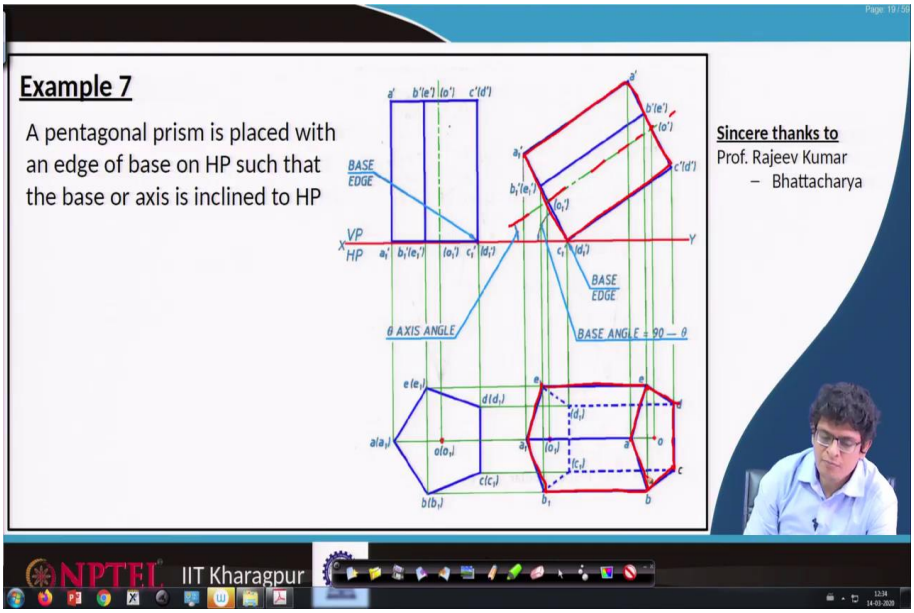
Engineering Drawing and Computer Graphics
Prof. Rajaram Lakkaraju
Department of Mechanical Engineering
Indian Institute of Technology, Kharagpur

Module – 04
Orthographic Projections II – Projection of solids
Lecture – 44
Projections of Solids - III

Hello all. Welcome to our NPTEL Online Certification Courses on Engineering Drawing and Computer Graphics. We are covering 'Projection of Solids'

(Refer Slide Time: 00:22)



In today's class, we will look at more complicated three-dimensional objects when they are inclined towards the planes, how to draw those pictures.

For example, here we have a pentagonal prism which is the place with an edge of the base on the horizontal plane, such that base or axis is inclined to the horizontal plane. So, either the base is a pentagonal prism that means, 5 sides is entire base or axis, whatever might be that is inclined to the horizontal plane.

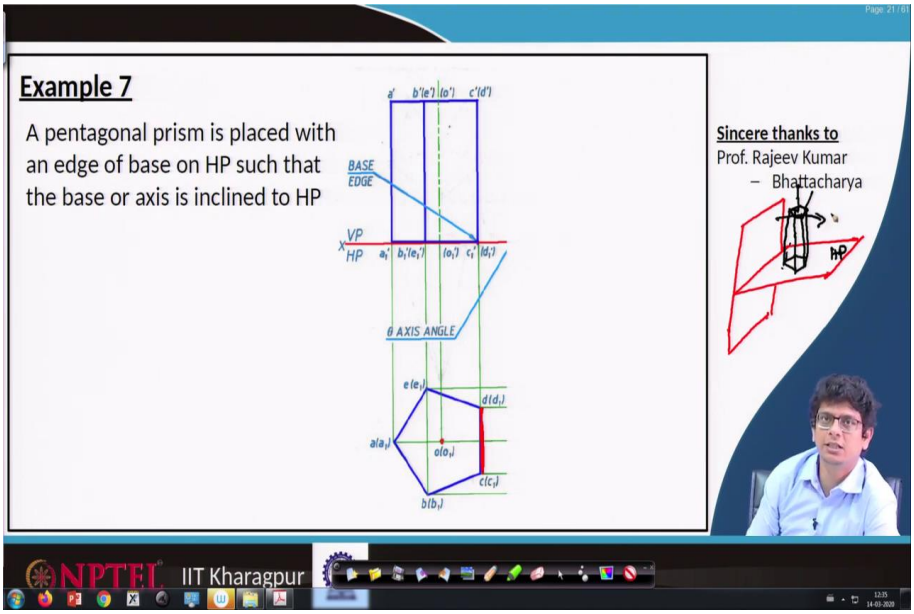
Now, this axis is neither perpendicular to the vertical plane nor this horizontal plane. So, slightly tilted kind of thing, ok. For example, if we are picking these pentagonal prisms in one of the views, maybe the axis especially in the front view because axis is inclined to a

horizontal plane that we can observe only in the vertical plane, front view. So, in that front view, we will see this axis is inclined to the horizontal plane.

So, after drawing we see that the prism perhaps inclined in that way. If that is the case, if we are looking at top view it will not give us straight forward pentagon or perhaps something like a rectangular box something like this kind of object shape, we will see. How to do that step by step? That is a thing what we are going to learn it in this lecture.

So, to do that inclined axis first of all what we will do is we will construct a pentagon resting on this horizontal plane.

(Refer Slide Time: 02:42)



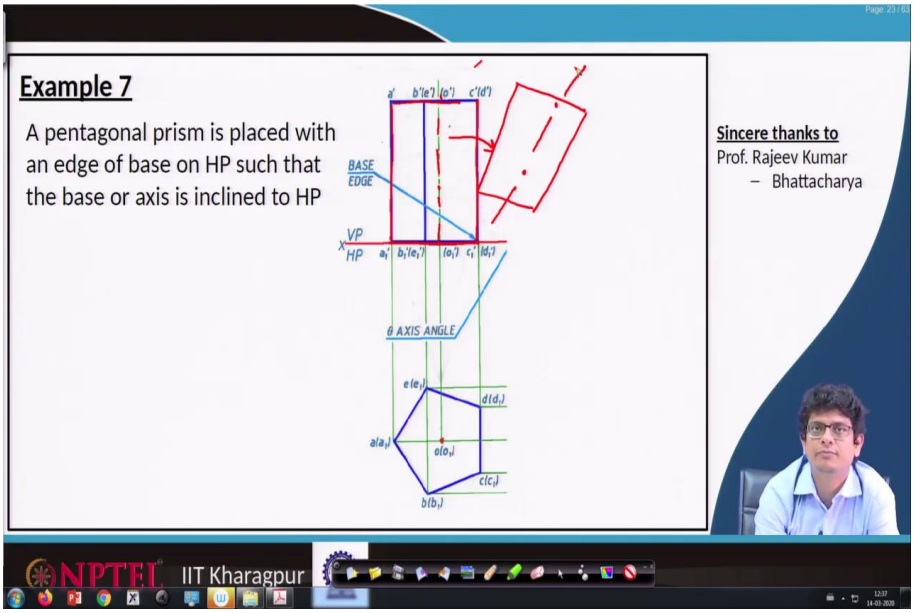
So, one of the edge, we make sure that it will be perpendicular to the vertical plane. So, it is more like if we have this prism first what we will do is we construct in such a way that this entire prism, so in the top view we will see something like such kind of thing, so where the axis is perpendicular to HP.

