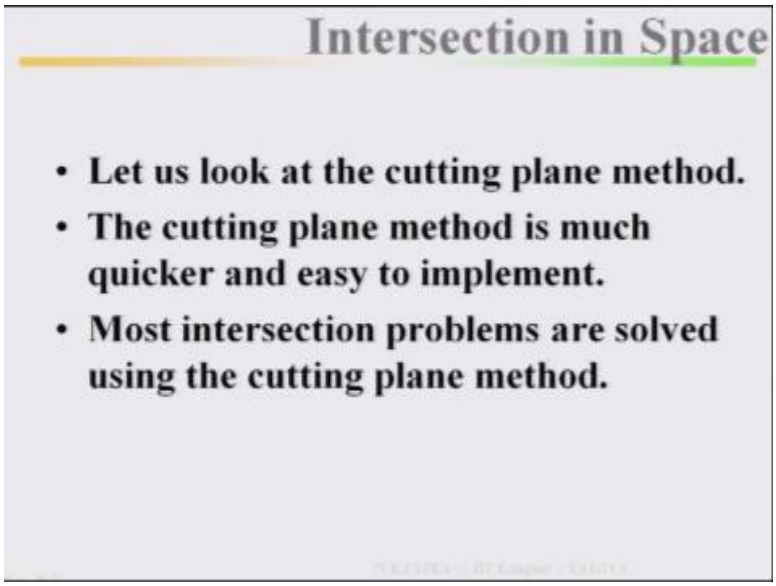
Two methods, one is by means of edge view method, second is by means of cutting plane method, we have already seen the edge view method.

(Refer Slide Time: 25:01)



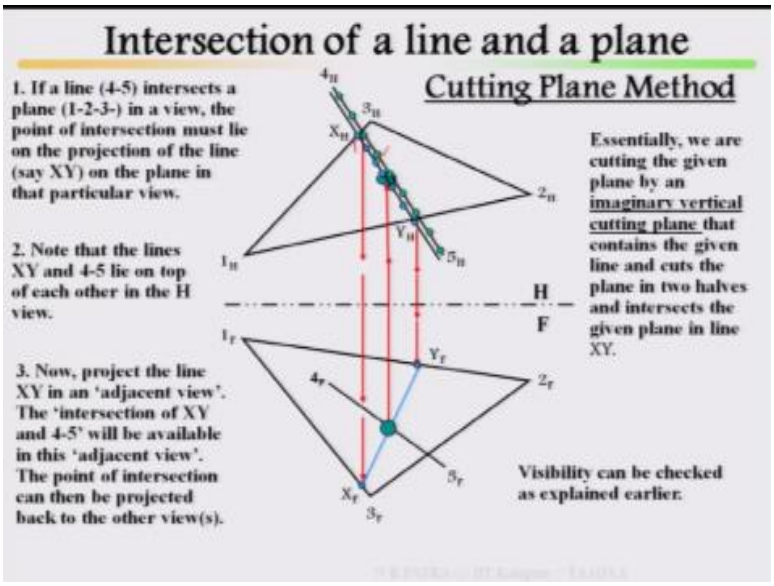
Edge view method already we have seen particularly plane will become edge view a line. So this method we have already seen.

(Refer Slide Time: 25:09)



Now let us look at the cutting plane method, the cutting plane method is much quicker and easy to implement, it is very easy to implement. Most intersection problems are solved using cutting plane method.

(Refer Slide Time: 25:26)



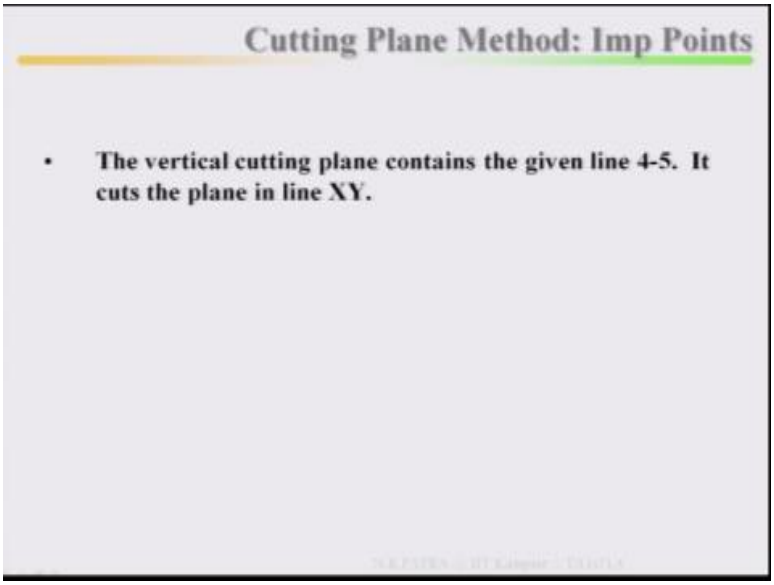
Now look at here, intersection between line and plane cutting plane methods. If a line, look at here, if a line (4, 5) this your line(4, 5) intersect the plane 1, 2, 3 in a view the point of intersection must be lie on the projection of the line say XY, say XY on the plane in that particular view. I have taken XY, note that the line x, y and (4, 5) lie on top of each other, in the H view.

Essentially we are cutting the given plane by an imaginary vertical plane that contains the given line and cut the plane into two halves and intersect given plane in a line XY. Hope you are getting? Essentially we are cutting the given plane, this is the given plane we are cutting it by an imaginary vertical cutting plane, this is a vertical cutting plane that contains the given line, that contains the given line and cut the plane into two halves and intersect the given plane in line x and y.

