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

Lecture – 28
Auxiliary Views
&
Relationships between Lines and Planes

by
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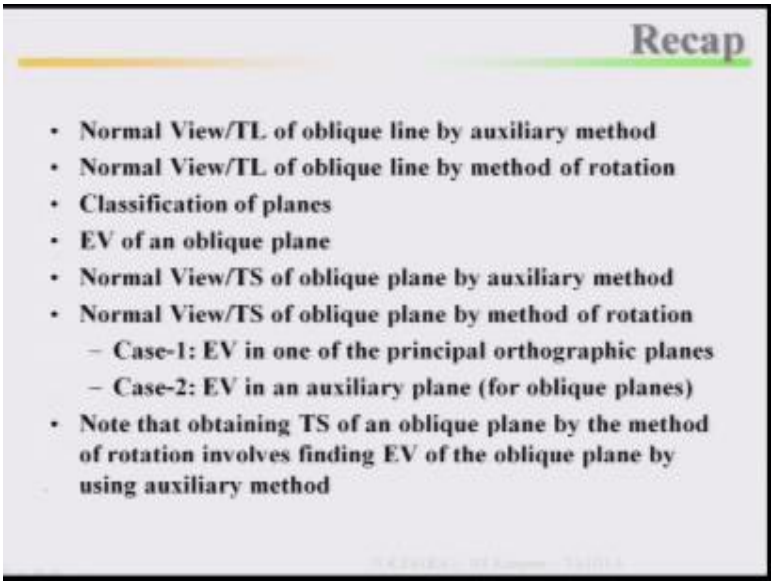

So space geometry what we have covered last time normal view, true length of oblique line by auxiliary method. Normal view true length of oblique line by method of rotation. Classification of planes. Edge view of an oblique plane. Normal view and true shape of oblique plane by auxiliary method. Normal view and true shape of oblique plane by method of rotations.

Case 1 edge view in one of the principal orthographic planes, case 2, edge view in an auxiliary plane for oblique planes. Note that to get true shape of an oblique plane by the method of rotation involves finding edge view of the oblique plane by using auxiliary method.

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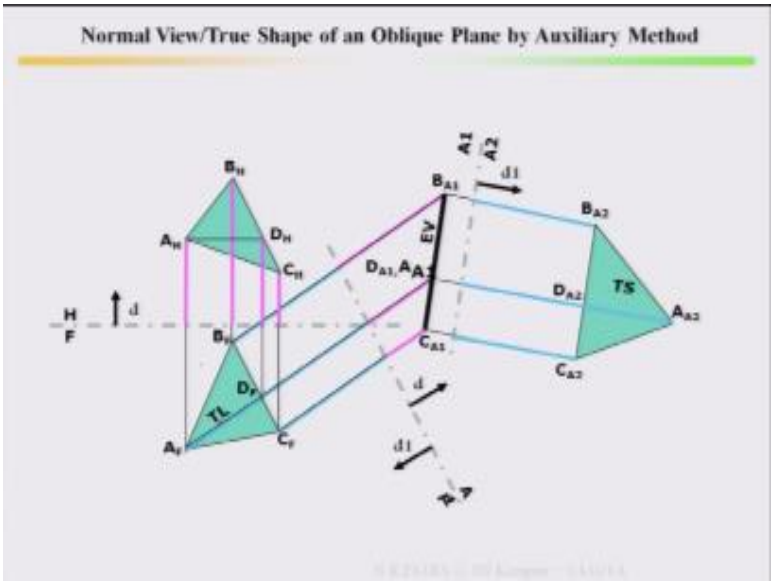

So let us review it, plane at the top, plane at the frontal view, then take the – this has been already discussed just for a review for your reference. Take a line AD parallel to your hinge line, then project it back. Then AF and DF is your true length of the line of AD, this line of AD true length is your AF and DF. Then with respect to AF and DF draw a line, then take any auxiliary plane at any distance from AF and DF.

Then from there measure the distance from the opposite view that from the top view. Then distance has been – then you extend this lines ABCDF and the distance from the opposite view has been measured, and the distance has been measured then located from your auxiliary view. Then mark it, it will be as a edge view, then with respect to edge view, then draw another auxiliary plane at any distance from the edge view.

And from there opposite – this is your D1 this distance will be your distance from here to here all points you mark it and locate it. This is what you are getting, this is your true shape of a plane by means of auxiliary method.

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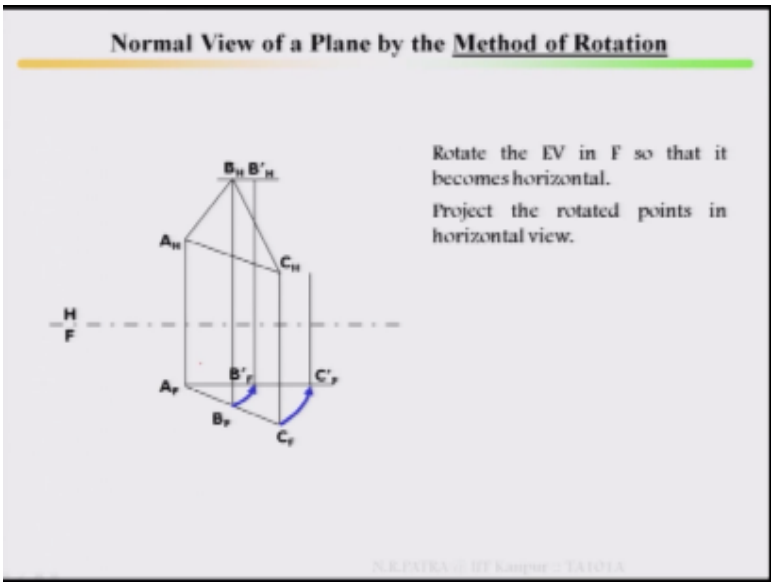

Then come to the method of rotations, this is a plane ABC, rotate the edge view in front so that it become horizontal. So rotate the edge view in front so that it become horizontal, this is your edge view it has been rotated so it become horizontal. So then ABC, ABC in frontal view has been rotated parallel to your hinge line, parallel to your hinge line. So this will be AF, BF and CF parallel to your hinge line.

Then project the rotated points of horizontal view, you project it back. As I said method of rotations the distance is not going to change.

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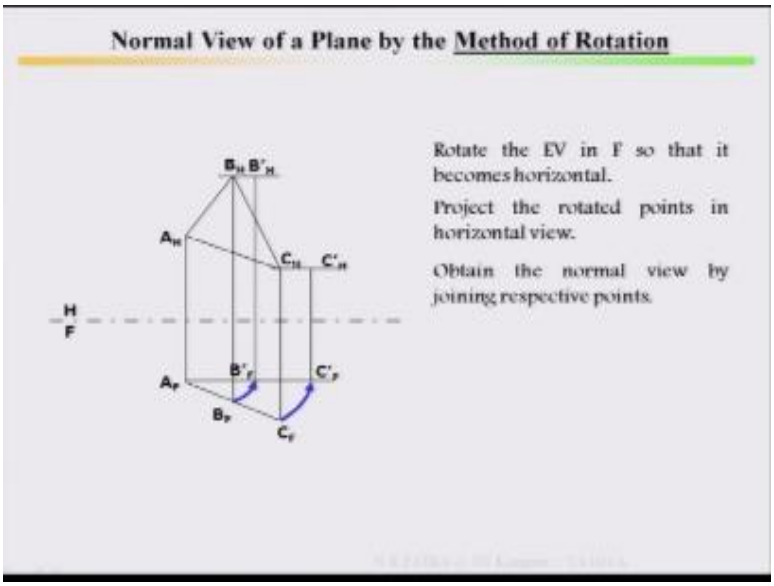

The distance from here to here is not going to change so draw a line here, then project it back, similarly see the distance will not going to change every coordinate will be there, distance will not change, but this position will change.

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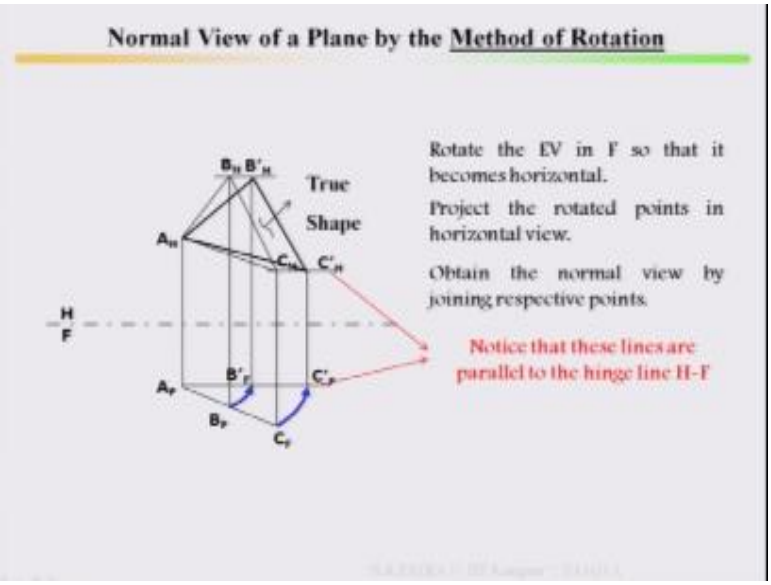

Then mark this points and join these and take it, because with respect to A it has been rotated edge view. So that means A is stationary, so your ABC, ABC it is your true shape of the plane. These lines are parallel to your hinge line of horizontal in frontal plane.

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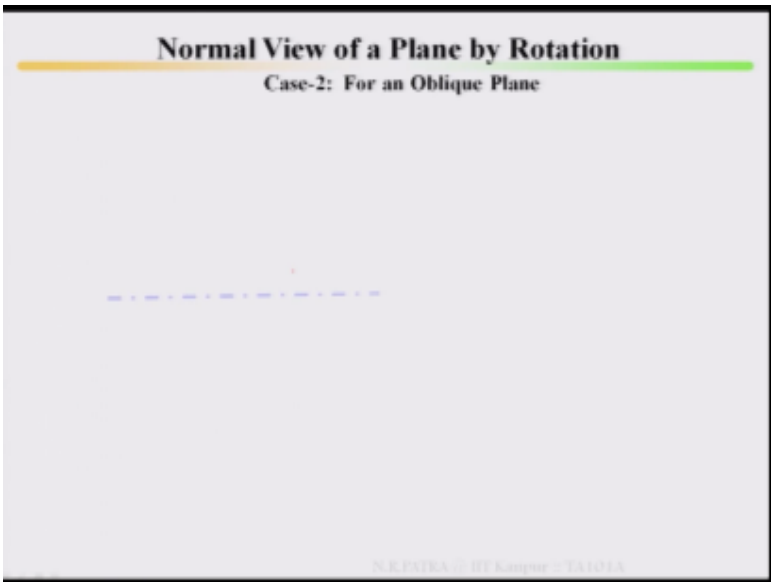

Then normal view of a plane by means of rotation case 2.

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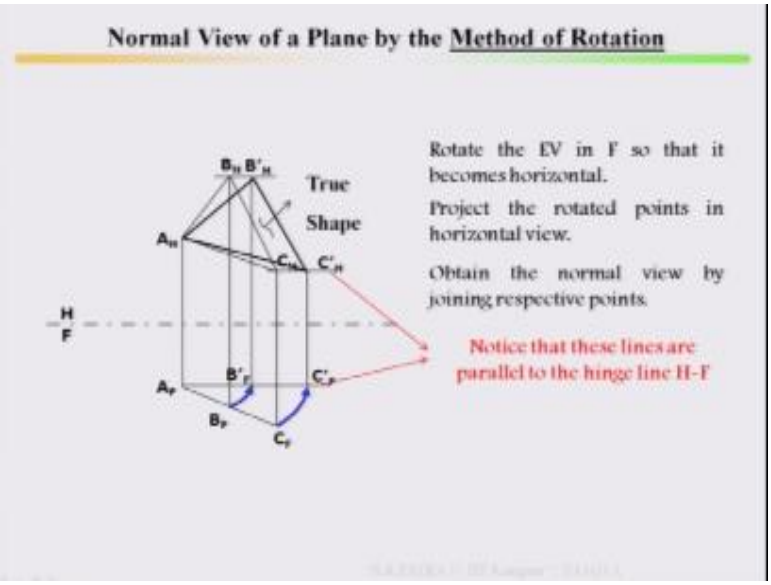

For an oblique plane earlier by simple normal view of a plane by method of rotation.

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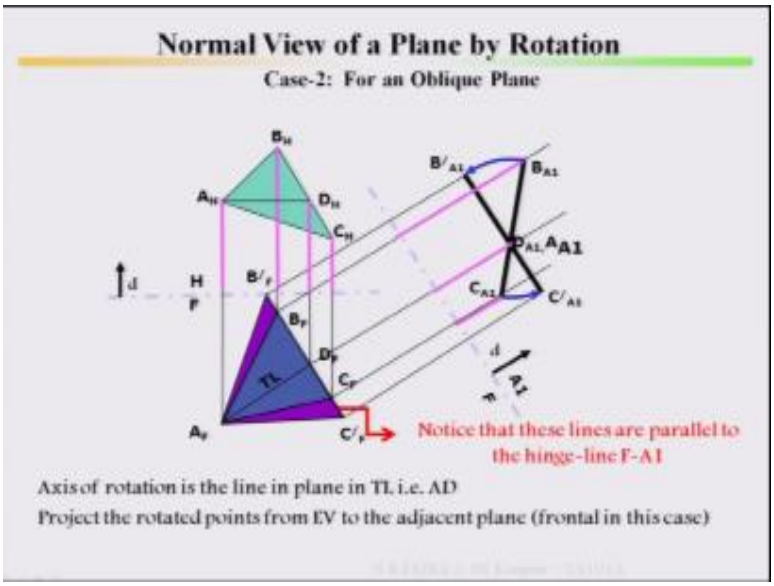

Case 2 for an oblique plane this is your plane, then second plane, then draw a line parallel to your hinge line ADH, then from there project it back to your opposite view AF, DF is your true line, then from there draw it, project it back, then take your first auxiliary plane A1 then locate your edge view, this is your edge view, then this edge view has been rotated by means of method of rotations, you rotate it.

Considering D as a stationary point with respect to D it has been rotated. So then – so once it has been rotated you are getting the edge C′ and B′. Then from there, from there project the rotated point from edge view to adjacent plane, this has been projected back and this has been projected back. So this is your BF′, this is your CF′. Then notice these lines are parallel to your hinge line, these lines are parallel to your hinge line.

Then draw this join B′F and C′F, so AF, B′F and C′F is your true shape. This is what you are by means of plane, by means of method of rotations and by means of auxiliary view or auxiliary plane you will get true shape of the plane.