Then, what we will do is we will rotate it in such a way that this axis may an inclination angle perhaps in that way. So, this entire object tilted in that direction. That is the way we would like to do to do that.

(Refer Slide Time: 03:46)

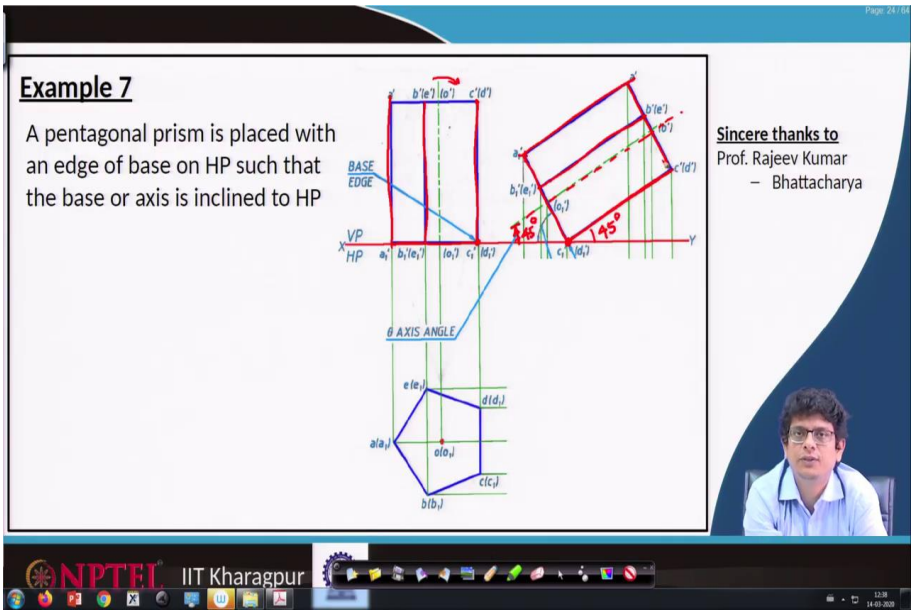
First of all, in the top view on the horizontal plane, we draw a pentagon, where one of this edge or surface is perpendicular to the vertical plane. Now, the projection if we are drawing this entire pentagon in this view front view if we are looking from that this line coincides with that one edge as a surface. This entire surface coincides with this surface. And it is resting on the horizontal plane, so this line always coincides.

(Refer Slide Time: 04:38)



Now, what we want to do is rotate this entire object in this direction. That means, basically the axis what we are having, dash-dot line this has to be rotated in that direction. So, all this line has to be rotated in that direction. This entire line has to be rotated in that direction and this one also in that direction. In that way, if we can make it our axis goes in that way.

(Refer Slide Time: 05:21)

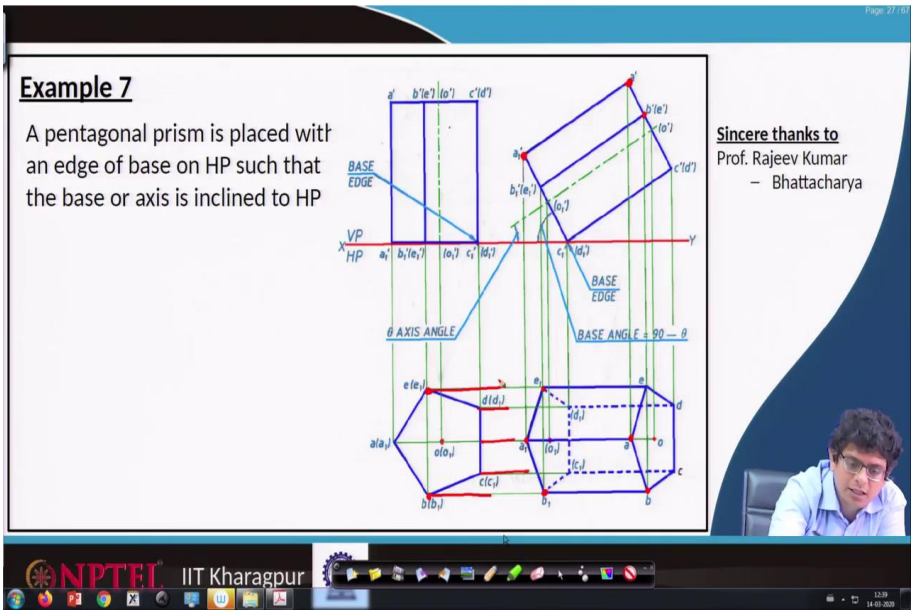


So, when we do that, first of all, we draw an axis making certain inclination angle maybe if it is making 45 degrees, at 45 degrees first we draw an axis. It is rotated about this point. So, this point always is resting on that; using our compass whatever this distance that distance we make an arch, perpendicular to this axis and join that line.

Similarly, when we are rotating this entire thing this a b line also gets rotated. To do that what we will do? c 1 to c' whatever that distance we make that same angle.

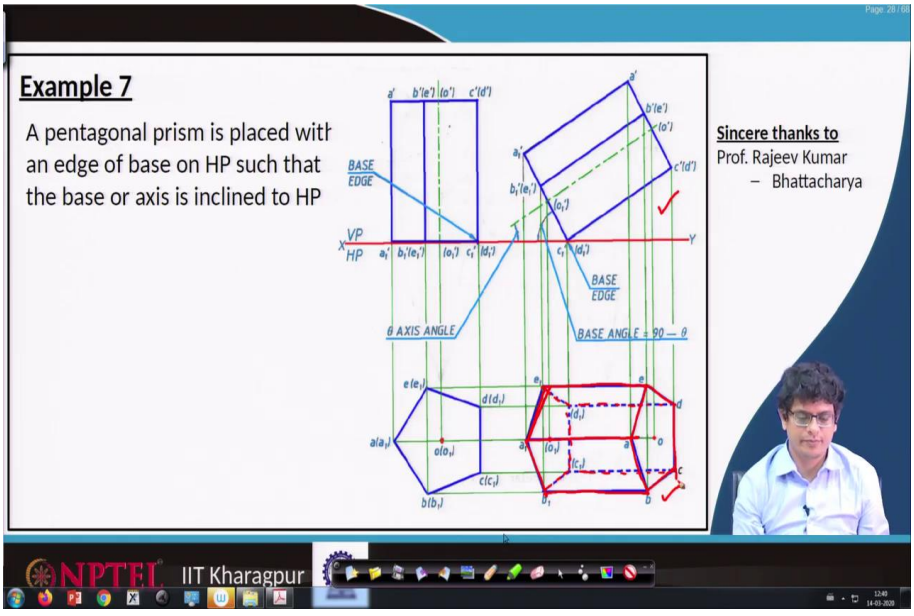
So, if this is 45 degrees let us consider, this one also 45 degrees line, we will draw it from this point. Transfer this length in this direction. Similarly, transfer this length in this direction. Similarly, transfer that length in this direction with the same 45 degrees angle. So, we have tilted that prism which can be visible in the front view.