Now project the line x, y in an adjacent view, intersection of XY and (4, 5) intersection of XY and (4, 5) will be available in the adjacent view, the point of intersection can then be projected back to other views. Now let us see this is your x, I put it back. So x is intersecting at 1 and 3, x is intersecting at 1 and 3 I project it back and 1 and 3 from this point to I project it back, this

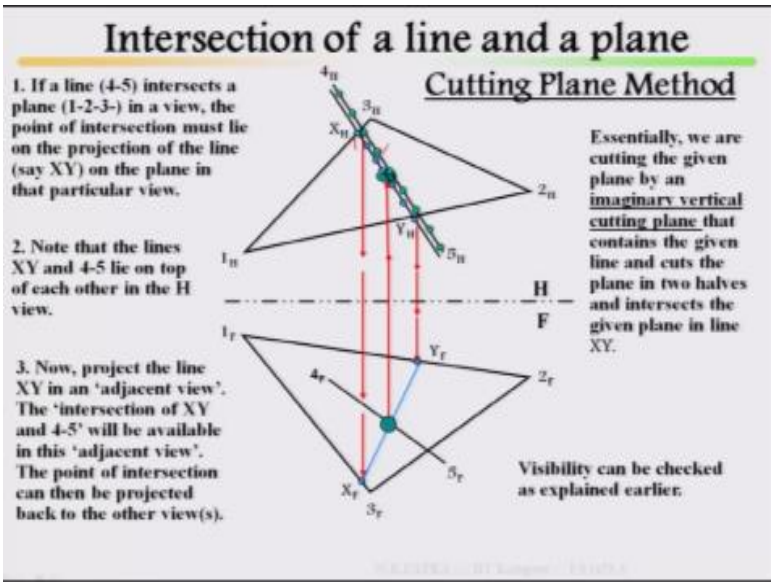
point to I project it back where it intersect I mark it XF. F is means in frontal view, similarly I take it. So y 1 and 2 project it back 1 and 2 from there I join x and y, I join x and y and I am getting (4, 5) where is your point of intersections? X and Y where is your 4 and 5 cutting that is your point of intersections, then from there once I get the point of intersection I project it back. So I am getting point of intersection in the other view, then visibility can be checked whatever you have discussed earlier, this is the procedure.

(Refer Slide Time: 28:31)



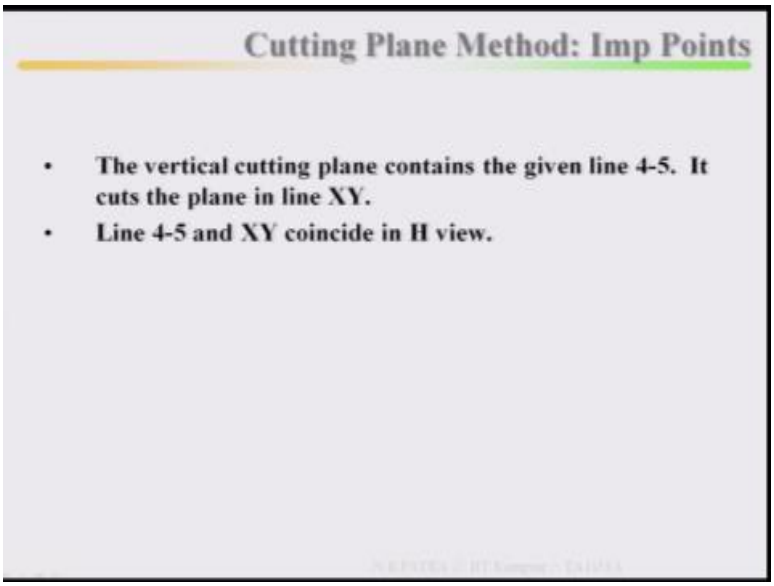
Cutting plane method important points the vertical cutting plane contains the given line (4, 5) it cuts the plane in x line XY.

(Refer Slide Time: 28:40)



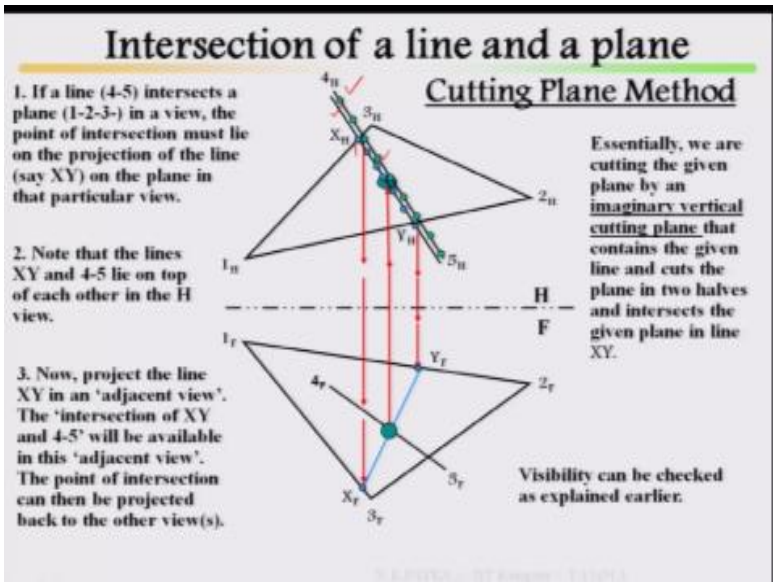
It cuts the plane in line XY.

(Refer Slide Time: 28:44)



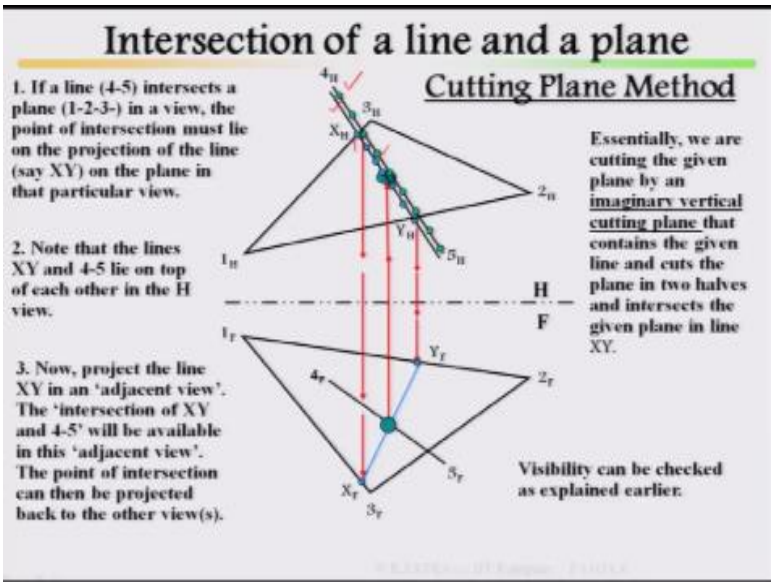
Line (4, 5) and XY coincide in H view.