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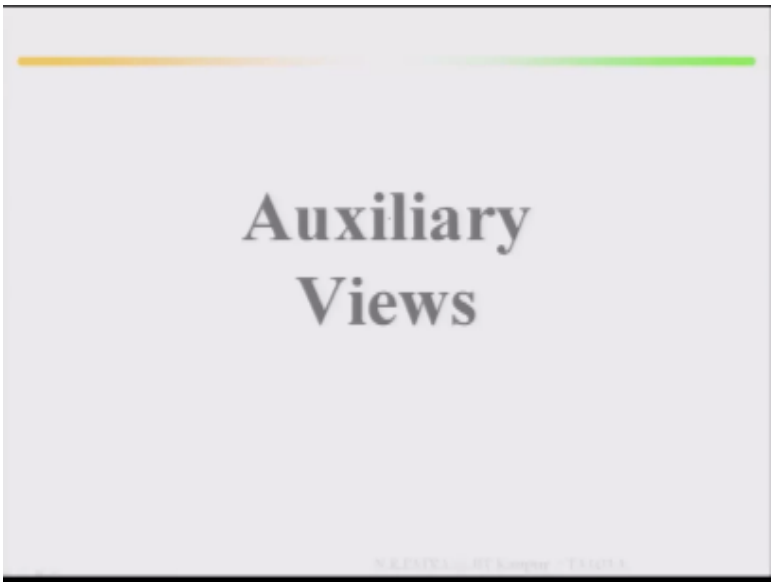

Now come to the auxiliary view.

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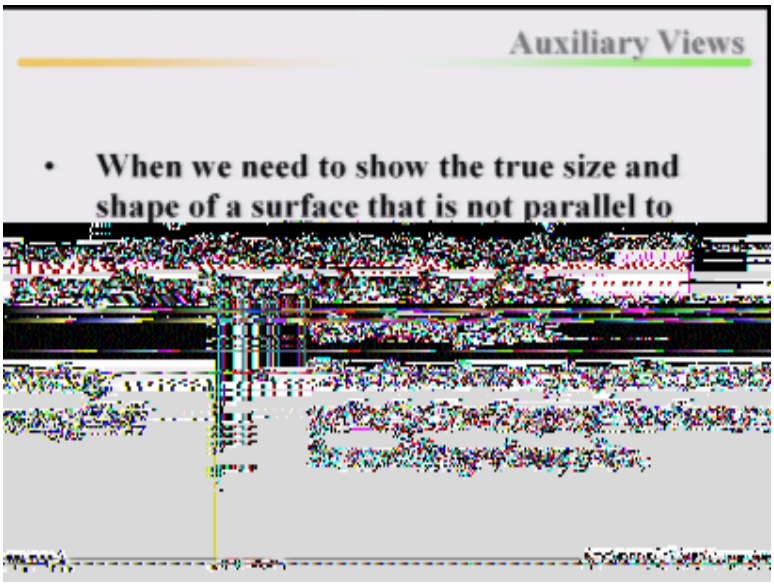

When we need to show the true size and shape of a surface that is not parallel to one of the principal planes of projection, an auxiliary line of sight and auxiliary view is required. The theory is employed in the constructing principal orthographic views are applied in auxiliary views also.

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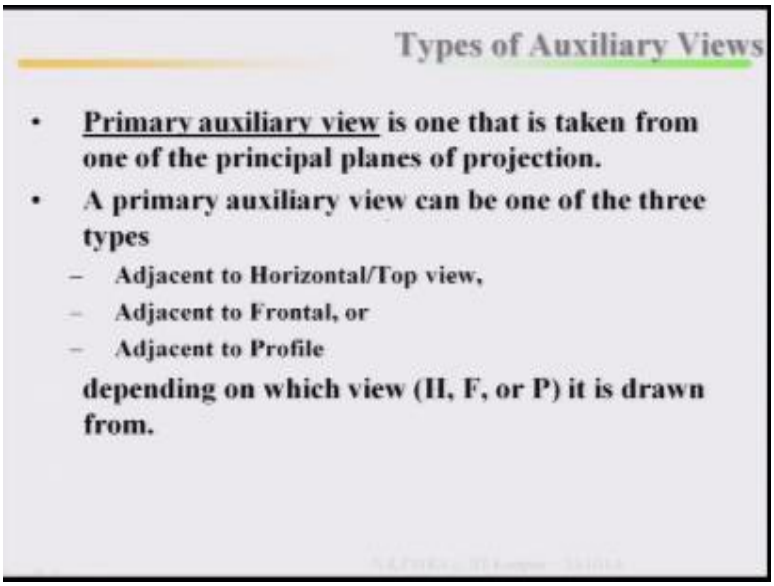

Primary auxiliary view is one that is taken from one of the principal plane of projection. Then a primary auxiliary view can be one of the three types, adjacent to horizontal or top view, adjacent to frontal, adjacent to profile. Depending on which view, horizontal, frontal, or profile it is drawn from. It is going to be drawn from that view.

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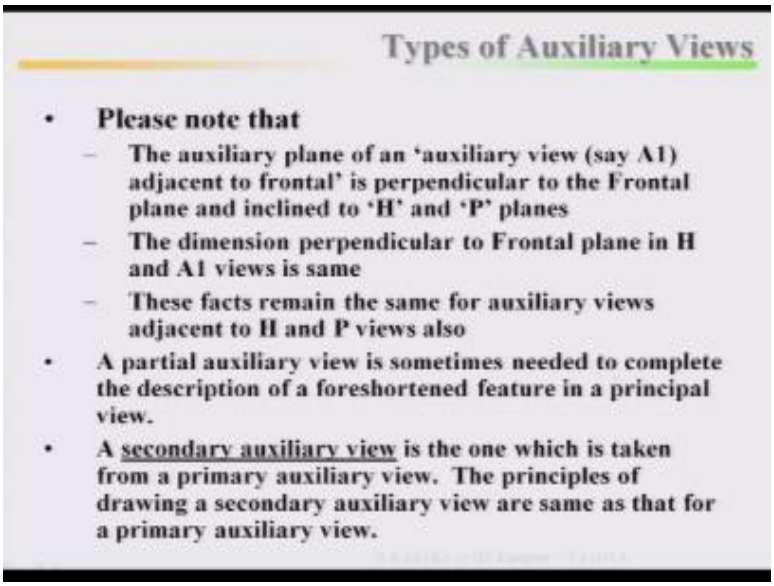

Type of auxiliary views, the auxiliary plane of an auxiliary view say A1, adjacent to frontal is perpendicular to frontal plane and inclined to horizontal and profile plane. The dimension perpendicular to frontal plane in horizontal and A1 view is same. These facts remain the same for auxiliary views adjacent to horizontal and profile views also. A partial auxiliary view is sometimes needed to complete the description of a foreshortened feature in a principal view.

Remember, last point the point – a partial auxiliary view sometimes not necessary that complete auxiliary view. A partial auxiliary view is sometimes needed to complete the description of a foreshortened feature in a principal view. A secondary auxiliary view is one which is taken from a primary auxiliary view. The principles of drawing a secondary auxiliary view are same as that for a primary auxiliary view.

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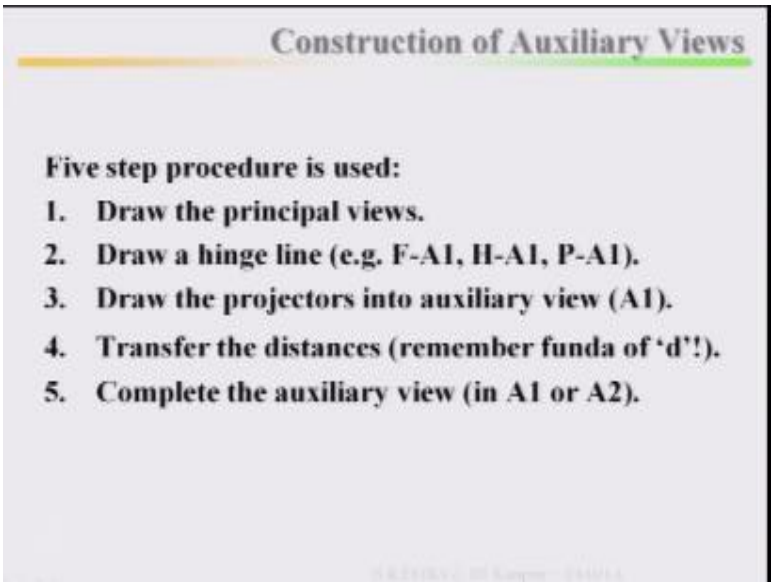

Five step procedure is used, draw the principal views, draw a hinge line, draw the projectors into auxiliary view A1, transfer the distance remember the funda of d opposite view take the distance, complete the auxiliary view A1 and A2, this is your five step.

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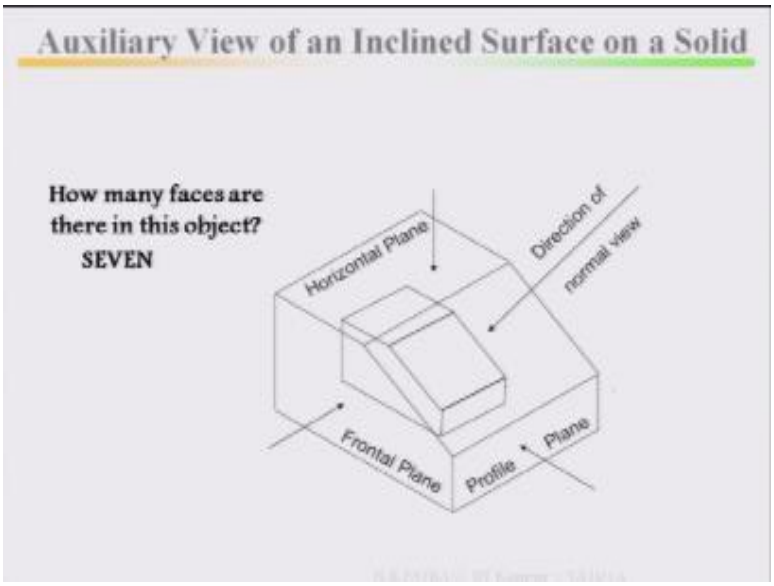

Look at the figure, how many faces there in this object? Because this is your auxiliary plane that means there will be seven faces.

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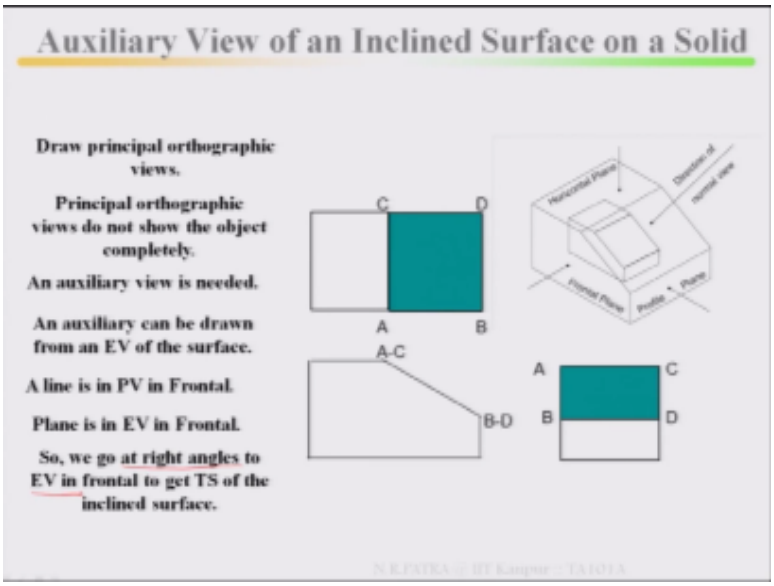

Draw principal orthographic views top, front and side, principal orthographic views do not show the object completely. An auxiliary view is needed. An auxiliary can be drawn from an edge view of the surface. A line is in point view in frontal. Plane is in edge view in frontal, the moment you go for auxiliary then a line will be a point and plane in edge view in frontal. So you go at right angle to edge view in frontal to get true shape of the inclined surface.

Remember here we go at right angle to edge view in frontal to get true shape of the inclined surface.

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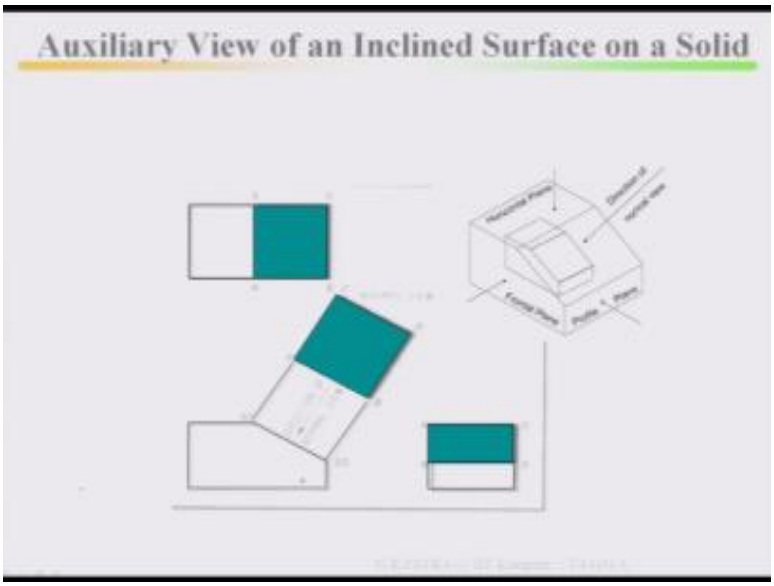

This is how it looks, you go to the right angle, here it is perpendicular line of sight so you will get a true shape.

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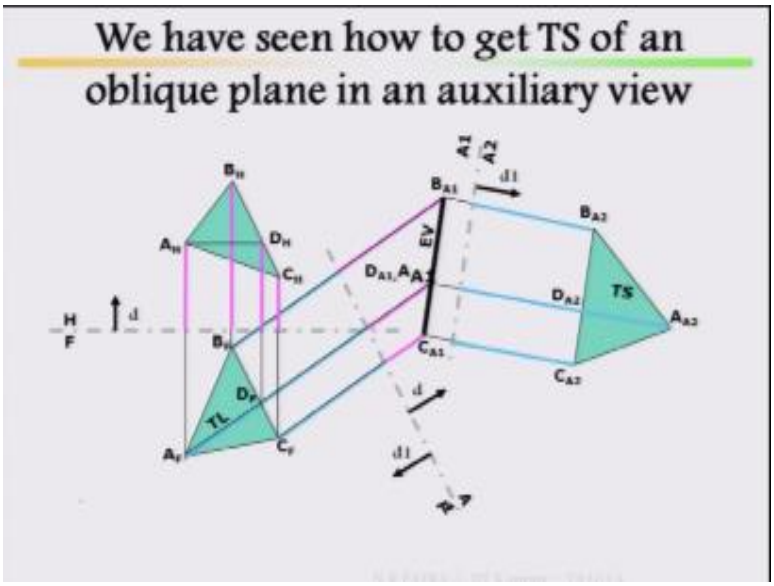

We have seen how to get true shape of an oblique plane in an auxiliary view, this is discussed.