(Refer Slide Time: 06:54)



Once that is done, we transfer all these points onto the horizontal plane, down. So, these point these points transferred in such a way that this line maps to that, this one maps to that and whatever the b b 1 point and so on.

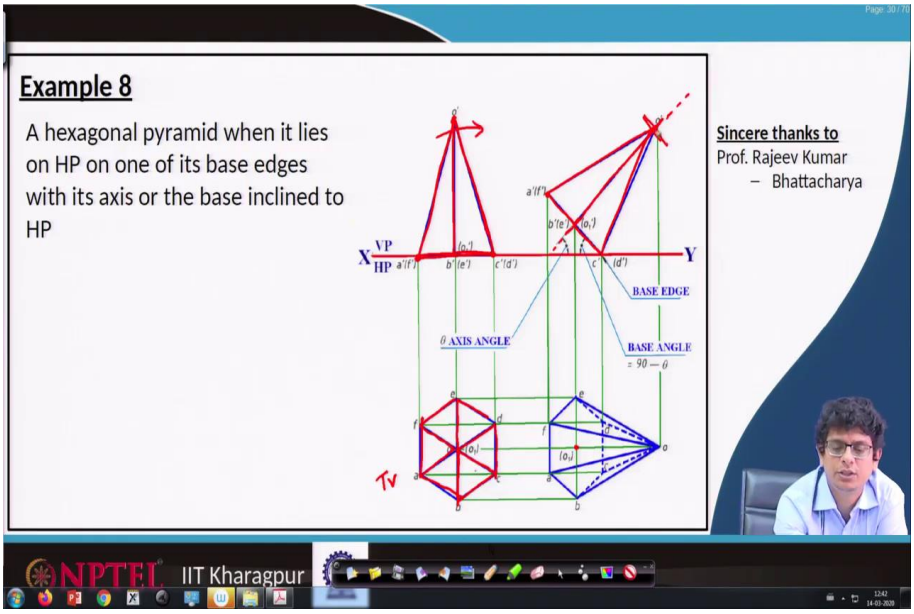
(Refer Slide Time: 07:38)



So, in this way we map these lines, map these points whatever those intersections we are having from that we will be in a position to construct this pentagonal prism. Any invisible side we showed them by dashed lines in that way and this is a continuous line. So, this

pentagonal prism whose axis is making an inclination angle with the horizontal plane in the front view looks like that and in the top view looks like that.

(Refer Slide Time: 08:26)



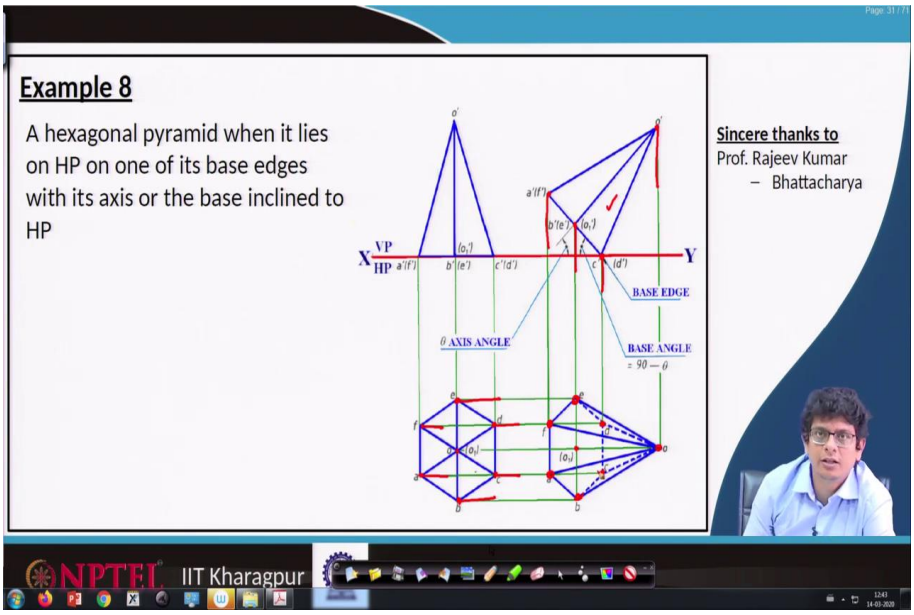
Let us look at another example. A hexagonal pyramid when it lies on the horizontal plane on one of its base edges with its axis or the base inclined to the horizontal plane.

So, we have a hexagonal pyramid and it is resting on the horizontal plane. 6 sides will be there, and one of these base edges with its axis also inclined to the horizontal plane. So, we have to construct in such a way that base and axis are inclined and edge also supposed to be inclined. So, let us look at that example.

So, it is a hexagonal pyramid. So, 6 sides are always there, those 6 sides is a hexagonal pyramid, so all the inclined faces will be visible in the top view. So, continuous lines we will show. And its projection, like a triangle. And one of these lines coincides there.