(Refer Slide Time: 28:50)



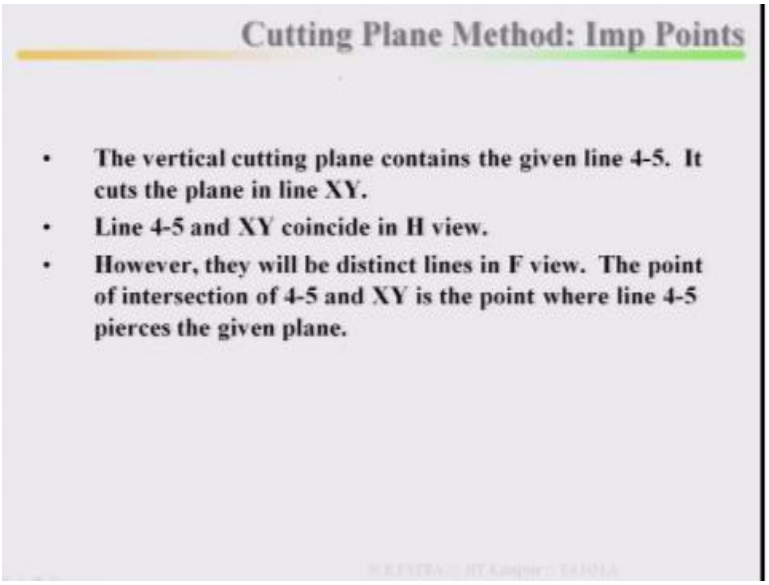
Line (4, 5) and XY it coincide in H view, for better understanding.

(Refer Slide Time: 28:59)



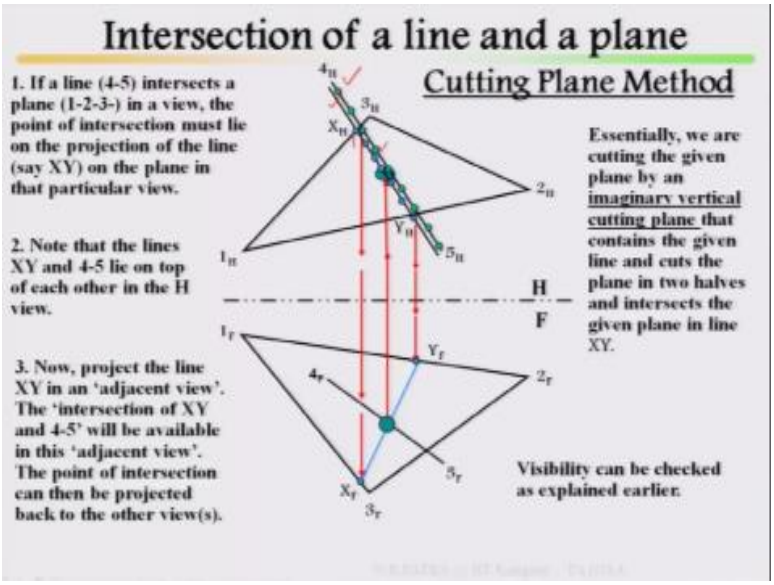
Just back to back eyes we show it.

(Refer Slide Time: 29:01)



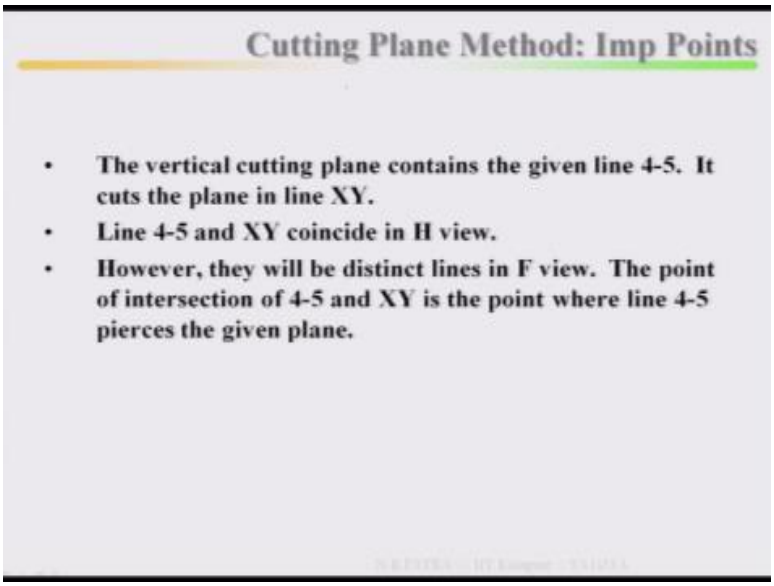
However they will be distinct it, distinct lines in front view.

(Refer Slide Time: 29:10)



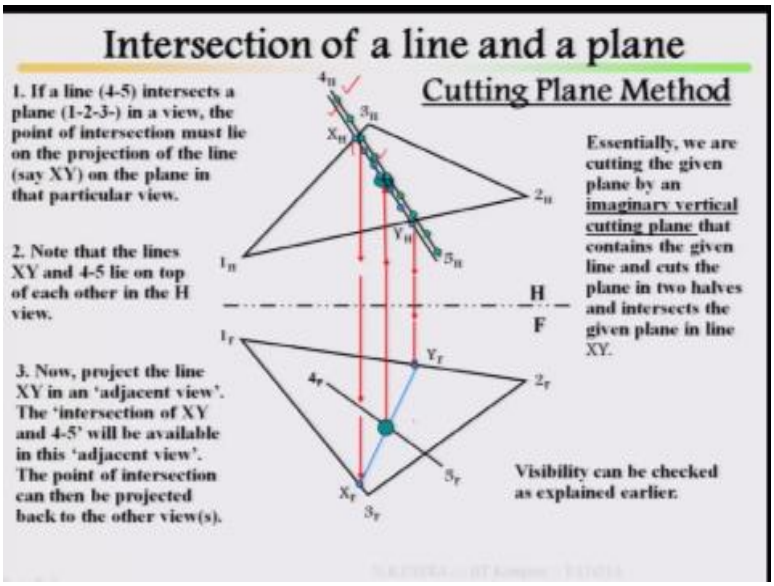
They will be distinct line in the front view.