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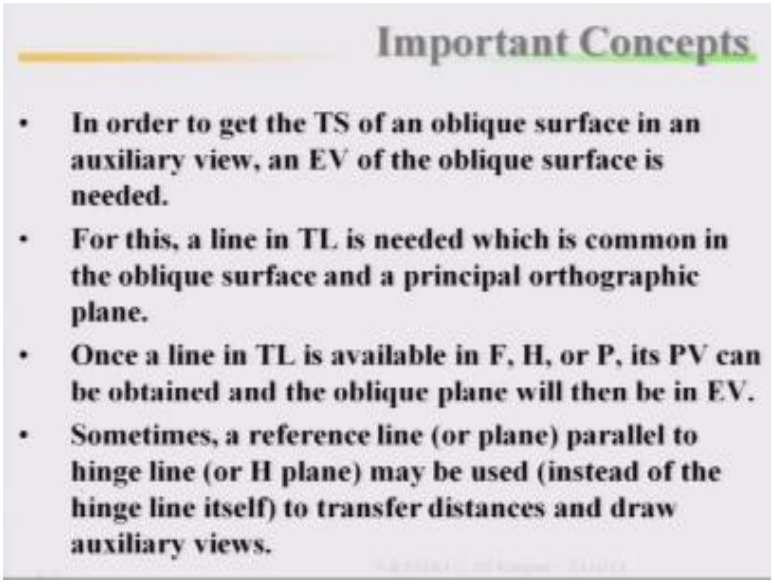

Important concepts, in order to get true shape of an oblique surface in an auxiliary view an edge view of the oblique surface is needed. For this, a line in true line is needed which is common in the oblique surface and a principal orthographic plane. Once a line in true line is available in frontal, horizontal and profile its point view can be obtained and the oblique plane will be then be in edge view.

Sometimes a reference line or a plane parallel to hinge line, sometimes a reference line or plane parallel to hinge line or H line, H plane may be used to transfer distances and draw auxiliary views.

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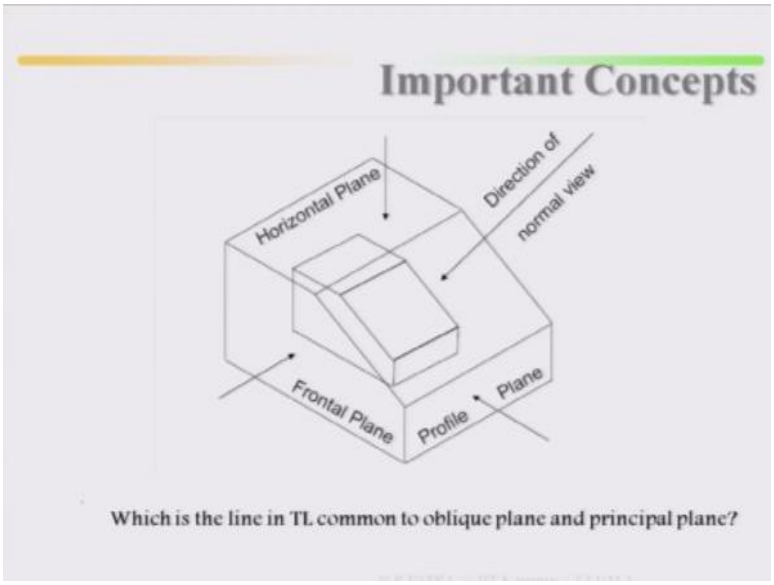

Which is the line in true length common to oblique plane and principal plane?

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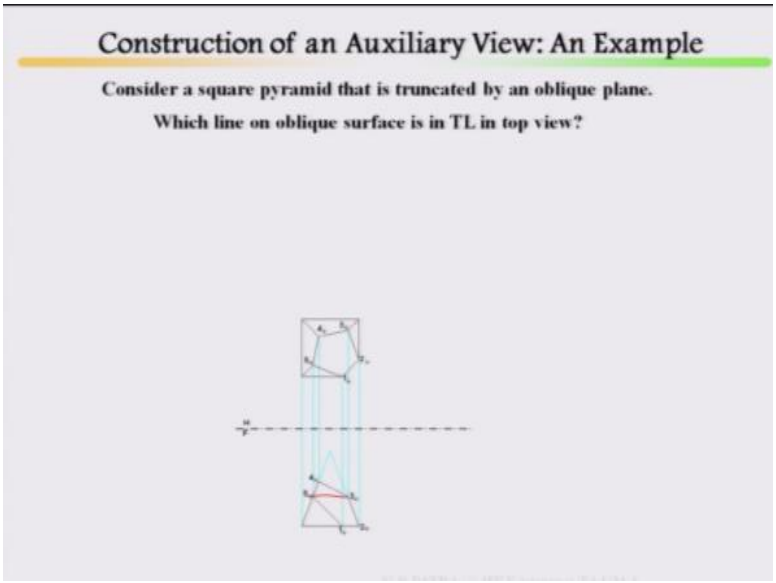

Construction of an auxiliary view, an example consider a square pyramid that is truncated by an oblique plane look at this, consider a square pyramid that is truncated by an oblique plane, this is square pyramid truncated by an oblique plane, this has been truncated by an oblique plane, first you name it, it is 1, 2, 3, 4, 5, then from there project it back then you name it 1,2,3,4,5, then which line on oblique surface is in true length in top view, which line on oblique surface is in true length in top view, if you look at here which line in oblique surface 3 to 5 if I join 3 to 5 particularly 3 to 5 that is parallel to your hinge line.

That means if I join a line between 3 to 5 that will give me, that is your true length of this line 3 to 5.

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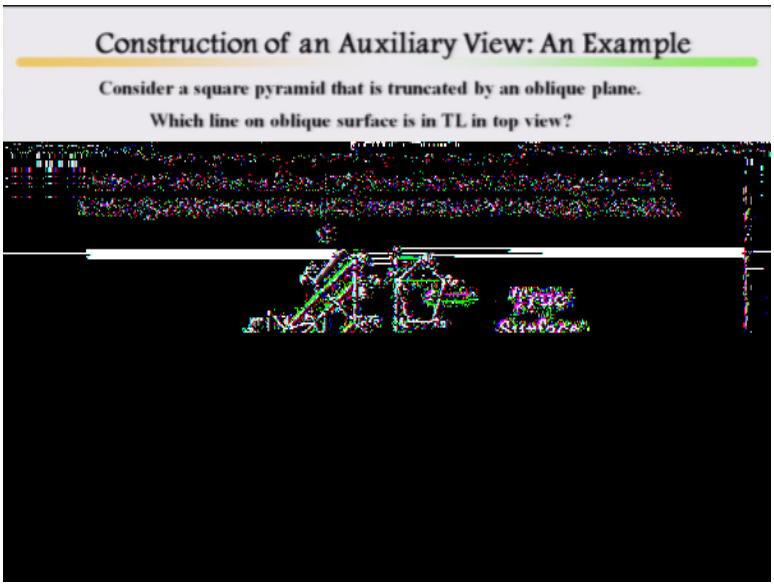

1-2. 2-3 ,3-4, 4-5, 5-1 or 3-5 in true length in top view so 3-5 in true length in top view, the way I said 3-5 is your parallel to hinge line hence 3-5 will be your true length, then this is your reference plane R1 has been taken, then this is your second reference plane or auxiliary plane has been taken, note that a reference plane R1 is used insisted of a hinge line H-F. Either you can take a hinge line or you can take a reference plane. Then measure the distance from the reference plane as I said earlier or from the hinge line, then the same distance this is your edge view because with respect to true length it has been extended, here it has been extended, then you are getting edge view because one point is joining your reference plane, this point is also joining your reference plane.

Then take the second reference plane parallel to your edge view, so then second reference plane once we are taking then you are take at the point of your point 5, then from there because reference plane has been taken, here reference line has been taken joining the point 5 then the point 5 has to be joined. Now this is your true surface, this is how construction of an auxiliary view one of the typical example.

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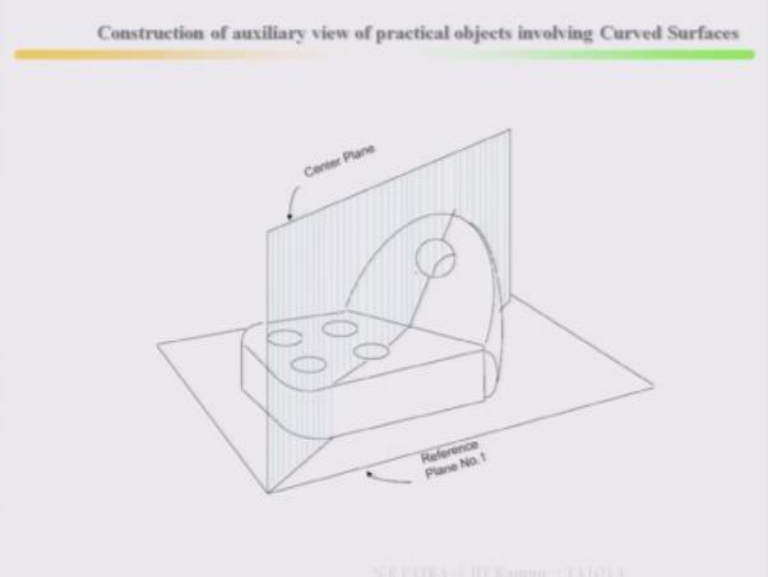

These are examples center plane you have to cut it, construction of an auxiliary view of practical object involving curved surface, if this surface is curved then you can take a center plane then find it out, find it out the curved surface practical purpose how it is there

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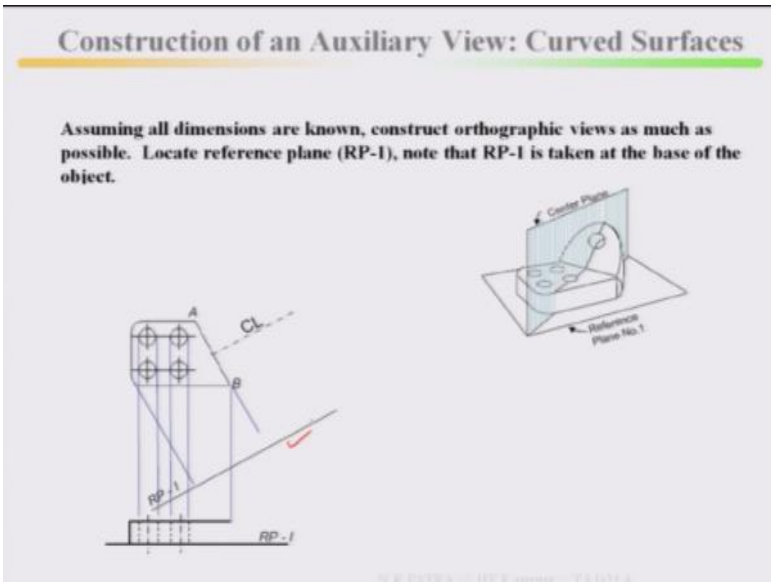

Assuming all dimensions are known construct orthographic view as much as possible, this orthographic view as much as possible. Locate reference plane RP-1 this is the reference plane has been made it here, note that RP-1 is taken at the base of the object.

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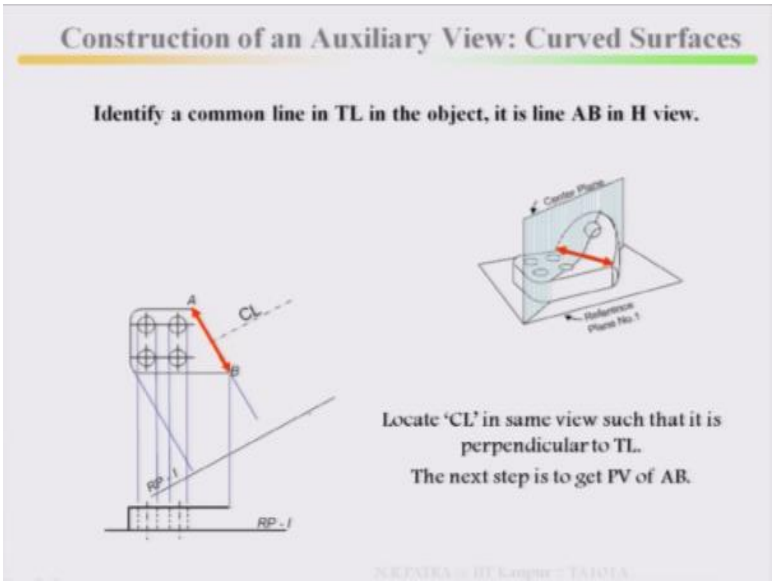

Then identify common line in true length in the object, identify common line in the true length in the object, so this is a common line, locate CL in the same view such that it is perpendicular to your true length, it is perpendicular to your true length, the next step is to get point view of AB

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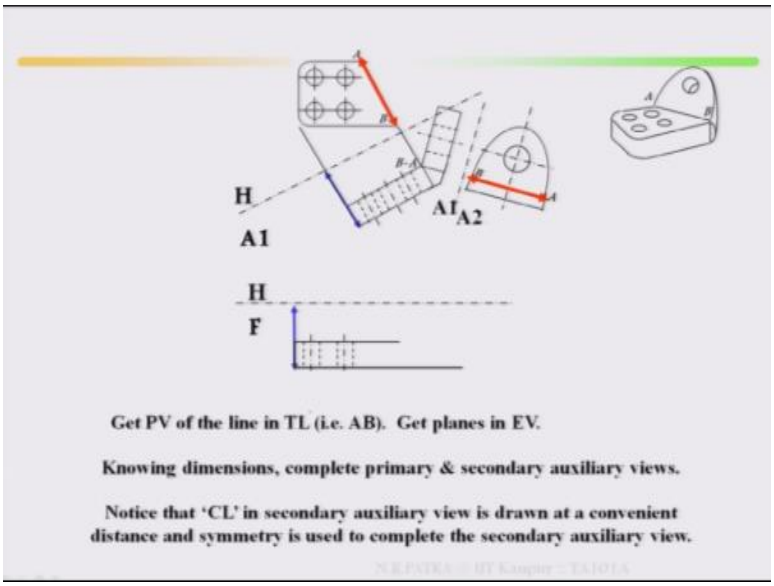

Take it, now take the point view, get point view of the line in true length that is AB, get the plane in EV, it is view then knowing dimensions complete primary and secondary auxiliary views this is the procedure.