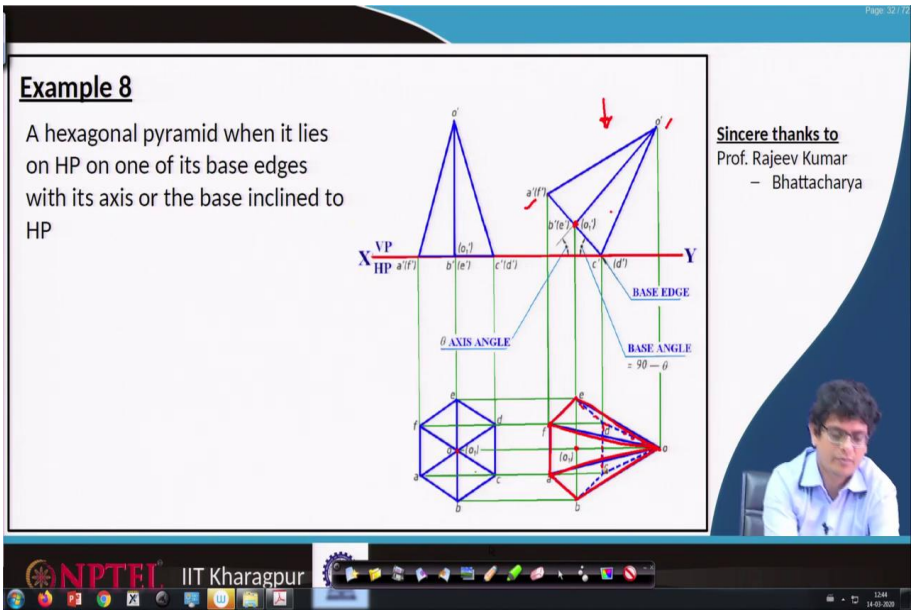
Now, the axis has to be inclined. So, this is the axis, this we rotate it. So, this axis if we are rotating by a certain angle it goes in that way. Transfer this length normal to that. Similarly, transfer these lines in that way is more like from here measure the distance, make an arc; similarly, from here whatever that distance makes an arc from that point. So, intersection point joins, so that we will have this part.

(Refer Slide Time: 10:39)



Now, transfer all these points on the horizontal plane. Similarly, transfer these points on this horizontal plane thing. These points intersect at this level.

(Refer Slide Time: 11:22)

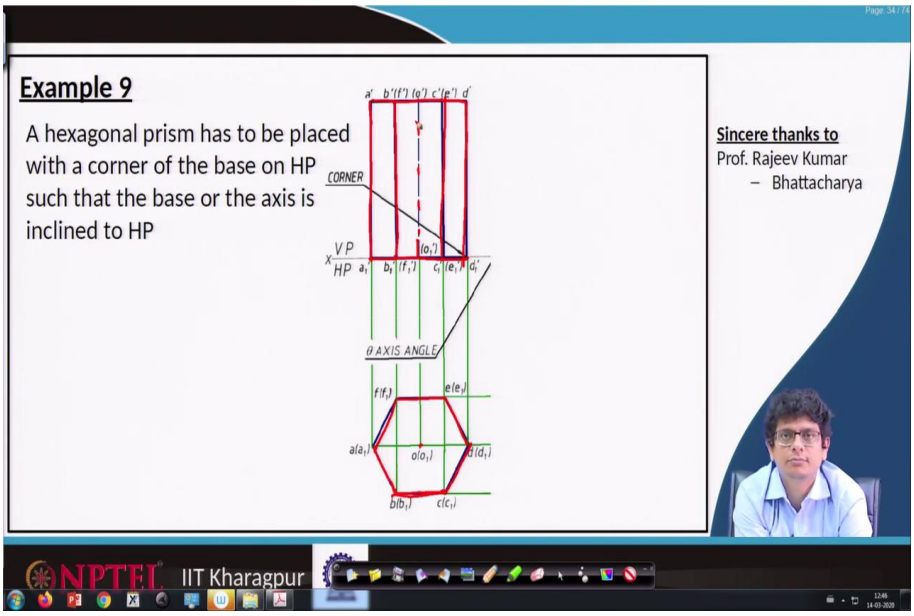


Now, identify the lines which are visible when we are looking from this direction will be seeing a' o o' lines that means, a to o will be visible. Similarly, f' o' that face also visible. So, it will be that. Definitely, a to f' whatever this line we can see that is also visible.

Now, b surface b to o when we are looking from that direction that is also visible. a to b surface also visible. Similarly, f to e surface, so f backside of that e is there that is also visible. f to o also visible and that e point to o also visible. So, this is the way cone looks like in the pyramid.

And the other internal things at the backside of that is not visible. So, it goes in that way. And this c to d line also invisible, so we will have that dashed line. So, the overall construction gives us the front view looks like an inclined one and the top view makes this obscured kind of pyramid.

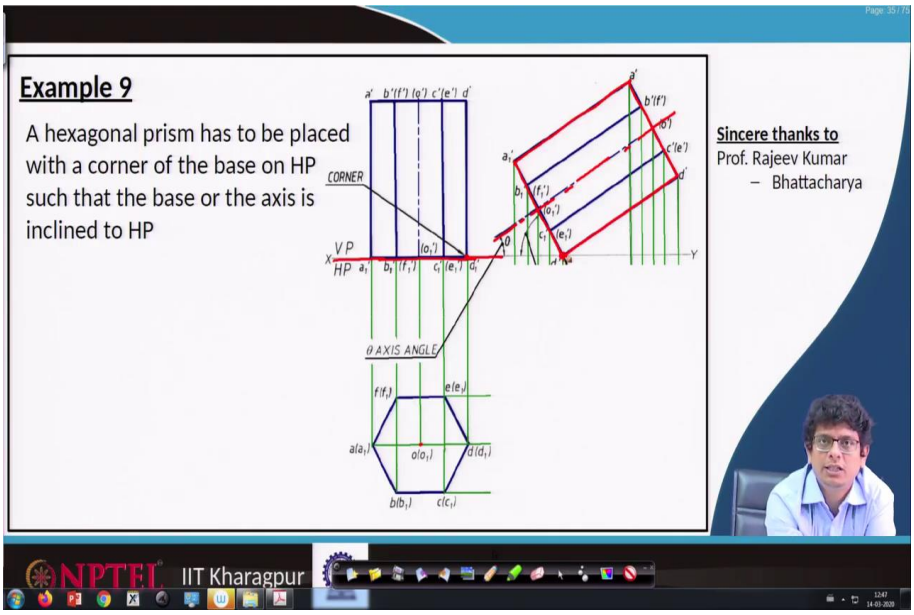
(Refer Slide Time: 13:08)



Now, let us look at another example. A hexagonal prism has to be placed with a corner on the base of the horizontal plane, such that base or axis is inclined to the horizontal plane. Think about it what are the points resting on the horizontal plane, is the axis incline with the horizontal plane or vertical plane. In what sense? And the corner of this hexagonal prism of that base is on HP. So, let us look at that example.