(Refer Slide Time: 29:12)



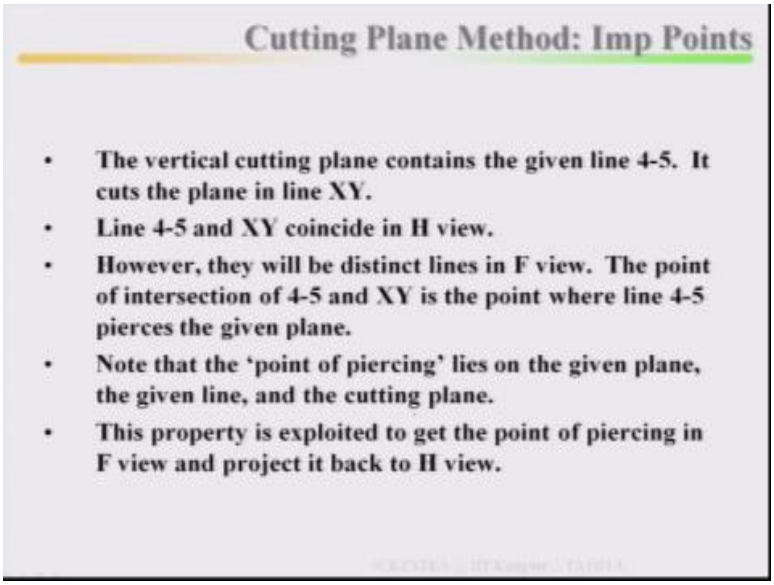
The point of intersection of (4, 5) and XY is the point where line (4, 5) pierce the given plane, the point of intersection of (4, 5) and XY.

(Refer Slide Time: 29:26)



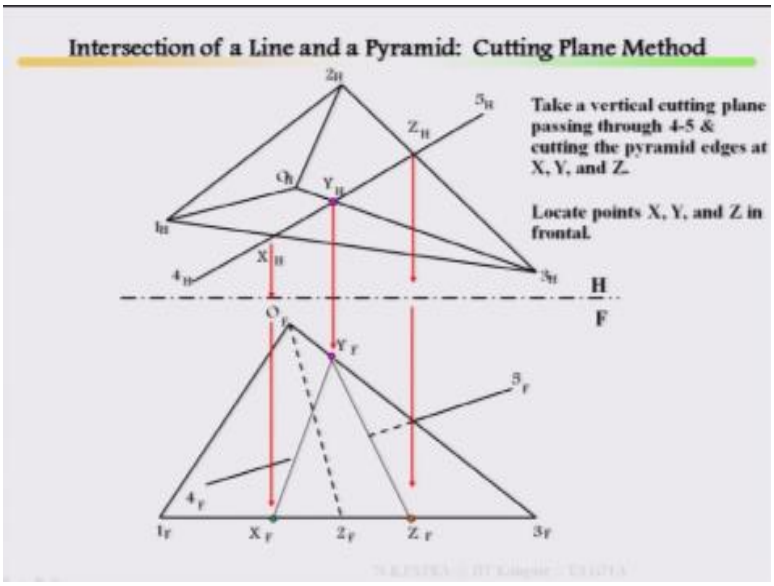
Point of intersection between (4, 5) and XY is the point of piercing point of the line inside the plane.

(Refer Slide Time: 29:34)



Note that the point of piercing lies on the given plane the given line and the cutting plane, this property is exploited to get the point of piercing in front view and project it back to your top view or H view.

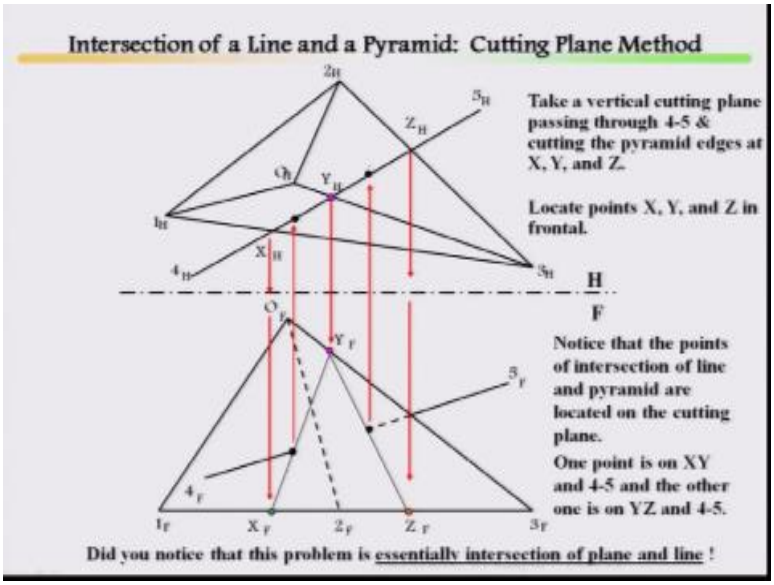
(Refer Slide Time: 29:51)



Now let us see intersection of a line and a pyramid by means of cutting plane, slightly, two are slightly difficult problem. This is your pyramid, and where is your line? There is a line and this is the line that means the intersection of a line and pyramid. Both lines has been shown in H view as well as frontal view. Now consider it, then next step take a vertical cutting plane passing through 4 and 5. So cutting the pyramid edges at x, y and z.