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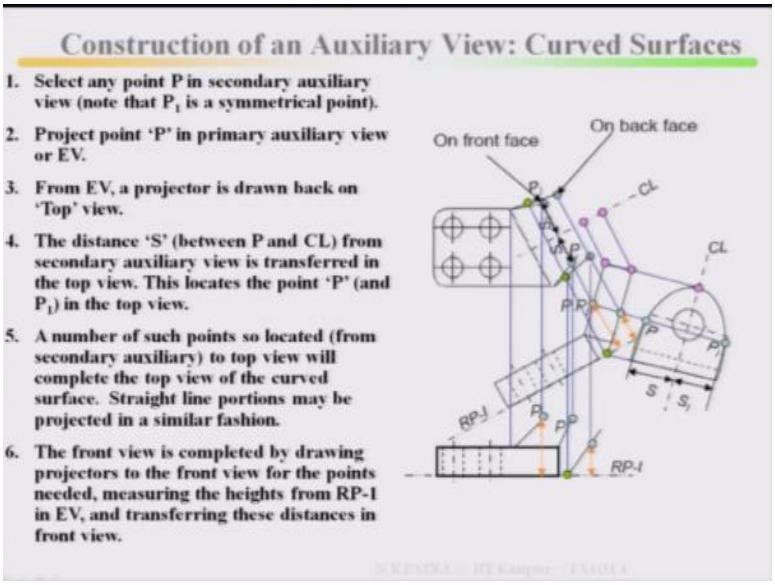

How it has been completed knowing the dimensions unless otherwise you are not going to practice it will be difficult How construction process, procedures, select any point P in secondary auxiliary view note that P1 is a symmetrical point, then project point P in primary auxiliary view or edge view, project point P, from edge view a projector is drawn back on top view back on the top view, the distance is between P and CL from secondary auxiliary view is transferred in the top view. This locate the point P in the top view and number of such points

So located to top view will complete the top view of the curved surface, top view of the curved surface, straight line portions may be projected in a similar fashions, the front view is completed by drawing projectors to the front view for the point needed measuring the heights from the reference point 1 in edge view and transferring this distance in front view.

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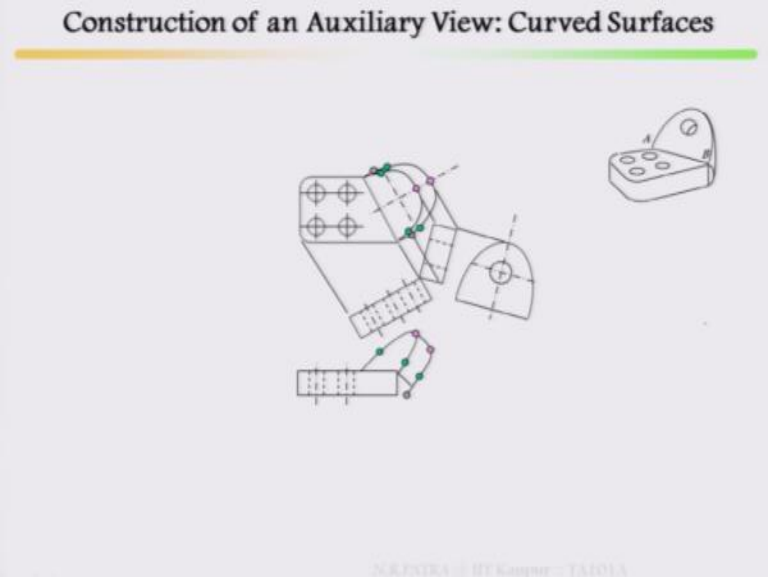

You see how it looks this is the procedure I have said it if you start with step by step with a reference line, reference plane you will get this curved surface.

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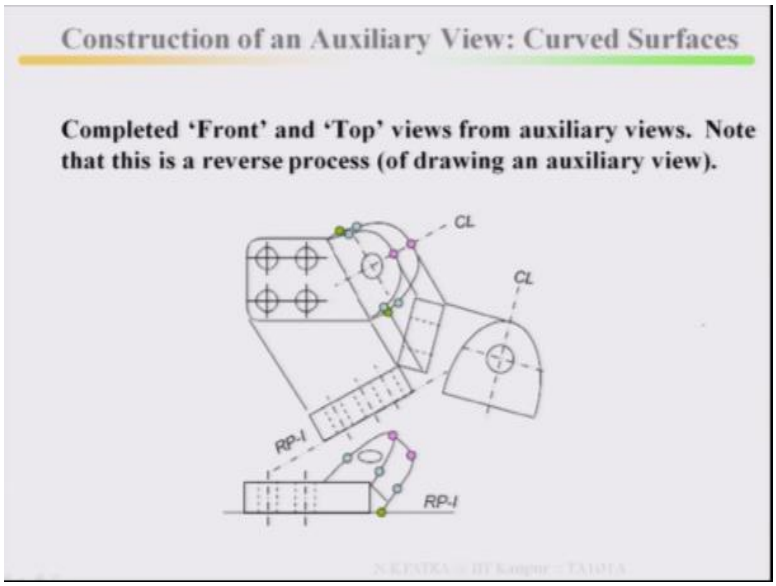

Completed front and top view from auxiliary views note this is a reverse process, this is a reverse process unless if you are not going practice it will have a problem, now another example.

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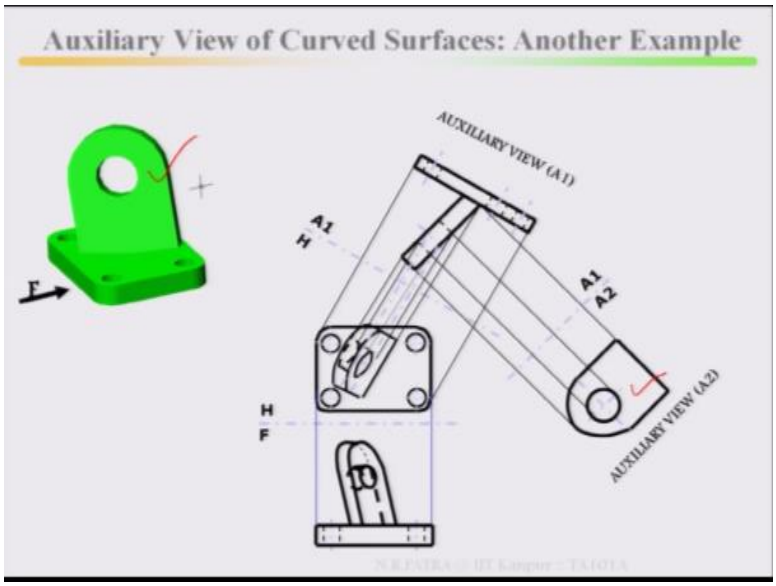

Let us draw it top view, front view, then this is how it looks with this because this is your curved surface we are looking forward, with this you are taking it A1 H then this is what how it looks, auxiliary view A1, then second auxiliary view A2, take point one by one then find it out auxiliary view A2, this is what true shape of the curved surface. Then after drawing this you project it back to your top view, project it back to your front view, this is a reverse process because if you want to draw.

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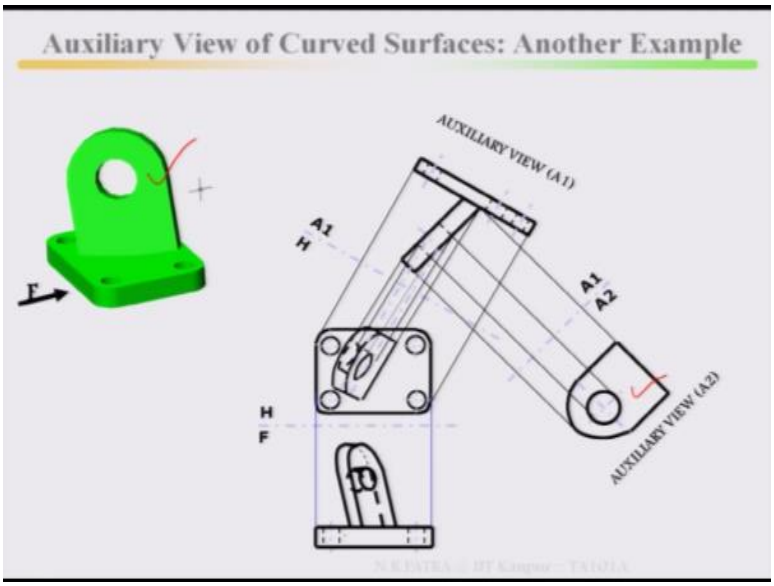

Front and top view you cannot locate the curved surface pictures, rather you go for, you go for auxiliary view 1 and auxiliary view 2, from there project it back to top view, project it back to front view then you can locate respective views of the curved surface

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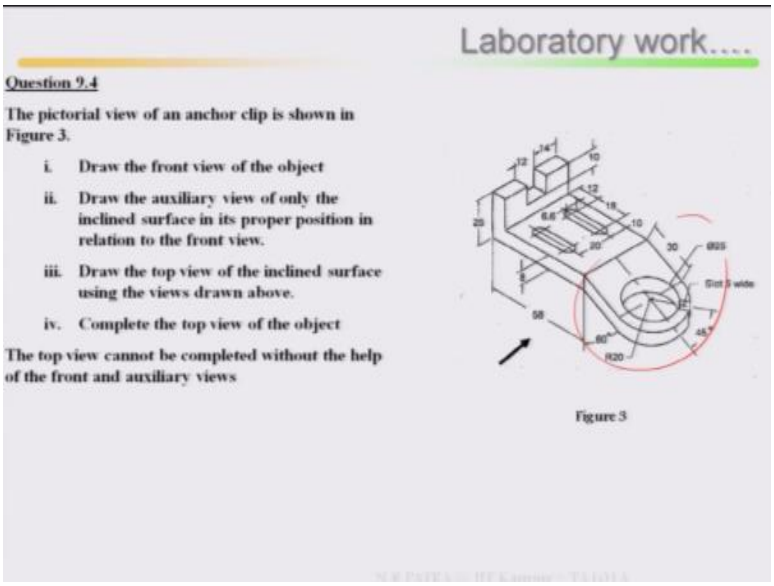

There is one example I am giving it to you for practice laboratory work question number 9.4 you can try it for this, this curved surface you can try it how your auxiliary view how you are getting and trace it back for top view as well as for front view. Now next part is we are going to start relationship between lines

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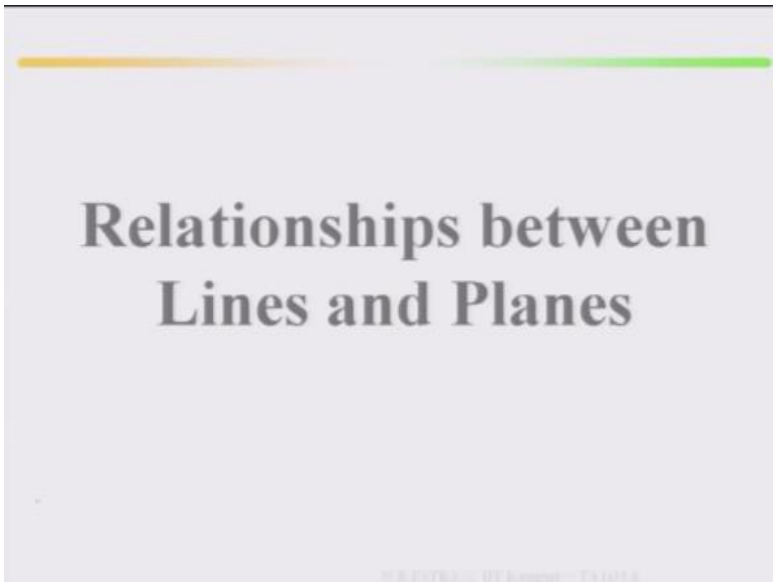

And planes.

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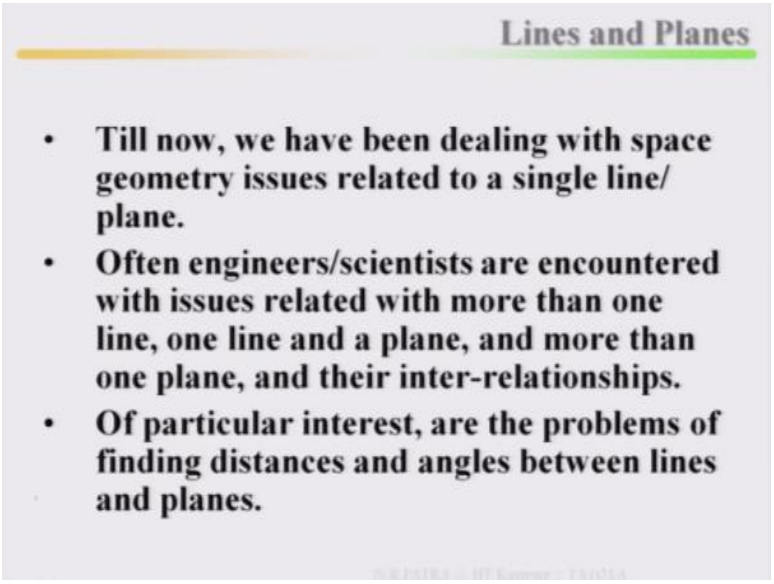

Lines and planes, till now we have been dealing with space geometry so related single line or single plane of an engineering, in engineering engineers or scientists are encountered with issues related with more than one line, one plane, or more than one plane or their inter relationship or intersection, of particular interest are the problems of finding distance and angles between lines and planes.

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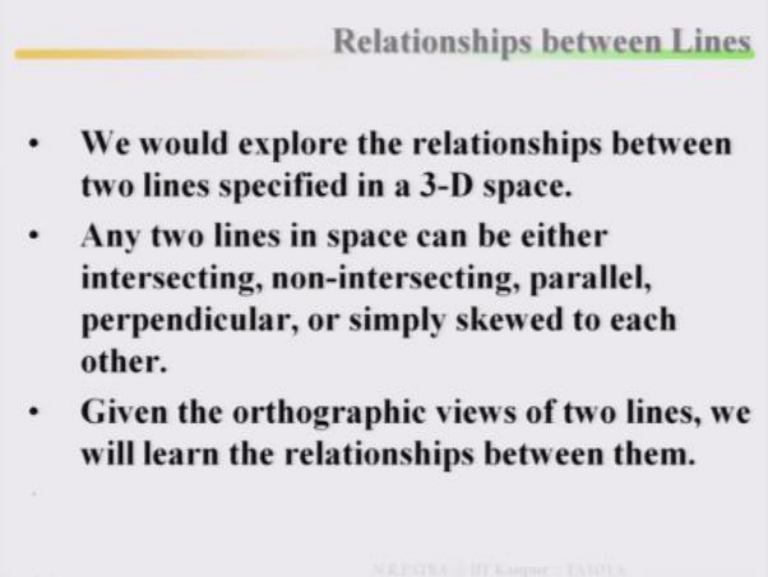

Now in this lecture we would explore the relationship between two lines specified in a 3-D space, any two lines in space can either intersecting, non intersecting, parallel, perpendicular, or simply skewed to each other, given the orthographic views of two lines we will learn relationship between them.