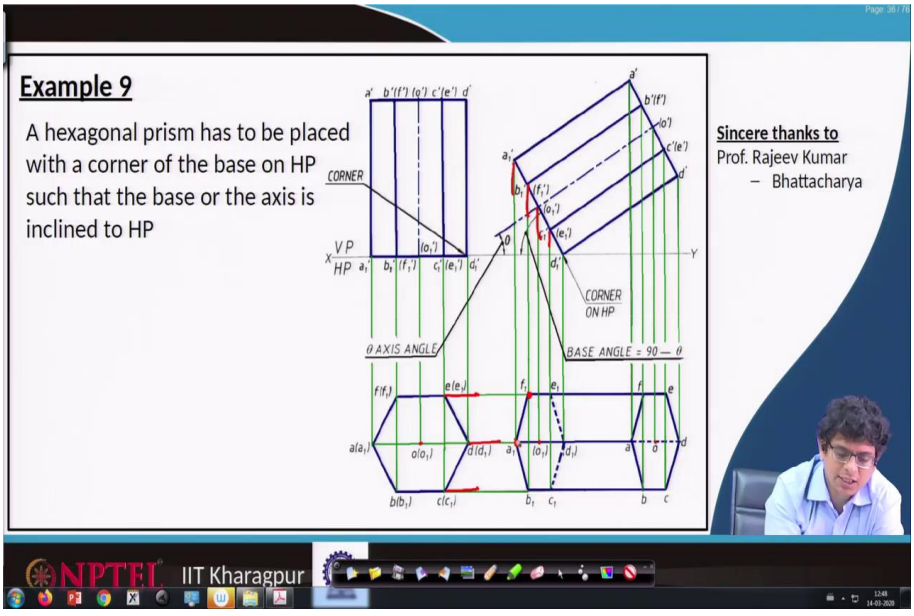
So, first, it is a hexagonal prism whatever might be the inclination angles, first begin with a picture, then suitable rotations we make it so that the given conditions will be met. So, first, draw a hexagonal prism. In the front view, it looks like a rectangle. This face entirely we can see, goes in that way. Axis is invisible, so dash-dot lines.

(Refer Slide Time: 14:55)



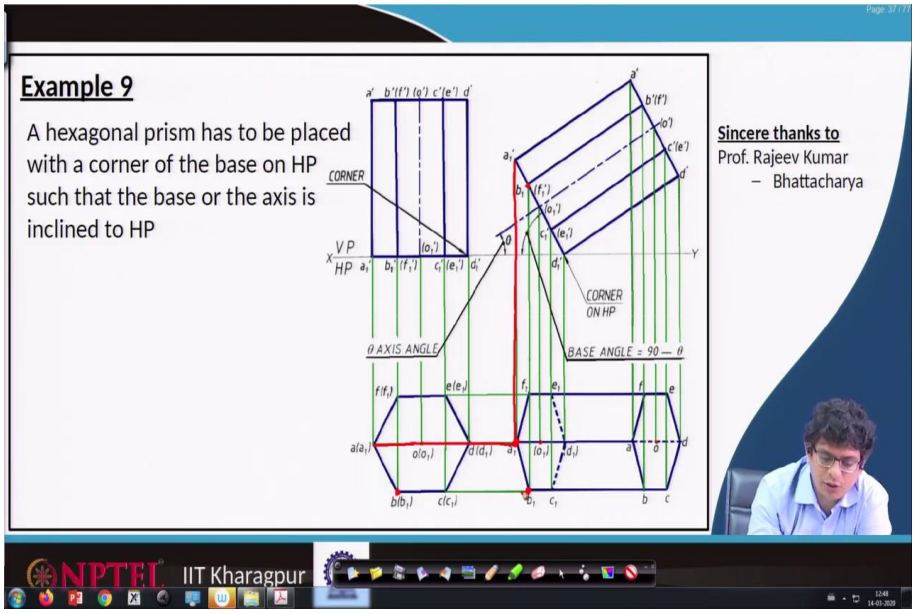
And axis is inclined to that horizontal plane which we can sense it only in the front view. So, the axis dash-dot line. Transfer all these lines, so that we will see, this one. If we are carefully noting corner of that base is always be resting on the horizontal plane, that is the reason we made it to rest it on this horizontal plane and this corner still rests on that horizontal plane. So, this point always is on that ground.

(Refer Slide Time: 15:49)



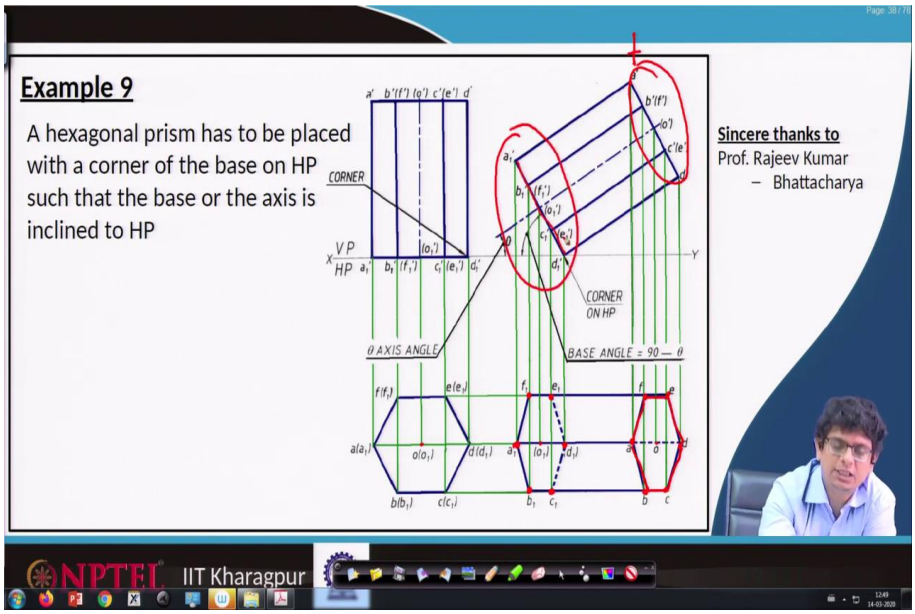
Now, project these points from top view on the from the front view and also from this direction. From here transfer the points, so that it intersects. So, one has to be careful.

(Refer Slide Time: 16:16)



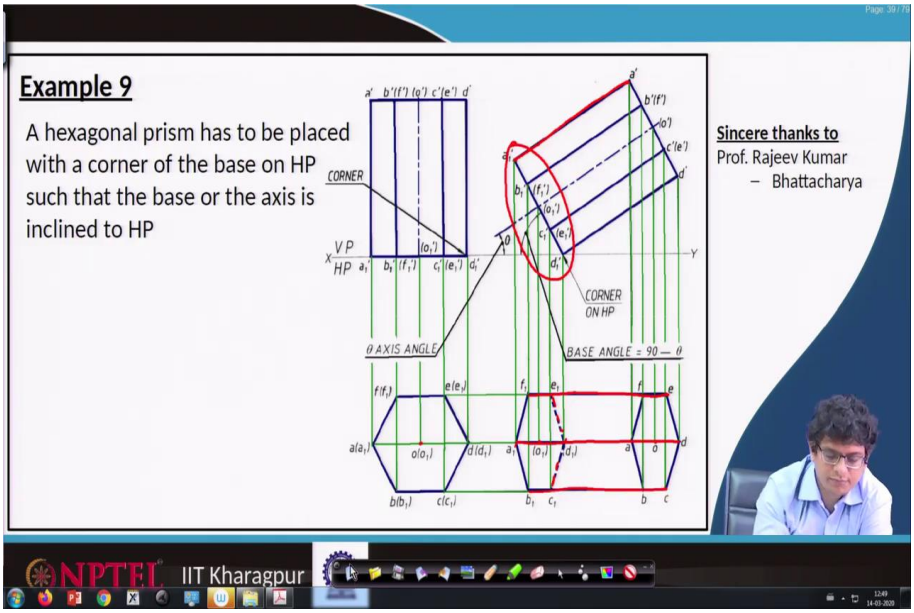
Let us transfer a from this direction. It goes somewhere. Similarly, a 1' transfer it, where they are intersecting first look at that point a. Then move from b, move from b, where they are intersecting locate those points.