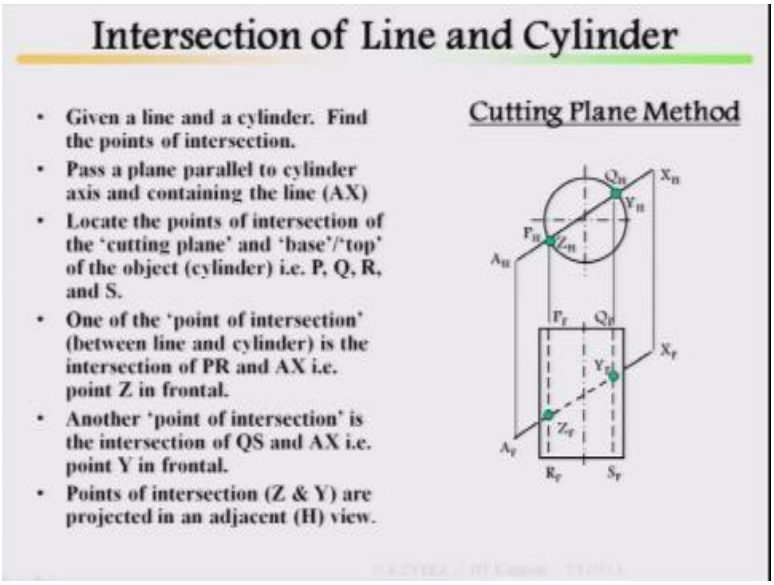
So this is x then y and z will come, from the x locate x, y and z in the frontal, locate x, y and z in the frontal. X is cutting what? 1 and 3 if you project it back within 1 and 3 x will be there, this is your XF, then this is your ZF, Z is cutting what? 2 and 3. So you project it back z is cutting between 2 and 3 you mark it, then y is cutting between what? Y is cutting between o and 3, y is cutting o and 3 you mark it, then join x, z, y in your front view, whatever the cutting you are getting.

(Refer Slide Time: 31:35)



Once you join it, this is your point where it pierce the line is piercing, then once you are getting piercing point you project it back you are getting it. Now note that point of intersection of line and pyramid are located on the cutting plane, note that points of intersection of line and pyramid are located on the cutting plane. One point is on XY, one point is on XY other is on YZ and 45, one point is on XY and 45, one point is on XY and 45, other point is on YZ and 45. Did you notice that this problem is essentially intersection of a plane and line, it is basically intersection of a plane and line.

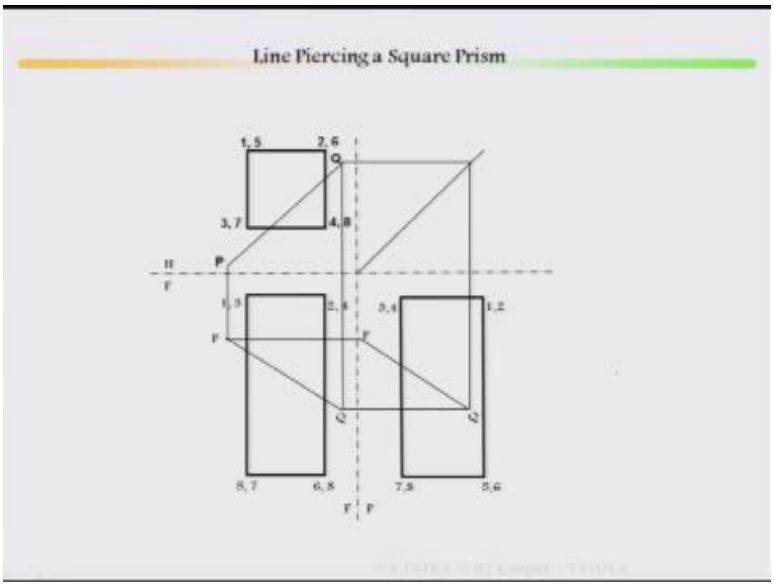
(Refer Slide Time: 32:39)



Now intersection of a line and cylinder, given a line and cylinder find the point of intersection, this is your cylinder and there is a line is piercing, then opposite view front view a line is piercing. So pass the plane parallel to cylinder axis containing the line AX locate, pass a plane parallel to cylinder axis and containing line AX in this way line is piercing, so pass a plane in that way, so I have passed this plane, so this is your PQ and you project it back in the opposite view.

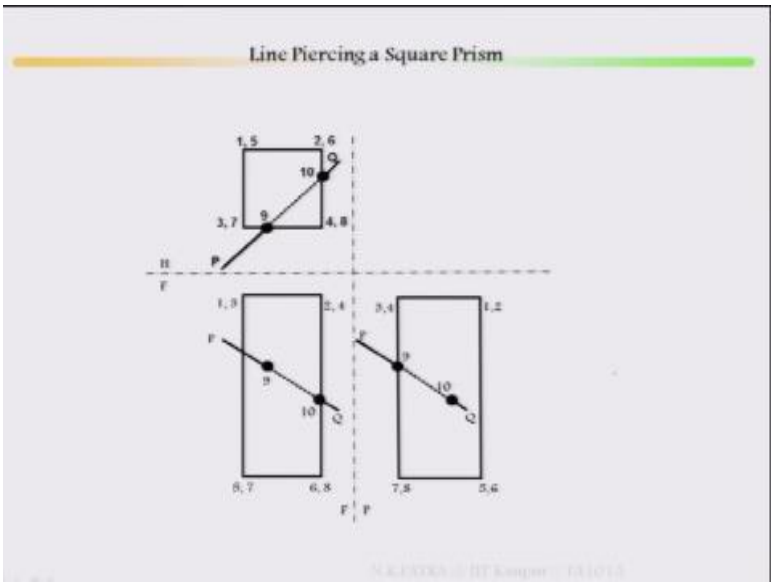
So once you project it back, here a plane cutting plane has been put and it has been projected back where it intercept your line, A_F and X_F you find it out Z_F and Y_F, then you project it back and this is your piercing points.

(Refer Slide Time: 33:48)



The next is your line piercing a square prism, three views has been given top, front, and side. The line is piercing in the top, line is piercing in the side, line is piercing in the profile view.