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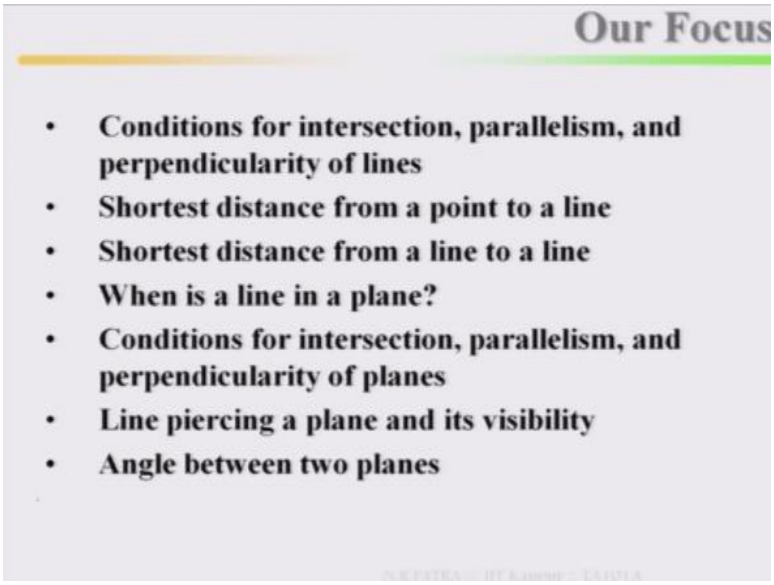

Conditions for intersection, parallelism and perpendicularity of lines shortest distance from a point to a line, shortest distance from a line to a line, when is a line in a plane? Condition for intersection parallel and perpendicular of planes, line piercing a plane and its visibility, how it is visible, then angle between two planes, these are the things we are going to discuss in this part.

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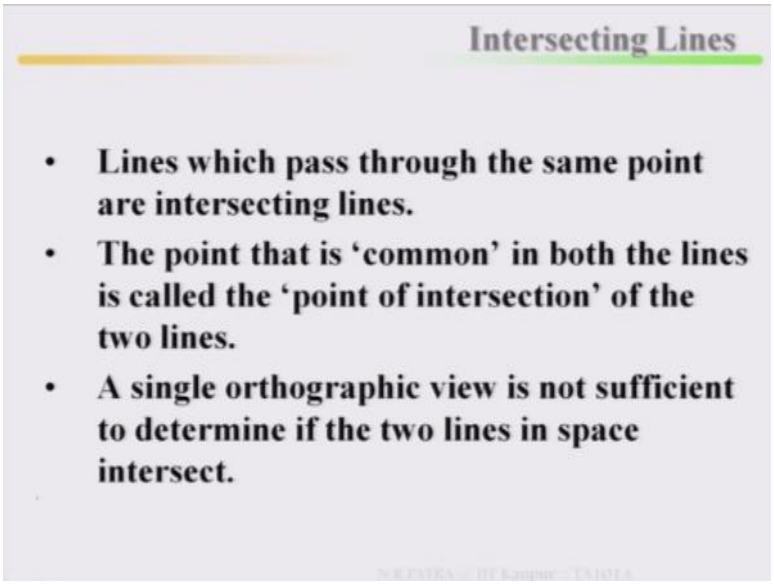

Lines which passes through same point are intersecting lines. Remember lines which pass through the same point are intersecting lines. The point that is common in both the lines is called point of intersection of two lines, a single a orthographic view is not sufficient, a single orthographic view is not sufficient to determine if two lines in space intersect.

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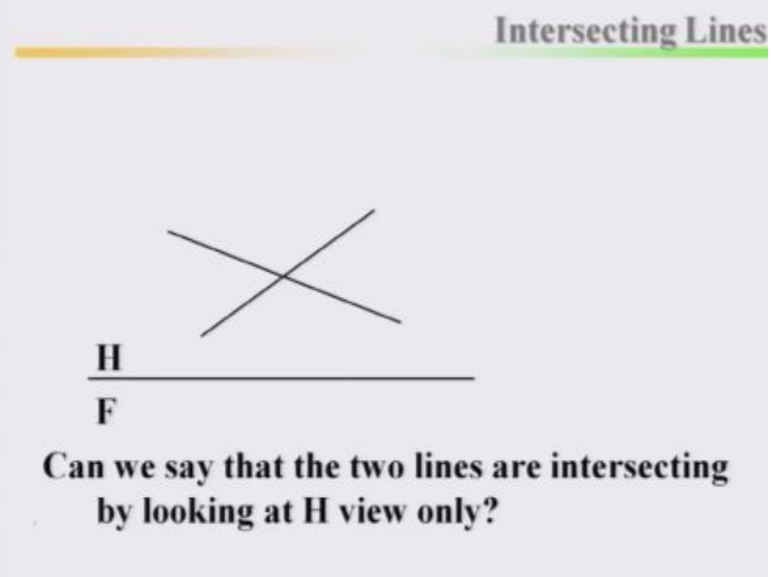

Can you say that the two lines are intersecting by looking horizontal view only, either yes or no we cannot say.

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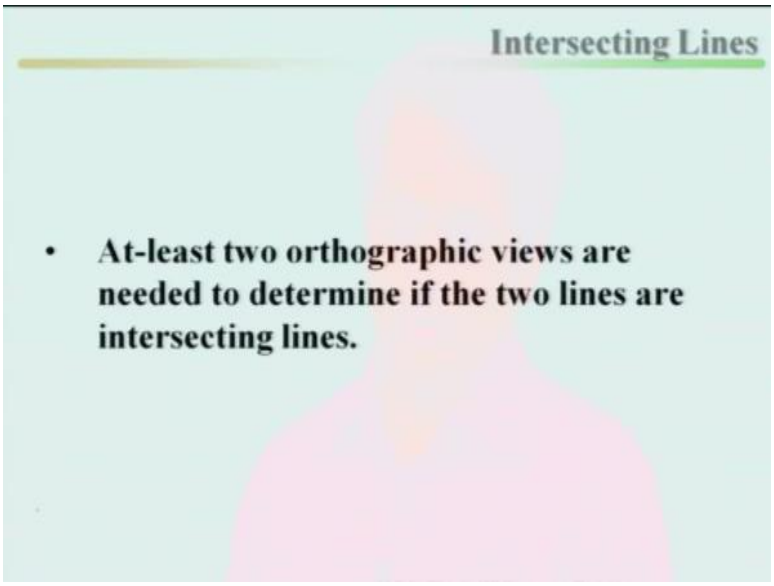

At least two orthographic views are needed, not single orthographic view we cannot say that two lines are intersecting with each other, at least two orthographic views are needed to determine if two lines are intersecting lines.

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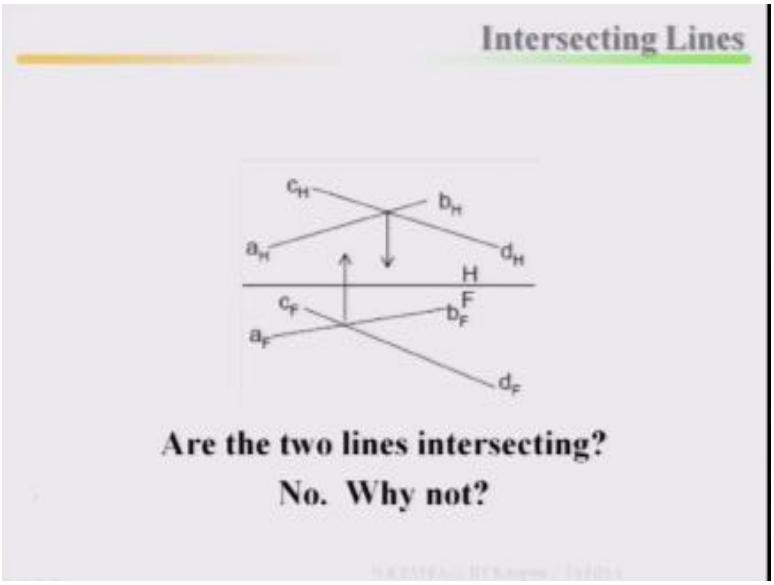

Now look at here, are the two lines intersecting? No, why not? Question is why not.

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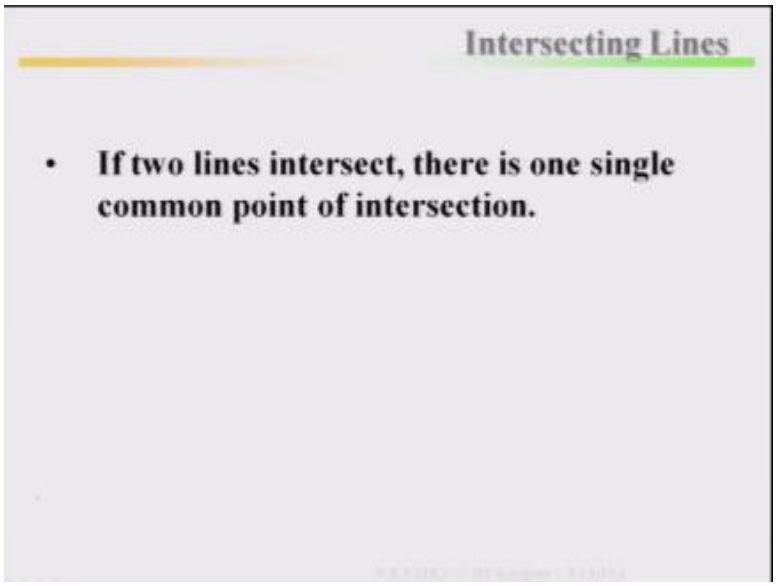

Let us see, if two lines intersect there is one single common point of intersections, there is one single common point of intersections.

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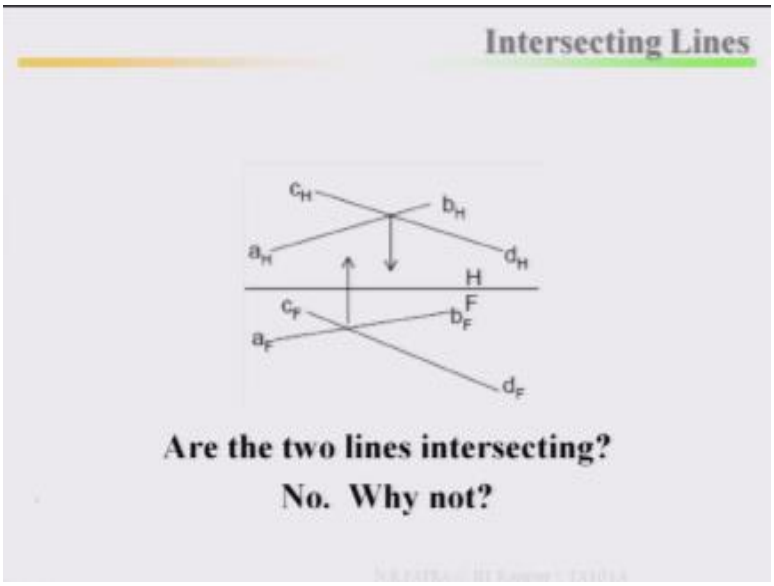

How come there is a double single common point of intersection?

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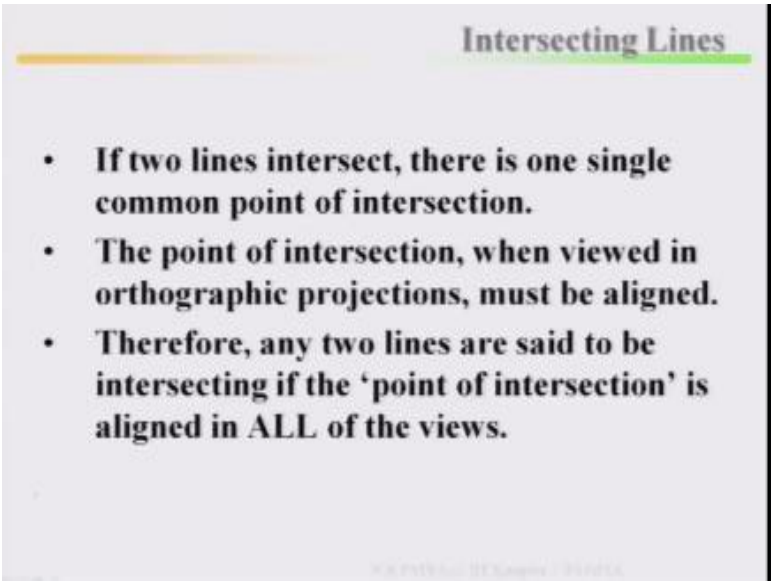

The point of intersection when viewed in orthographic projection must be aligned, therefore any two lines are said to be intersecting if the point of intersection is aligned in all of the views.

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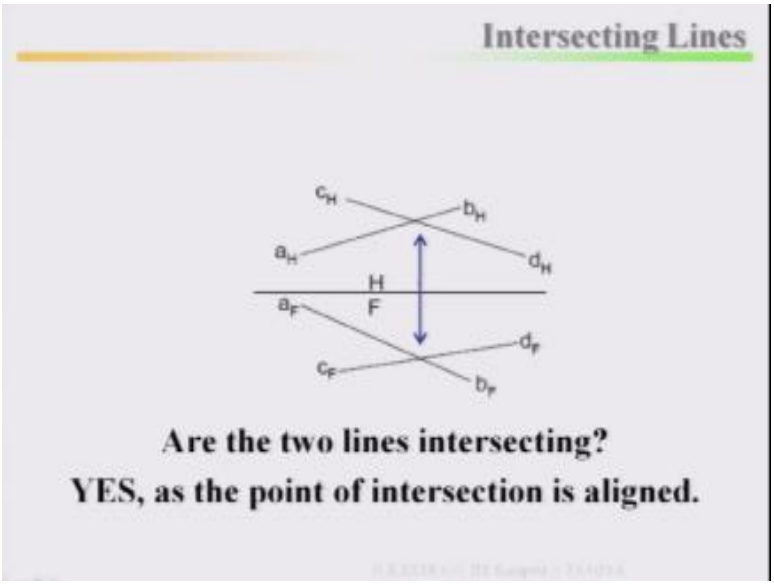
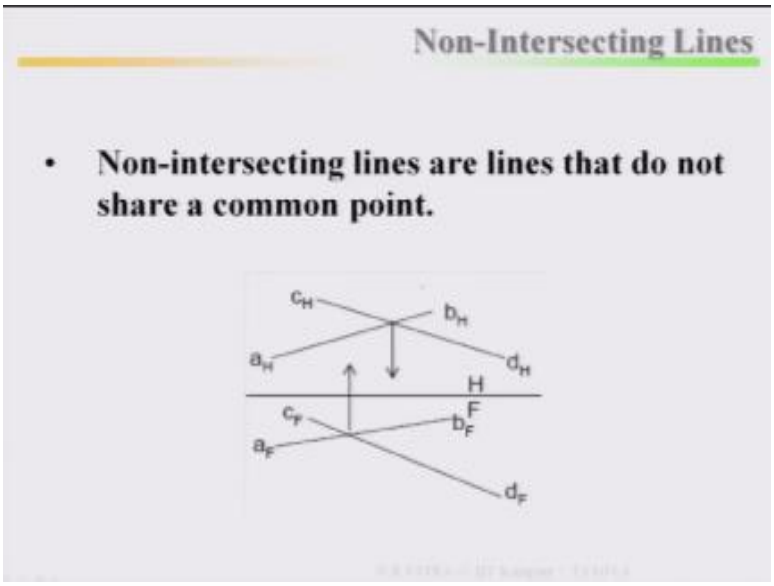


Here you see top view, front view it is aligned that means what we can say, are these two lines intersecting? Yes, as the two point of intersection is aligned.