(Refer Slide Time: 16:37)



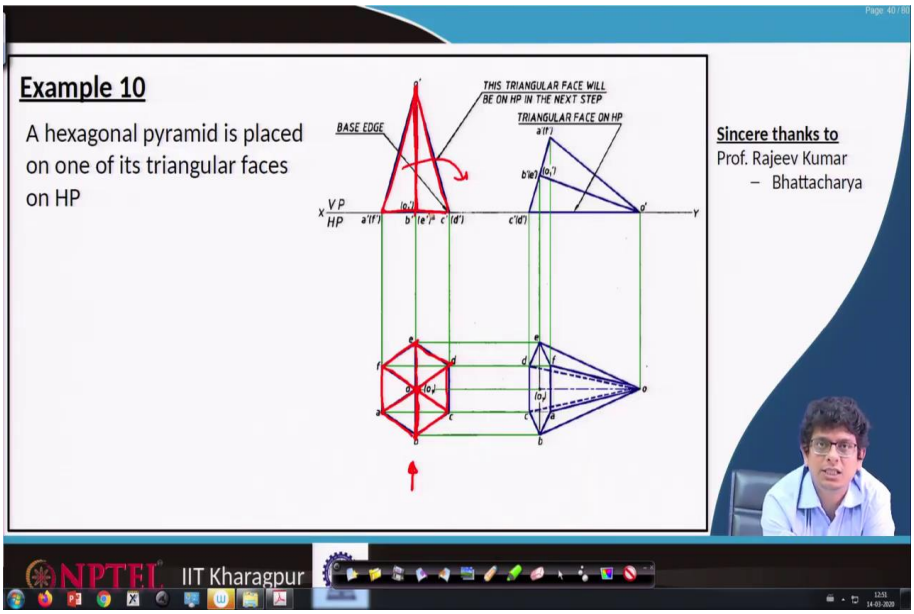
Similarly, c map to that point c map to that point d e 1 f 1, similarly on the other side a' e' c' d' points gives us this information. When we are looking from top view this entire plane will be visible. So, that one what we are seeing it as a hexagon. When we are looking at this most of this hexagon is invisible other than the edges. So, internal things are invisible. So, there is a reason we have this one.

(Refer Slide Time: 17:16)



And this one is visible. So, we have a continuous line. These edges are also visible that is a reason these are continuous lines.

(Refer Slide Time: 17:42)



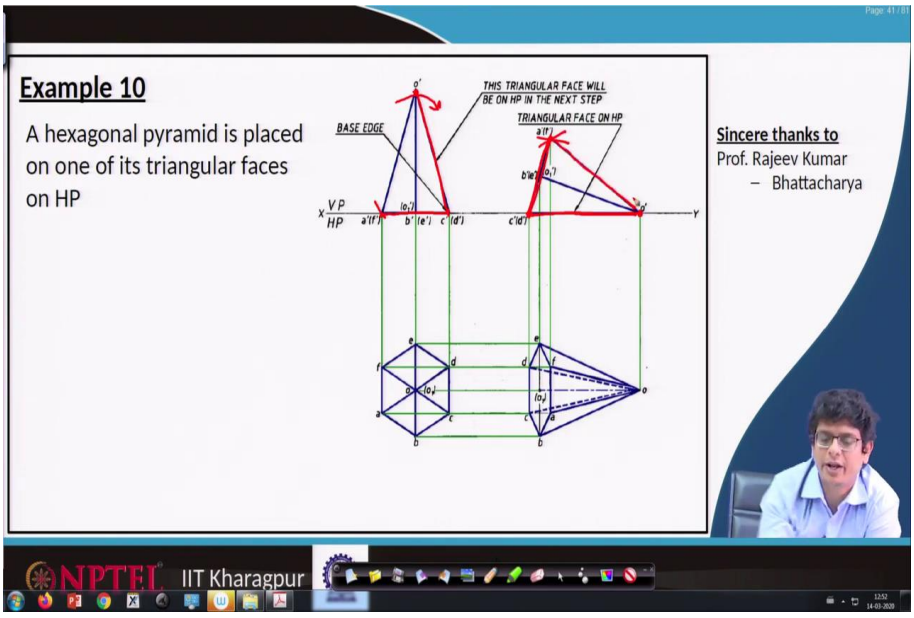
Let us take one more example. It is a hexagonal pyramid. Pyramid means we have this apex or vertex and it is placed on one of its triangular faces on the horizontal plane.

So, we have a pyramid which is laying on that horizontal plane. So, the face is always be touching that horizontal plane. If that is the case what we have to do is first rotate it in such a way that is resting on the horizontal plane with its base.

So, when this pyramid, hexagonal pyramid resting on the horizontal plane with its base. So, in the top view, we will see this hexagon in that way. Axis, axis goes all the way through o. Project it, so that in the front view we will see it as a triangle along with this additional edge. When we are looking this entire edge will be visible here.

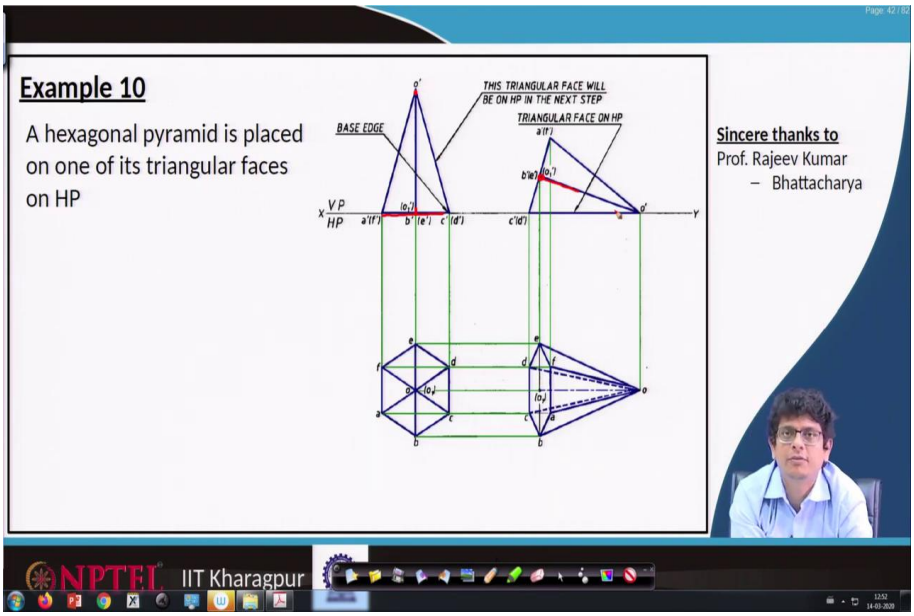
Now, rotate in such a way that this axis makes an inclination angle with the plane, horizontal plane and one of the edges will be resting on this plane. One of the edges, if we are looking this is one of the edges.