(Refer Slide Time: 34:11)

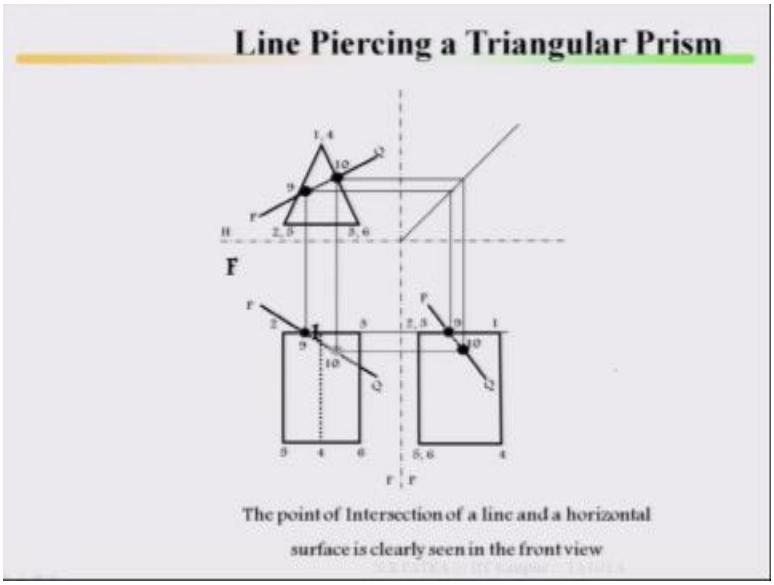


This is, now find it out what is your point of your intersections, I can get it very easy, then visibility this is what, how it looks.

(Refer Slide Time: 34:24)

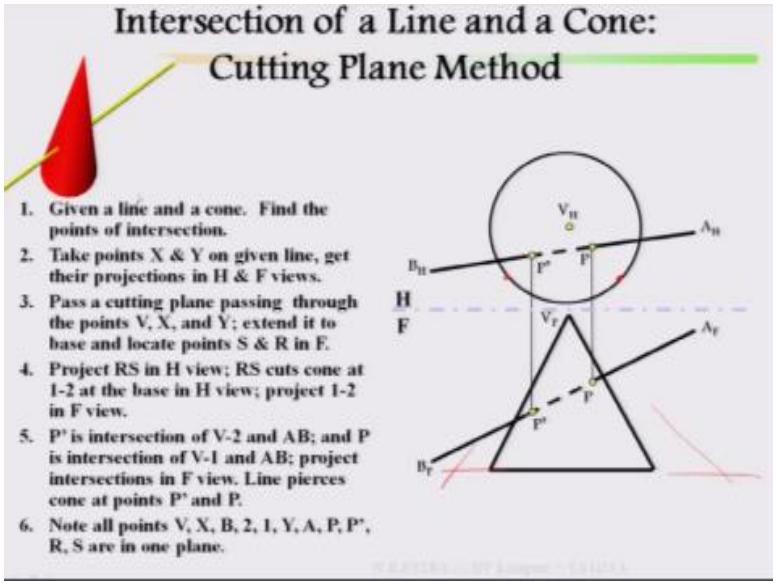
Line piercing a triangular prism, these are all example I am showing one by one.

(Refer Slide Time: 34:32)



So if you look at here this is a triangular prism and line is piercing then you project it back, project it back, front view, top view, side view is given then find it out your piercing points. The point of intersection of a line and a horizontal surface is clearly seen in front, view take it, take it and look at it. I am just doing it very fast once you do the by means of cutting plane methods it will be very easy, one by one I am showing example.

(Refer Slide Time: 35:12)



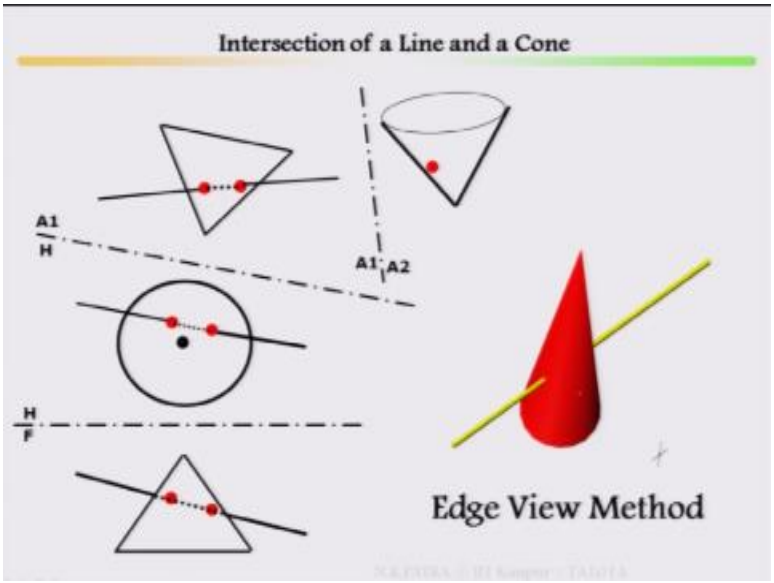
Intersection of a line and a cone by means of cutting plane method, look there is a cone and there is a line. This is a cone top view and there is a line is piercing and in the front view cone how it looks and line is piercing. Now given a line and cone find the point of intersection. Take point XY on the line on the given line, this is the given line, take point XY, I have taken point XY. Then from there you project it back opposite view mark the points X_F and Y_F, X_F and Y_F pass a cutting plane passing through the point V, X, and Y extend it to base and locate the point S and R in F, this your center.

Now there is a cutting plane here along the line I marked any two X and Y and it is joining here, then I join V, X and Y, then V, X and Y then once you get the extended part this you join it then you extend it, from here to here you extend it, from here to here you extend it, then you extend it, then you extend it. It has been extended then you get it, then from there once you get the extension then you project it back at the top, project it back at the top with your extension lines the way you have done.

Now you can find it out where this plane is cutting, here it is cutting, here it is cutting, 1 and 2 edge. Similarly same 1 and 2 edge you project it back then do it, then 1 and 2 edge where it

cutting your plane a line, this point and this point mark it, this is what your piercing points. Unless you are not going to practice it is not going to be clear to you, so you start with your method of by means of one is edge view or by means of cutting plane, cutting plane is easy and fast whatever example I have solved you practice of yourself then it will be clear to you, then it will become easier for complicated cases.