(Refer Slide Time: 20:57)



No intersecting lines are lines that do not share a common point remember, no intersecting lines are lines that do not share a common point.

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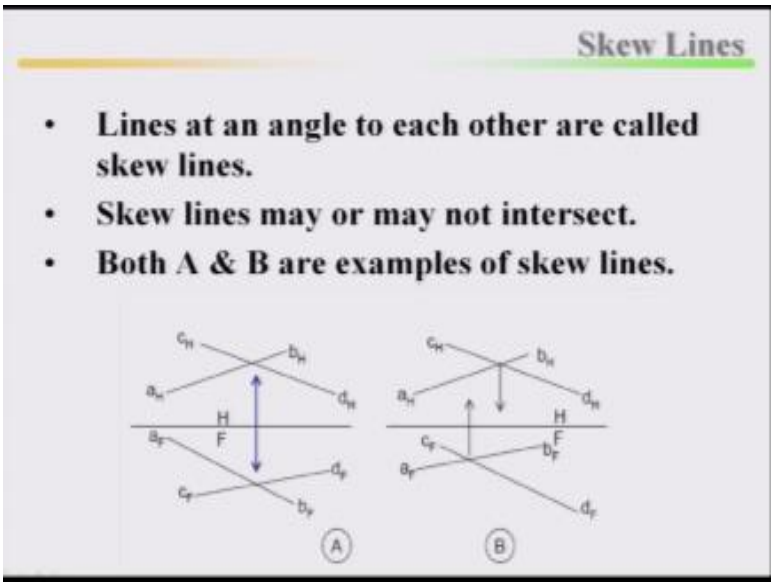

Angle to each other are called skew lines, skew lines may or may not intersect, remember here skew lines may or may not intersect, both A and B are examples of skew lines.

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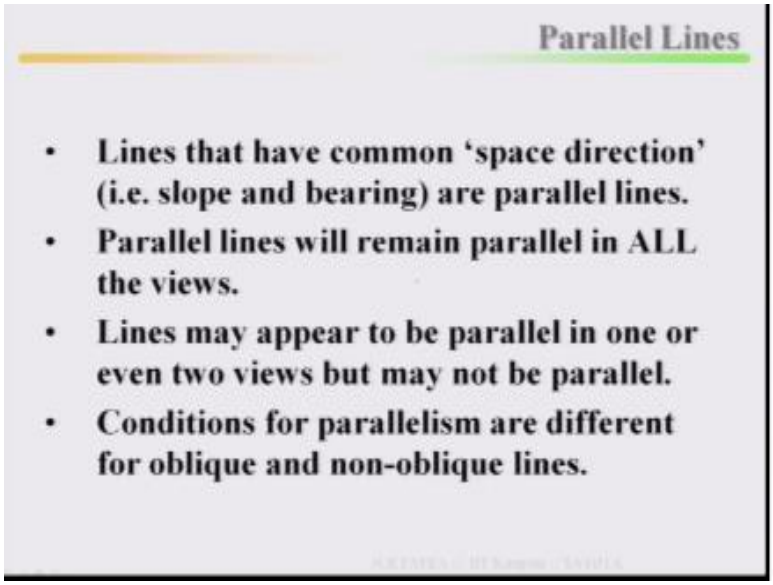

Lines that have common space, direction, slope, and bearing are parallel lines, lines that have common space direction are parallel lines, parallel lines will remain parallel in all the views, all the views. Lines may appear to be parallel in one or even two views but may not parallel, conditions for parallelism are different for oblique and non oblique lines.

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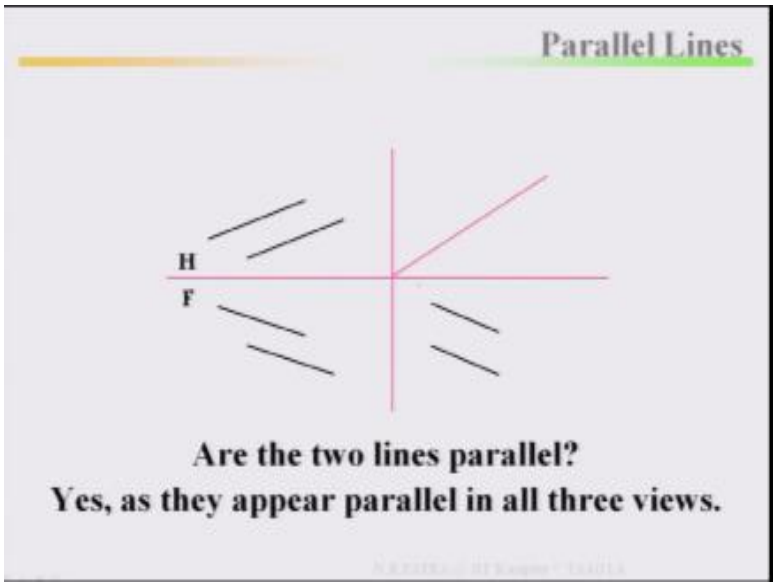

Look at here, are the two lines parallel? Yes, as they appear parallel in all three views.

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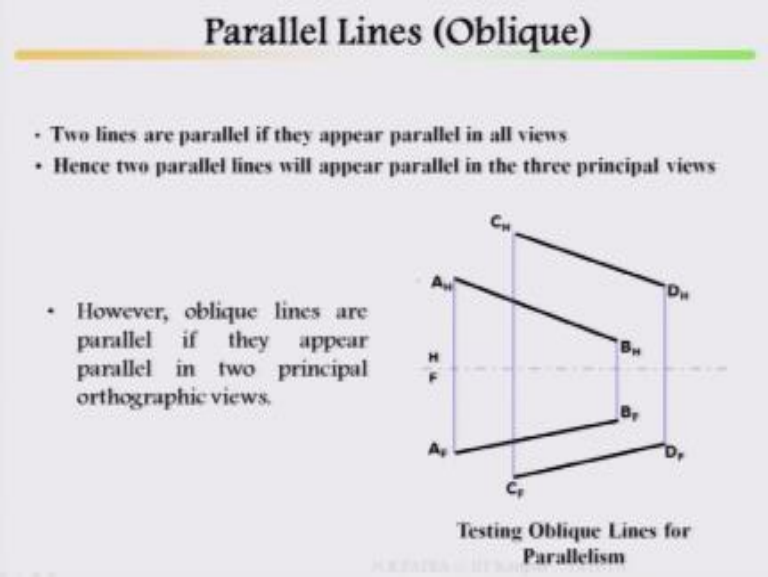

Parallel lines oblique two lines are parallel if they appear parallel in all views, hence two parallel lines will appear parallel in three principle views, testing oblique lines for parallelism, take it look at here, both this views top and front it is parallel, however oblique lines are parallel, if they appear parallel in two principle orthographic views.

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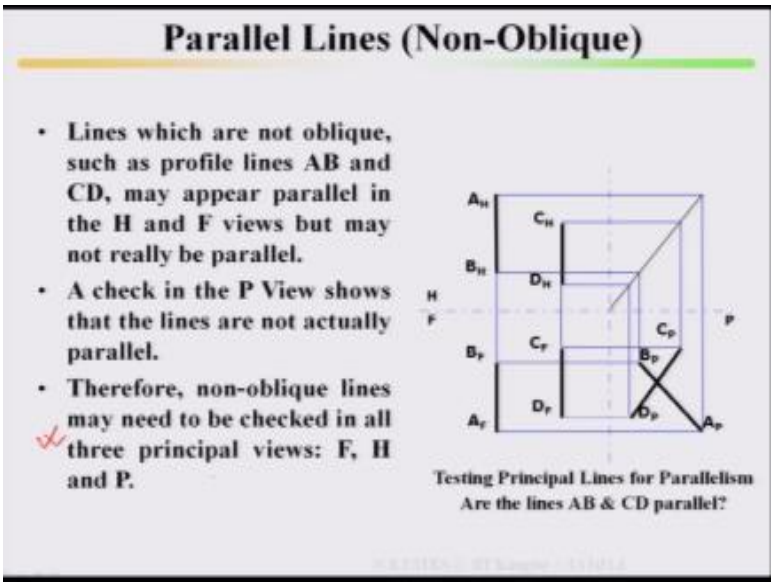

Then look at here, in this case parallel lines non oblique, see lines which are not oblique such as profile lines AB and CD may appear parallel in horizontal and frontal view but may not really be parallel, here lines appear parallel in top view and front view it is not necessarily that it is going to be parallel in profile view.

A check in profile view shows that lines are not actually parallel, therefore non oblique lines may need to be checked in all three principle views, remember this point, therefore for non oblique lines may need to be checked in all three principle views front, horizontal, and profile view.

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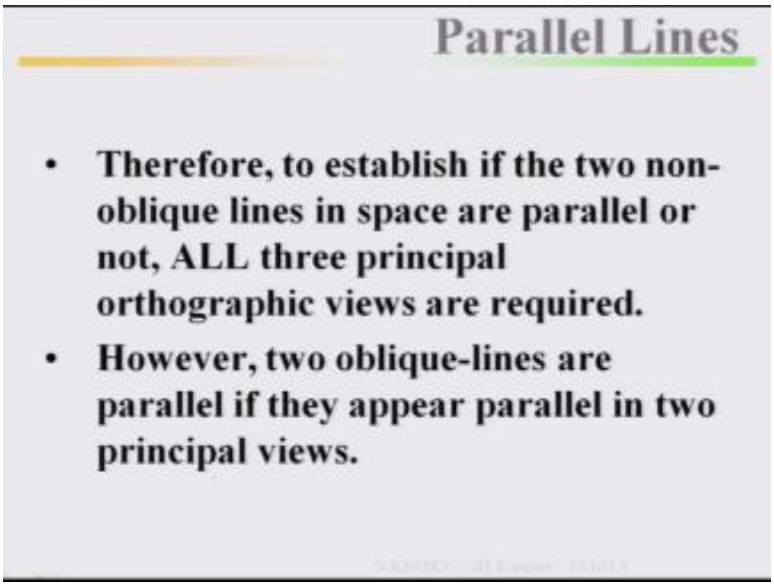

Therefore to establish if two non oblique lines in space are parallel or not all three principle orthographic views are required, I am talking about non oblique lines, however two oblique lines are parallel if they appear parallel in two principles views, if they appear parallel in two principle views.

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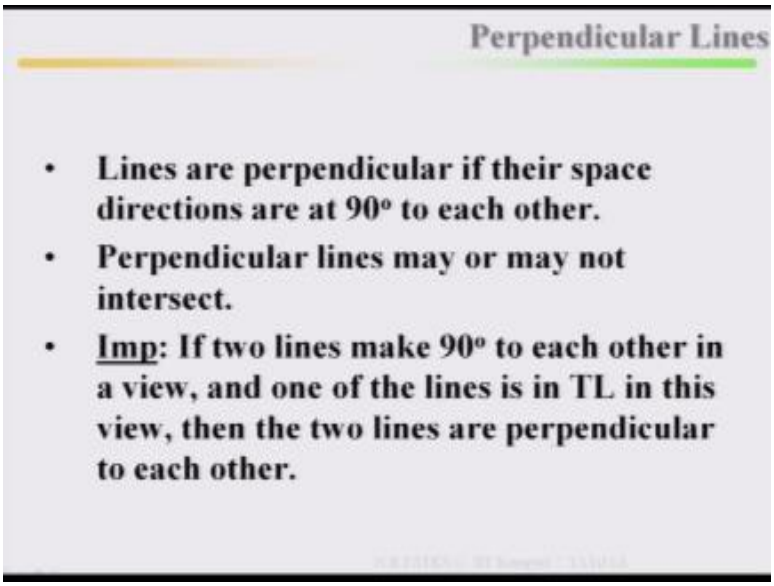
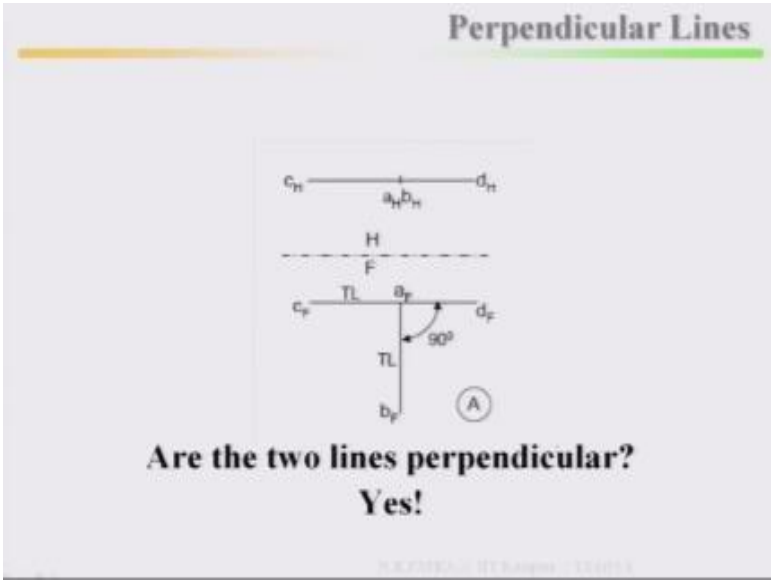


Lines are perpendicular if their space directions are 90 degree to each other, perpendicular lines may or may not intersect, if two lines make 90 degree to each other in a view and one of the lines is in true length in this view then the two lines are perpendicular to each other, if two lines make 90 degree to each other in one in a view and one of the lines is in true length in this view conditions look at, 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.

(Refer Slide Time: 24:30)



Are this two lines are perpendicular to each other? Yes .

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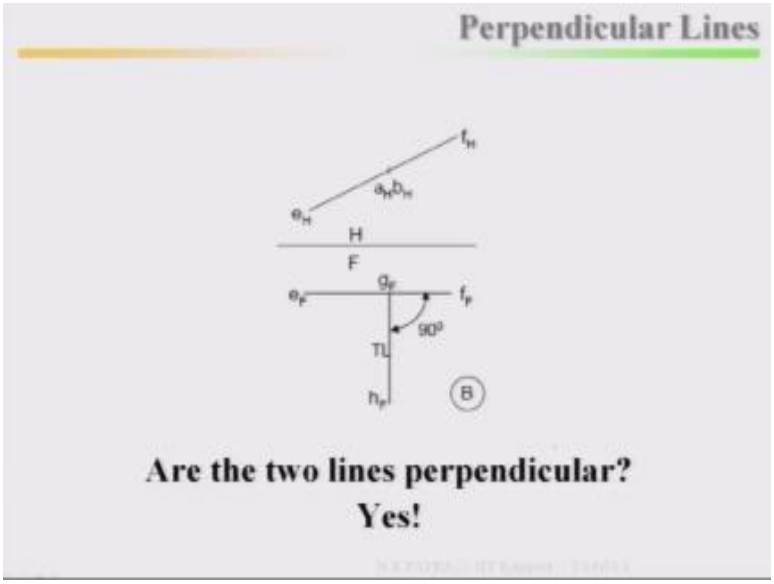

As per the condition, are these two lines are perpendicular to each other? Yes.