(Refer Slide Time: 19:26)



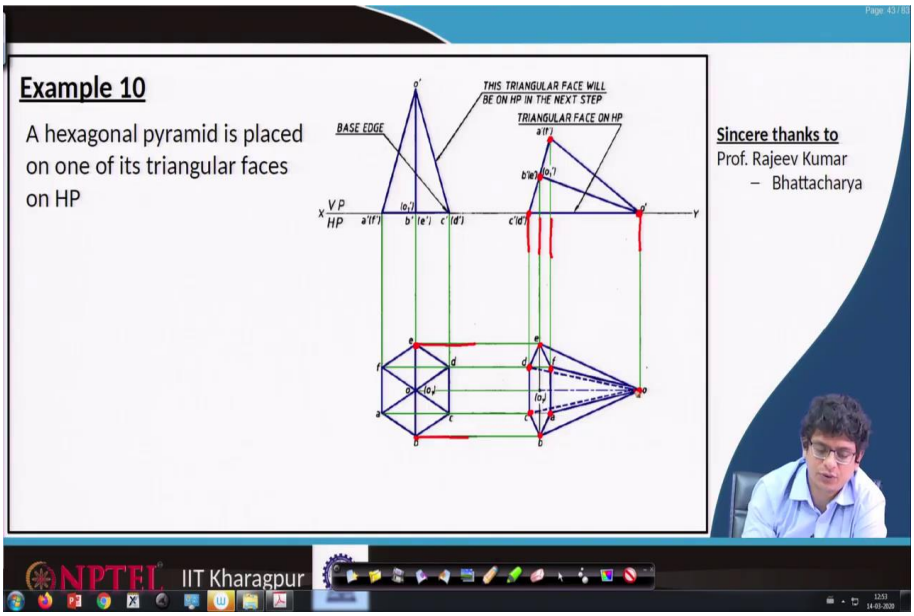
If I am rotating it in that direction this o' c' edge has to be resting on the ground. So, o' c' we draw it. Measure o to c', locate o' c', draw that. Now, transfer this a d' in this way. From here measure the thing whatever that length makes an arc, because this entire thing; from here also measure this one; make another arc. So, once we have that point connect this by the triangle.

(Refer Slide Time: 20:22)



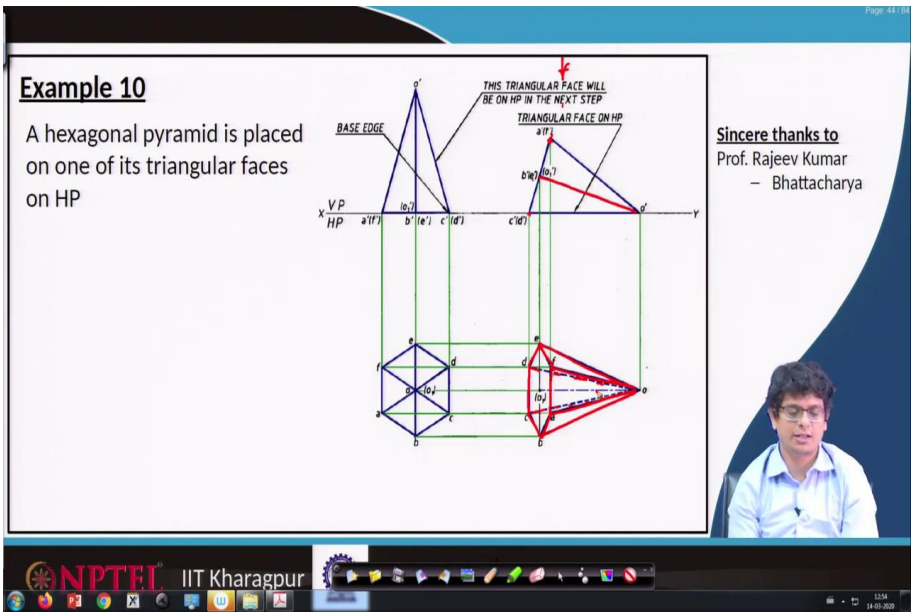
Once we know that this length which is in the middle the same thing, we can connect it so that we can make that triangle. Once we have that transfer this point projections vertically down.

(Refer Slide Time: 20:35)



Similarly, we have these points e b things those who are also projected in that way. In that way, we can locate, point a, b, c map to c, d, then e point maps to e, and f point. Already o point, we transferred it.

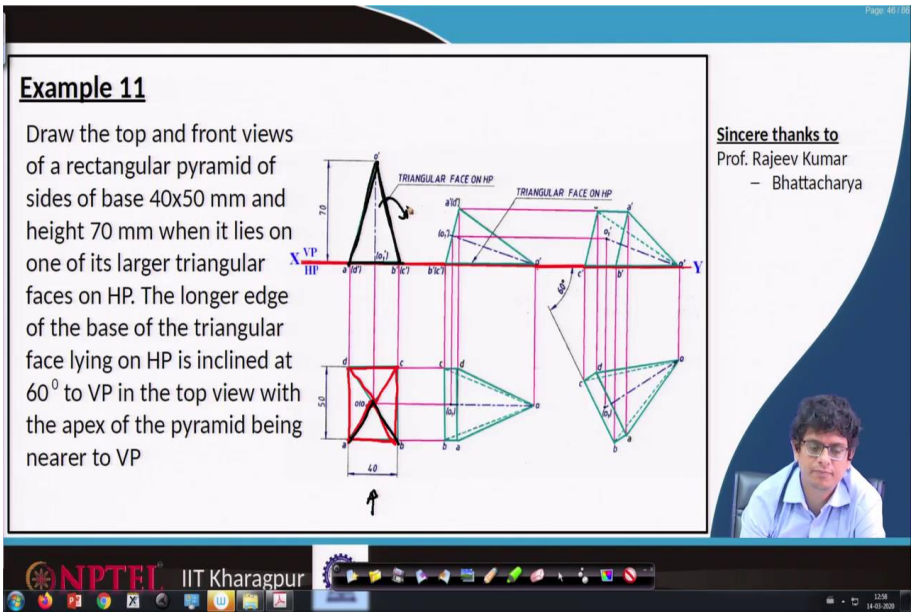
(Refer Slide Time: 21:07)



Once it is done, we connect join whatever the visible faces. So, the visible face is always a o face, so visible one. And this one also visible be o thing, so that is also we will connect it.