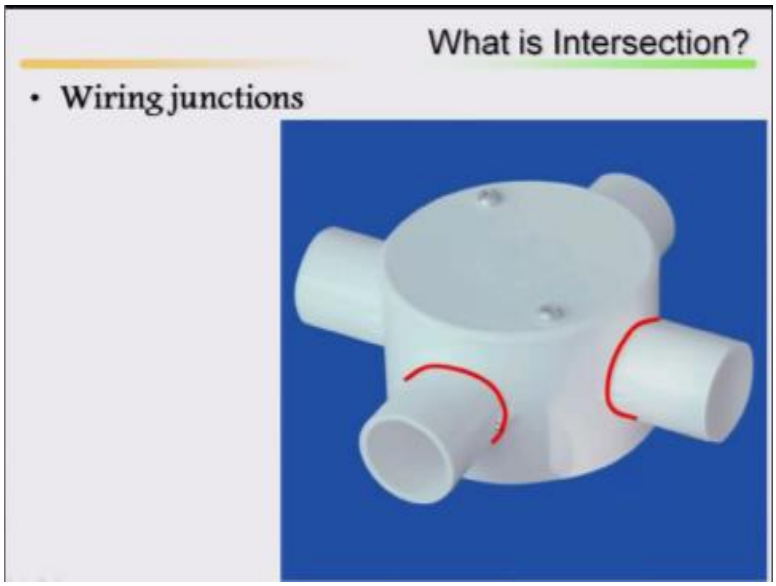
(Refer Slide Time: 37:44)



This is what I have said by means of edge view, by means of edge view there are two example one is your by means of cutting plane we have solved, now by means of edge view, edge view has been one auxiliary plane, edge view will come then from there you take the then line become line, then plane then where it is cutting, then you project it back, then you will get point of intersections. I am going slightly faster because it required for you to practice.

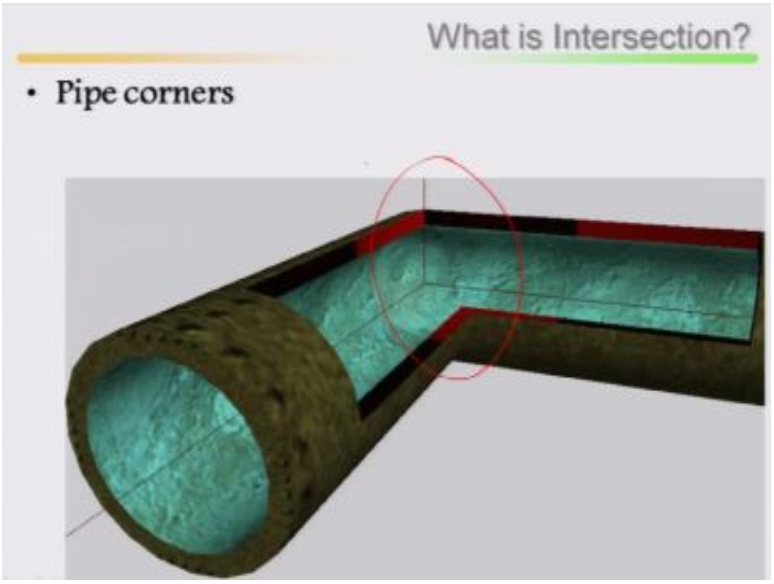
What I have explained now intersection between lines, prism, intersection between plane, intersection between line, cone, what is the meaning, practical meaning. Where junction there are two pipes are going.

(Refer Slide Time: 38:37)



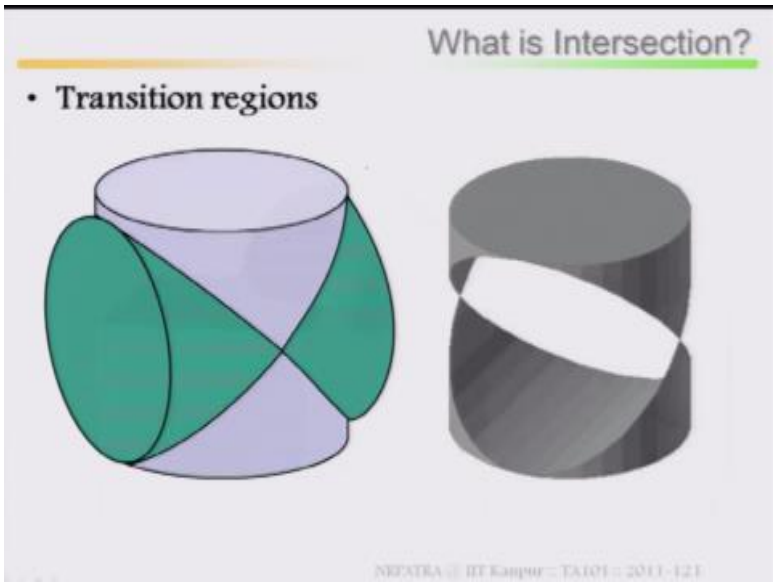
Two pipes are going look at this, here it is intersection of this and this. How the intersection looks like.

(Refer Slide Time: 38:46)



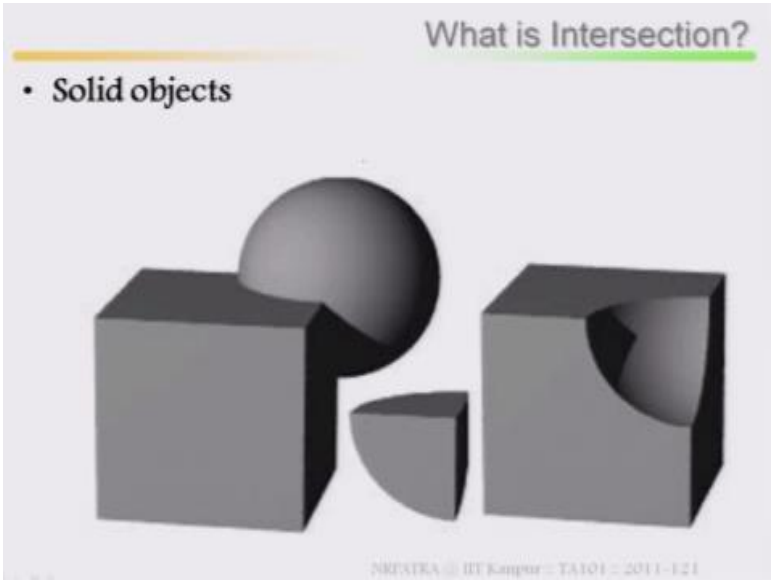
Then come to the second example, pipe corners, actually in practical utility where the drawing is required few cases I am showing, I have already explained lines, lines, line plane, line cylinder few examples. Now if you look at two pipes, two pipes corners, one pipe is going here other pipe is coming here at the corner how it, how it looks, at the corner how it looks this is called your intersection.