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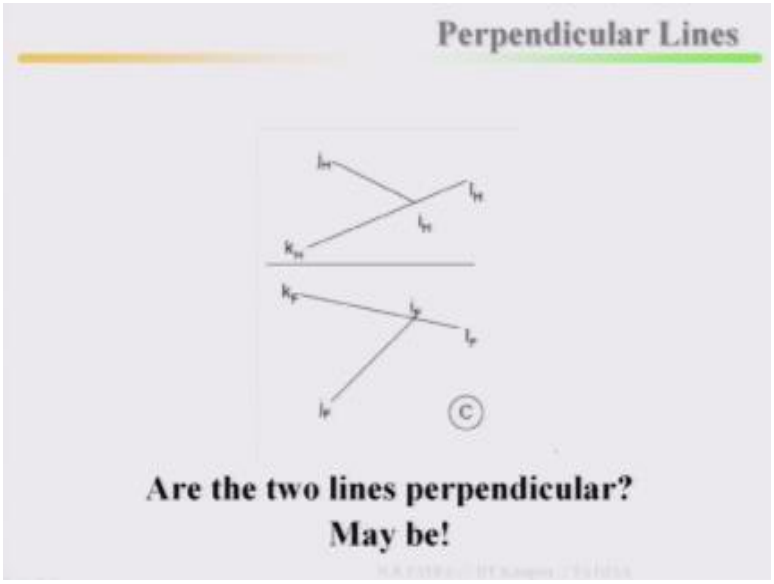

Are the two lines are perpendicular each other? May be!

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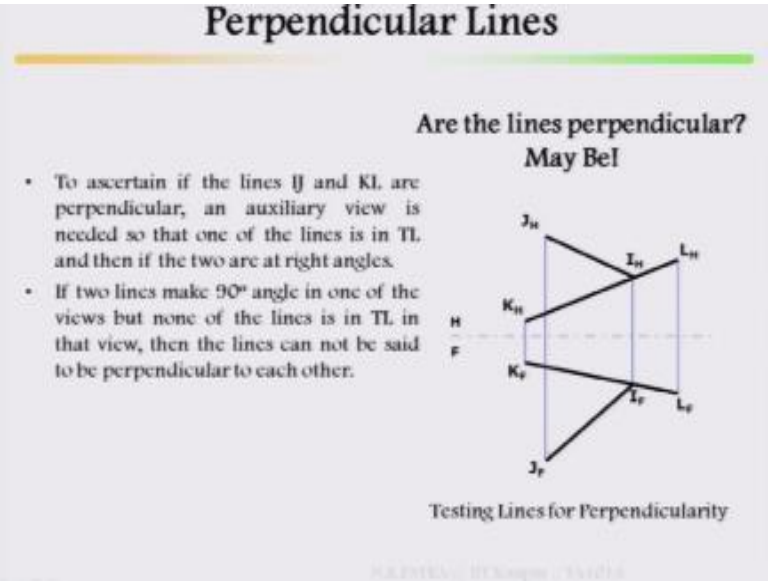
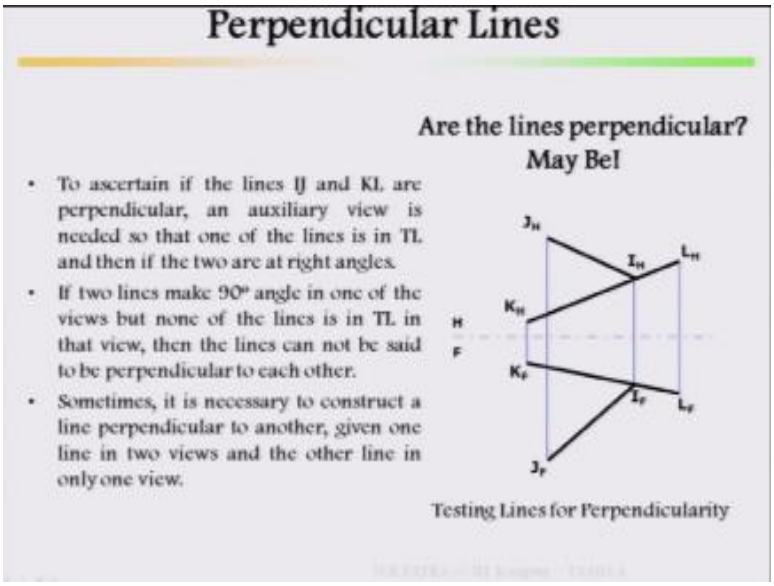


Look at here, perpendicular lines testing lines for perpendicular, perpendicularity whether the lines are perpendicular or not, draw the lines horizontal, frontal view draw it, are these lines perpendicular? May be, to ascertain if the lines IJ, KL are perpendicular an auxiliary view is needed so that one of the line is in true length, then if the two are right angles.

You have to take auxiliary view, then one of the line should be true length then both are perpendicular, then you check whether both are perpendicular or not right angle to each other or not, if two lines make 90 degree in one of the view but none of the lines is in true length in that view, then lines cannot be said to be perpendicular to each other, that means one of the line has to be in true length.

(Refer Slide Time: 25:52)



Sometimes it is necessary to construct a line perpendicular to another given one line in two views and the other line in only one view, these are the kind of say you can check whether lines are perpendicular or not.

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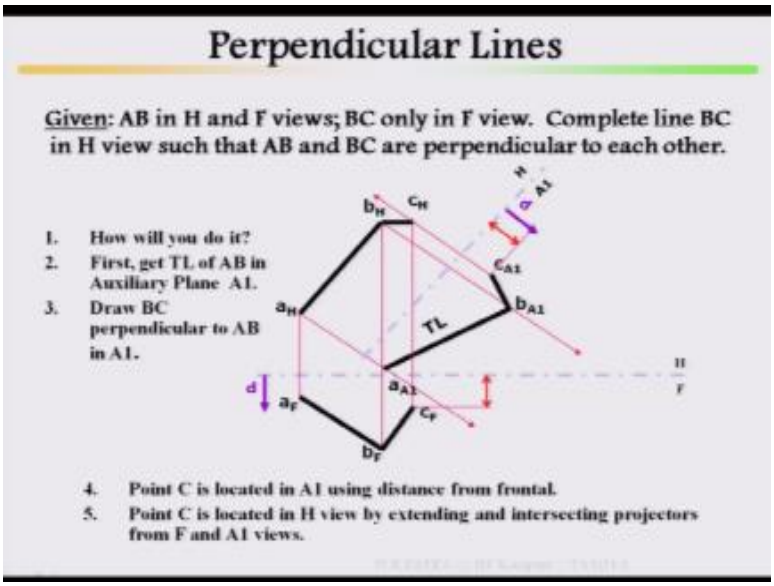

Given AB in horizontal as well as frontal view then BC only in front view, this BC is not given in the top view compete line BC in horizontal view, how will you do it? First get the true length of AB in auxiliary plane A1, draw it, measure the distance then find it out true length of the line AB then draw BC perpendicular to AB in auxiliary A1, right?

Then point C is located in A1 using distance from frontal, distance from frontal point C, then point C is located in horizontal view by extending and intersecting projector from front and auxiliary view, look at from point C I project it back, then from here front view it has been projected back and you locate point C then you get it.

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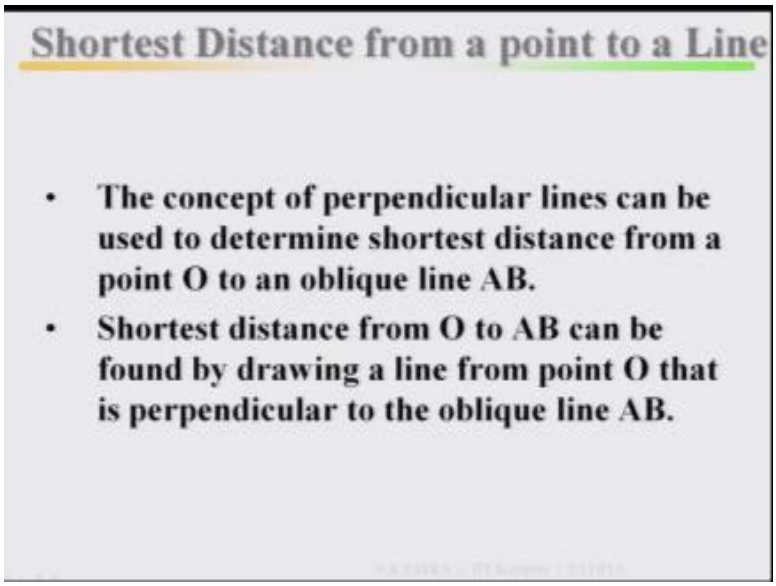

Then second concept is your shortest distance from a point to a line, shortest distance from a point to a line, the concept of a perpendicular line can be used to determine shortest distance from a point O to an oblique line AB, shortest distance from point O to AB can be found by drawing a line from point O that is perpendicular to the oblique line AB.

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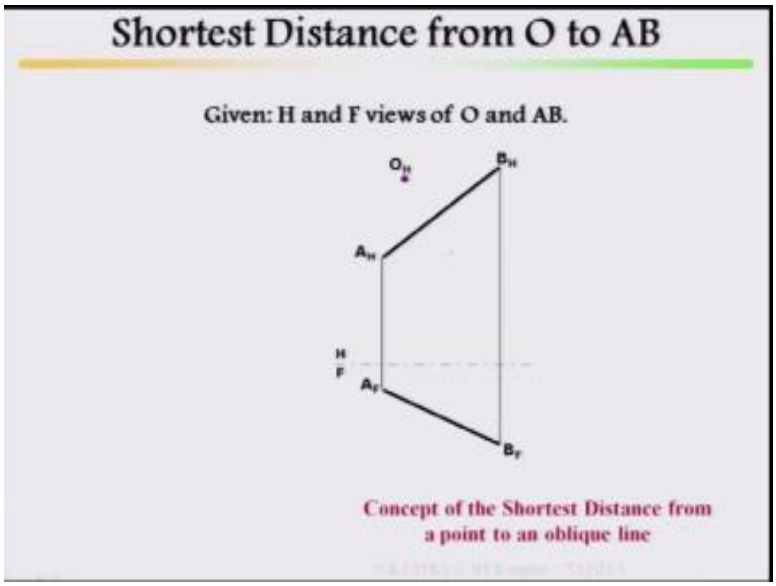
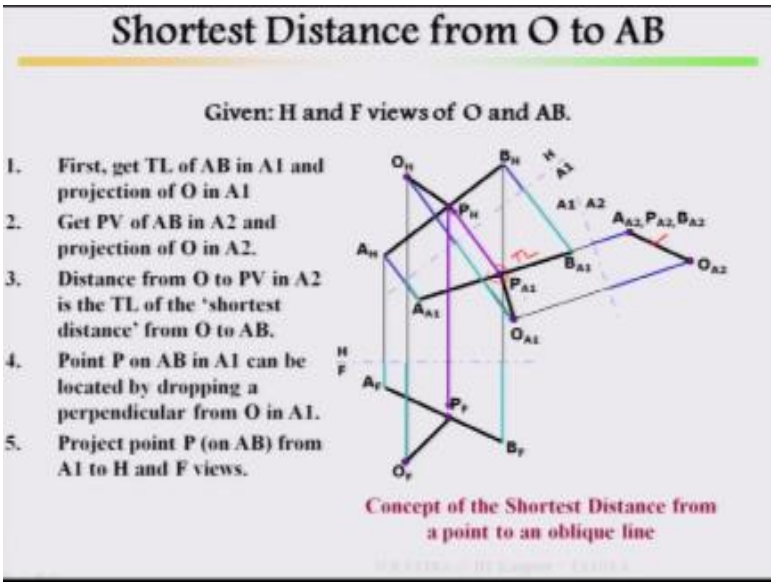


H and F view of O and AB, concept of shortest distance from a point to an oblique line this is your oblique line, this is your oblique line, then there is a point, how do you know that? In the space this point and this line will be somewhere else, how do say that it is the shortest distance? That means this line has to be converted to an true length, then bring back this point to that plane then draw perpendicular. So that you can say that this is your shortest distance.

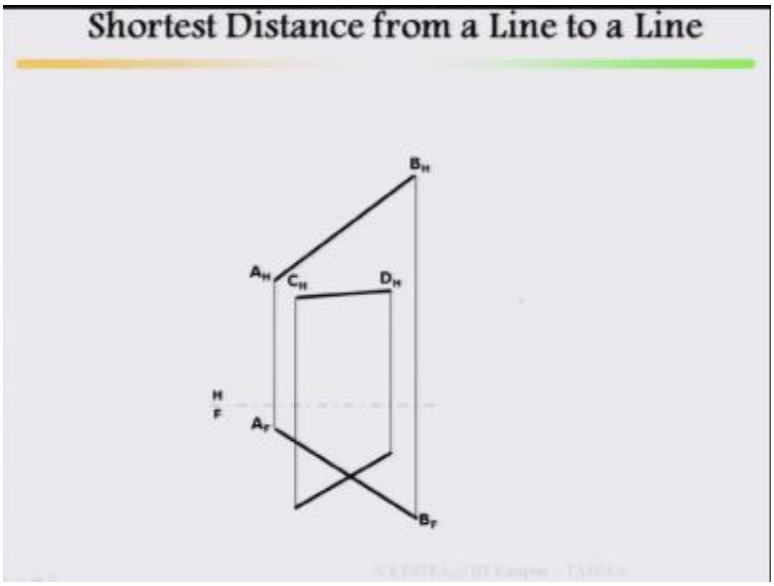
(Refer Slide Time: 28:23)



First get as I said true length of AB in A1, projection of O in A1, draw it back find it out true length, this is your true length AA1, BA1 then point OA1 then, then draw it back from point O draw it back. So you will get line as a edge view that means that is appoint here AA2, BA2 and BA2 then this line this point has been extended, extended. So then join this two points then point P, point P on AB in A1 can be located by dropping a perpendicular from O in A1.

This is your true length, from here you draw a perpendicular so this will be your shortest distance. So project P on AB, from A1 then this is your PH then project PAB in your front view then join, join OPF, OFPF, OHPH then OA1 and PA1 is your shortest distance.

(Refer Slide Time: 30:01)



Now earlier we have discussed about shortest distance.