(Refer Slide Time: 39:16)



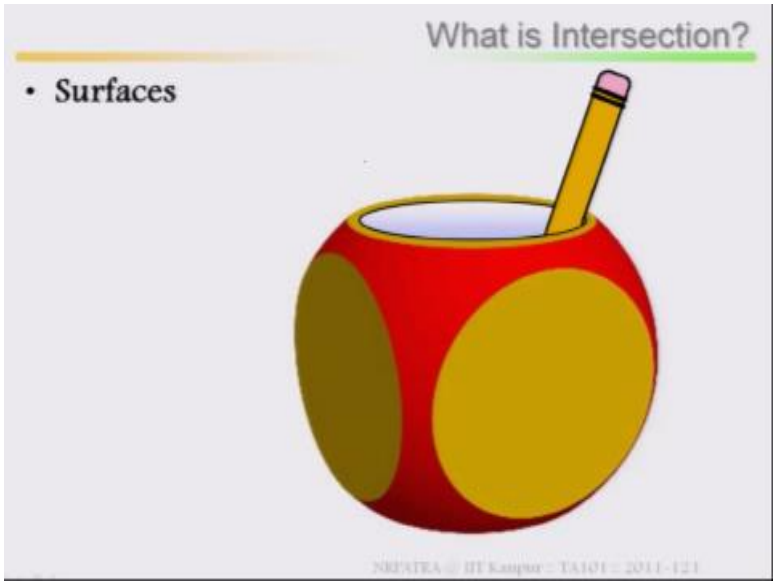
Now transition region, look at here, look at here how it looks.

(Refer Slide Time: 39:23)



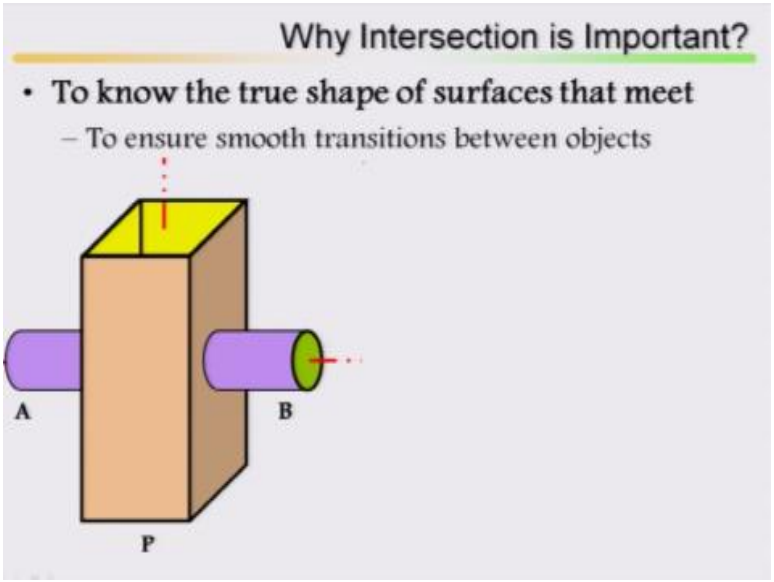
Solid objects look at here.

(Refer Slide Time: 39:26)



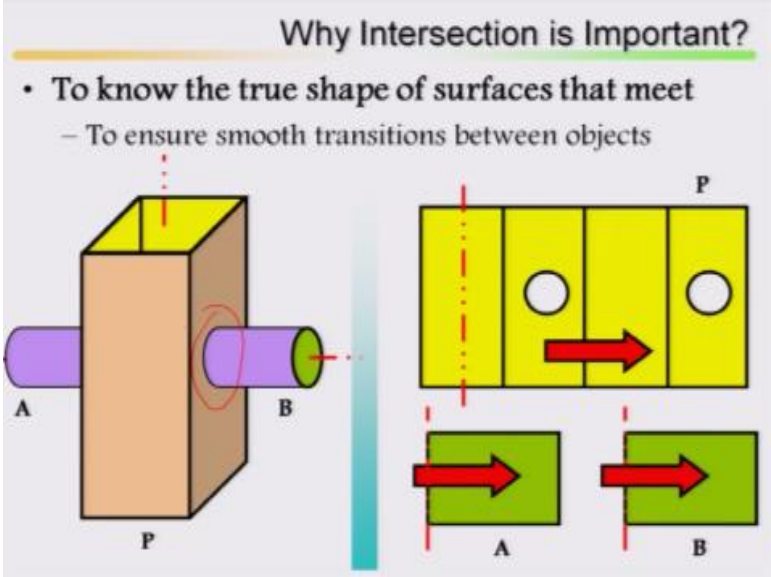
Surfaces how it looks.

(Refer Slide Time: 39:29)



True shape of surface that meet to ensure smooth transition between the objects, suppose there are, one is solid object, another is solid object it is moving inside. What is that intersection? What is that intersection, what is the rear true surface at this junction?

(Refer Slide Time: 39:46)



At the intersections, why intersection is important? Basically to know the true shape of surface that meet, true shape of the surface that meet to ensure smooth transition between the objects. I will stop it here, so next class I will explain more about this intersection of the solids. Thank you.

Acknowledgement
Ministry of Human Resource & Development

Prof. Satyaki Roy
Co-ordinator, NPTEL IIT Kanpur

NPTEL Team
Sanjay Pal
Ashish Singh
Badal Pradhan
Tapobrata Das
Ram Chandra
Dilip Tripathi
Manoj Shrivastava
Padam Shukla
Sanjay Mishra
Shubham Rawat
Shikha Gupta
K. K. Mishra
Aradhana Singh

Sweta
Ashutosh Gairola
Dilip Katiyar
Sharwan
Hari Ram
Bhadra Rao
Puneet Kumar Bajpai
Lalty Dutta
Ajay Kanaujia
Shivendra Kumar Tiwari

an IIT Kanpur Production

©copyright reserved