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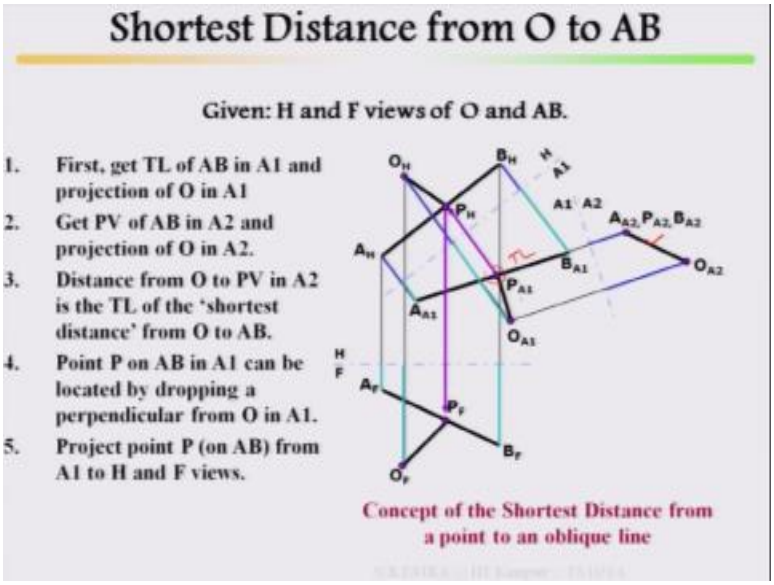

From a point to line.

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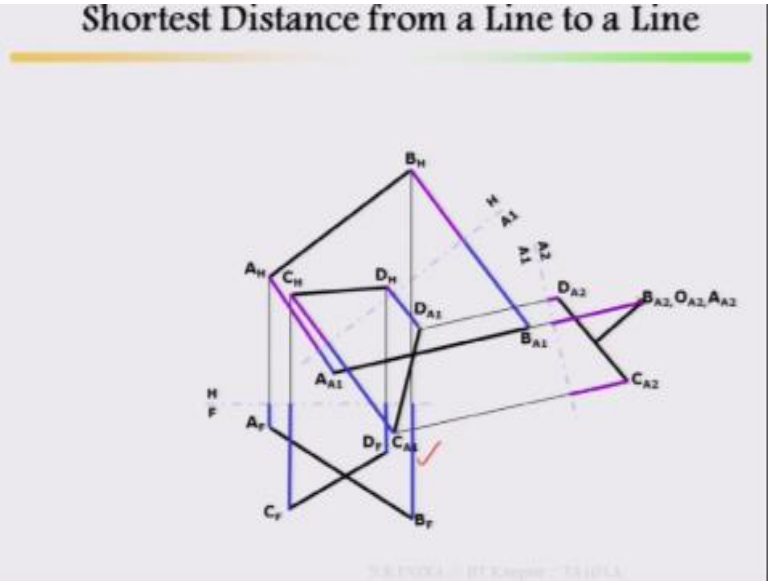

Now in this case shortest distance from a line to line, we will go one by one there are two lines A,B and C,D, top view and front view has been drawn, then take one auxiliary plane then from there measure the distance opposite distance, these are the opposite distance from the opposite view. Then draw the auxiliary plane, from there measure the distance from the opposite view that is from the front and this distance you have to locate and make it draw the line, this is your true line of A,B, then join it then you are getting a point of intersection.

Then this line has a edge view another auxiliary plane you take it, this line has a edge view that means edge, this line true length edge view this is your point, this is your point view then this line again you project it back, join it, then from that line draw perpendicular particularly in this case what happen if there is a shortest distance between two lines. One line has been converted to one line you find it out its true length, step one. Then from true length you convert it into point view, from point view you take out in same way you project the other line then you are getting.

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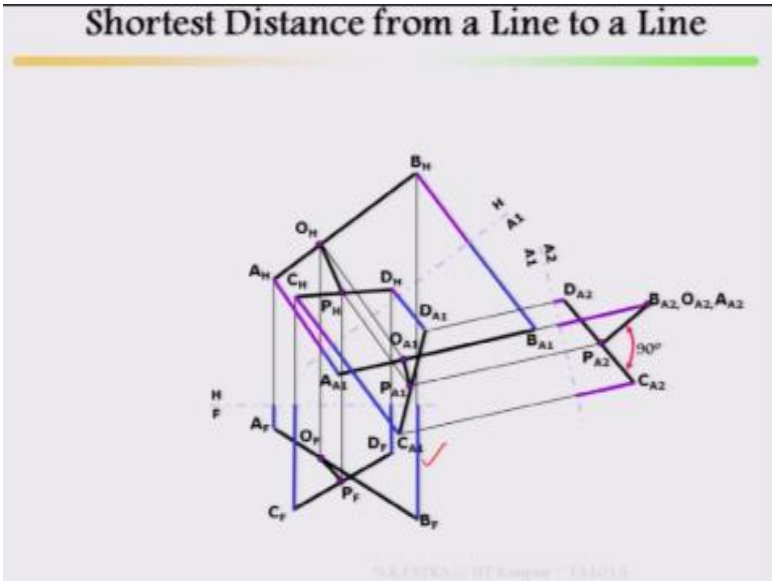

A point view of that line true length then other line draw perpendicular, so this is your shortest distance and this distance has been this point P, this is your 90°, this is your point P this point P has been traced back in the two views front view as well as top view, project it back, locate it where it is C,D where it is lying then join from there C,D to you join it project it back A,B locate it then same thing you project it back this to C, D then from there again you project it back A,B then join, then join, then you join. This shortest distance has been project it back in top view as well as in front view.

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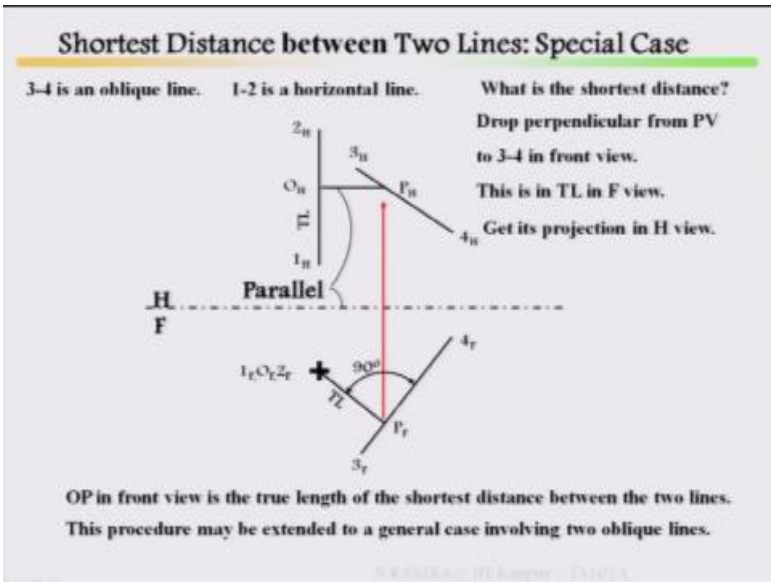

Shortest distance between two lines special case, look at this. 1, 2 is a horizontal line, 3, 4 is an oblique line. What is the shortest distance? Very easy 1, 2 is a horizontal line, the moment you look at this will look as a point view, then from there you draw, the line is there draw perpendicular, that means it is parallel to, it is parallel to one of this it is in true length 1, 2 is in true length because it is parallel to one of the principal planes, so then you project back then this is your point of intersections.

So this is your parallel line, then project it back, OP in front view is true length of the shortest distance between the lines. This procedure may be extended to generate case involving two oblique lines.

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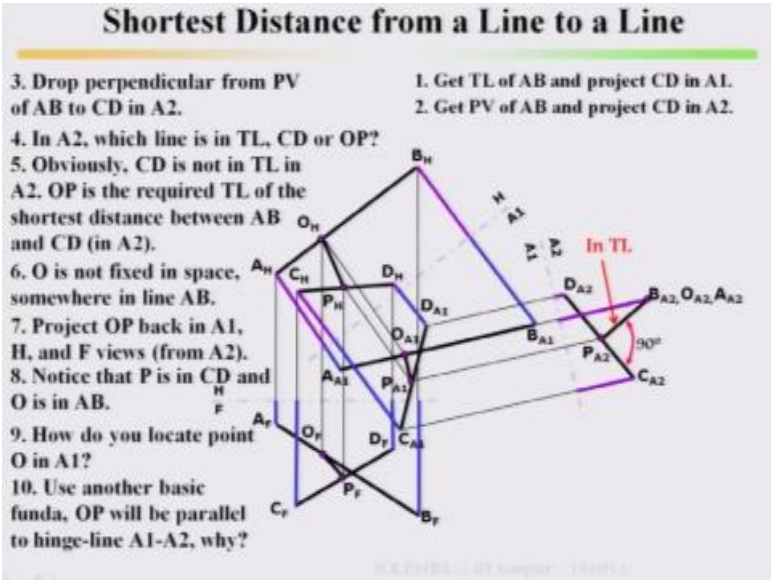

Look at this, this is what I have discussed 90° then you project it back, first you take one of the true length then take the edge view as a point, then same line has been extended, draw the projections so this the shortest distance in true length, this shortest distance has to be project it back, we are other views.

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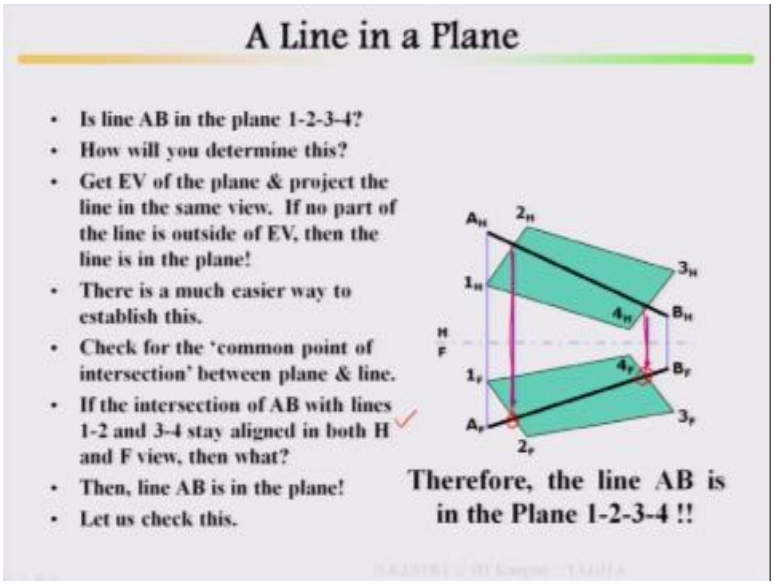

A line in a plane, is the line AB in the plane 1234? How will you determine this? Get edge view of a plane, edge view of the plane and project the line in the same view. If no part of the line is outsides the edge view, outside of the edge view then the line is in plane that means you take the edge view and project the line to there. If no part of the line is outside of a edge view then line is in the plane. There is a much easier way to establish this. Check for common point of intersection between plane and line. If the intersection of AB with lines 1234 stay aligned in both horizontal and frontal view, than what?

Then line AB is in plane, then line AB is in plane. Let us check if intersection of look at this point, if the intersection of AB with the line 12, AB with line 1234 stay align in both horizontal and front view then line AB is in plane. What happen aligned or not I draw the project here, project it back, whether it is touching the same point AB and line in the front view. Again I draw it the projection back, whether it is touching the same point in the line and plane, here in the frontal view, so that means then line AB is in plane. Therefore, line AB in the plane 1234 this is a check.

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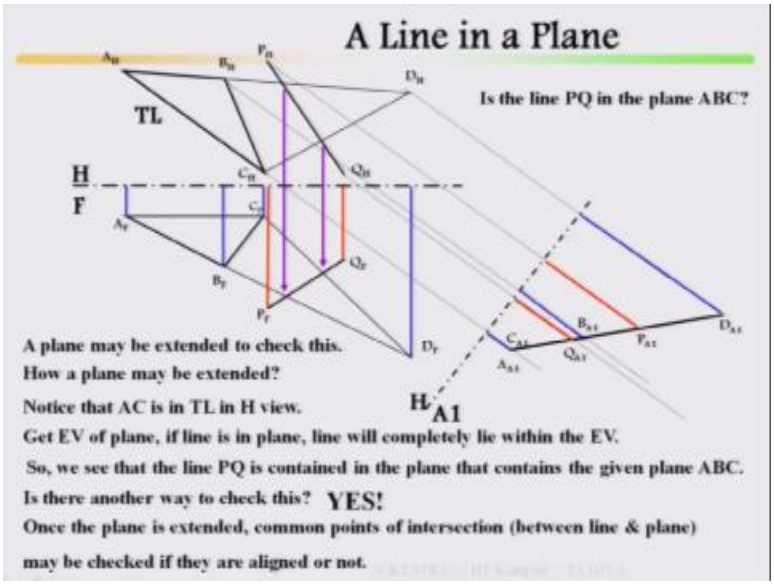

Look at the another example, a line in a plane is the line PQ in the plane ABC, is the line PQ in the plane ABC we do not know this is in the space we do not know. Then what is the shape, a plane may be extended to check this plane can be extended. How a plane may be extended? Look at any of the line has been extended, plane has been extended. Notice that AC is in true length, AC is parallel to here it is in true length. AC is true length here AC is parallel to your hinge line that means opposite view it is in true length.

Get edge view of plane, if line is in plane line would be completely lie within the edge view. This is in the true length extend it, this plane has been extended so that the line has been covered, here it has been extended, so that line has been covered. Then get the edge view of the plane, extended plane, so it will be a line then extend that line it will be a line of the plane, then extend that line PQ along the same plane and check. It is another way of checking whether a line is in a plane or not here, the line is in the plane.

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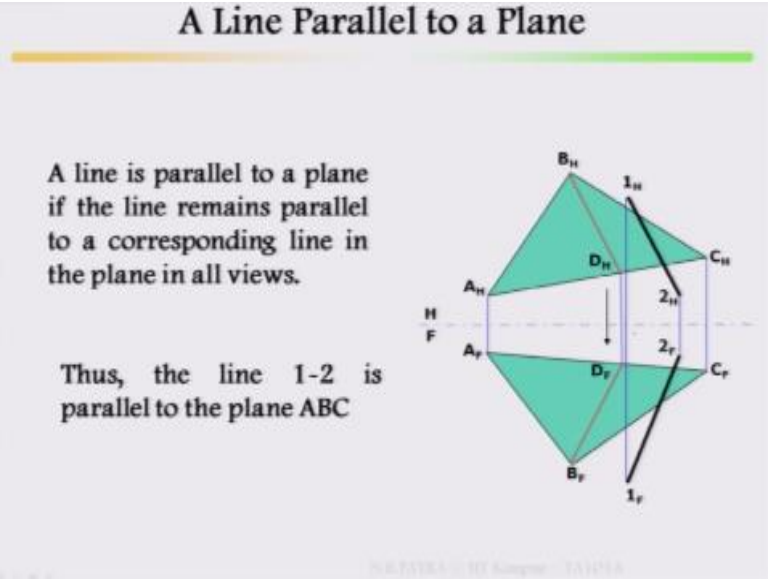

A line parallel to a plane, a line is parallel to plane if line remains parallel to corresponding line in the plane in all views. A line call to be parallel to plane, if the line remains parallel to a corresponding line in the plane in all views, see there is a line 1, 2, line 1, 2 is parallel to plane ABC, because it remains same in both the views. So thank you all for this, I will start next class it is now line and plane. I have covered line, line, line plane. Now we will intersection of plane, plane and line, line how far it will go. Thanks.

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