Similarly, on the other side, e thing will be visible. Similarly, f thing will be visible. And when we are looking from top view this a to f line always be visible, we join it, and c to d also visible, so we join that. Now, when we are looking from c this point e is connected. So, that and this one will be visible. The remaining lines are always invisible. So, we show it by dashed lines.

(Refer Slide Time: 22:10)



Let us take another example. Draw the top and front views of a rectangular pyramid of sides of base 40 by 50 mm, is a rectangular pyramid. There is a reason you have different sides different lengths 40 and 50 mm and it has a height of 70 mm.

When it lies on one of its larger triangular faces on the horizontal plane because it is a pyramid, we always have this apex vertex and base might be the rectangular thing. When you are connecting this base to vertex, we will see triangular faces. And the larger triangular faces that are on the horizontal plane.

Further, the longer edge of the base of the triangular face lying on the horizontal plane and it is inclined at 60 degrees to the vertical plane. And that is visible in the top view, with the apex of the pyramid being near to vertical plane.

So, when we are constructing this first of all based on the conditions, we have to visualize how the object might be looking. If you are looking carefully at this last point the apex of the pyramid being near to vertical plane that gives us preferential direction already which way we have to orient this pyramid.

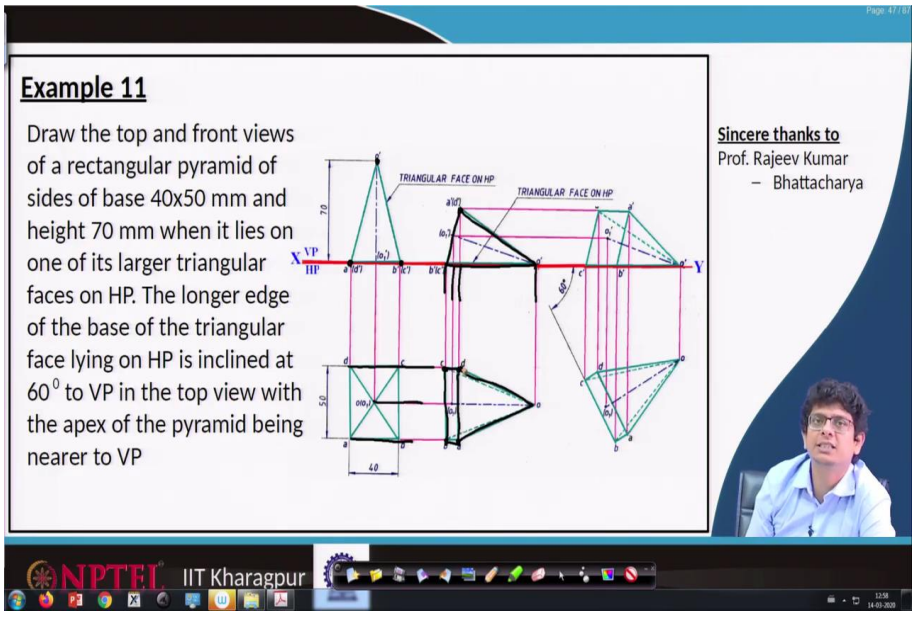
So, the apex always is near to vertical plane. So, we have to make if this is the vertical plane if this one is apex it has to be brought in that way. It might be in that way, it might be in that way, but this apex has to be in that way, but it should not be something like that.

And the second condition if we are seeing, the longer edge of the base of the triangular face lying on the horizontal plane and it is inclined 60 degrees in the top view. So, when we are seeing the longer edge of the triangular face that makes 60 degrees with this vertical plane. With that visual, we can easily recognize how this pyramid is inclined. So, let us look at that.

First of all, we may have to do multiple rotations. So, the easiest way is to begin it in such a way that we will be drawing a rectangle. It is a pyramid, so edges will coincide there.

Let us use some other color, black. Different view projection is a pyramid. So, we will see it as a triangle. This one when we are looking this direction coincides with this triangular face, similarly this one coincides with that triangular face. Now, it is lying on a horizontal plane with this part.

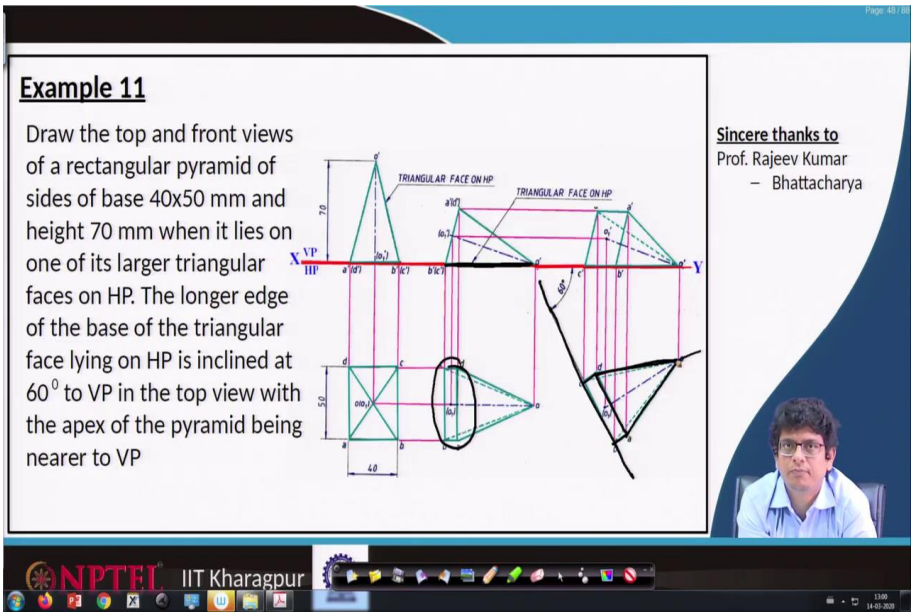
(Refer Slide Time: 26:05)



So, what we will do? o to b' first of all we locate it on that horizontal plane. Then, transfer this a point precisely to that location. Then, project all these points down. Similarly, project these points, then we will have the pyramid. In this way, it looks like in the top view. The remaining things are dashed lines.

After that what we have to do is this long edge makes an inclination angle with the vertical plane, that means, we should not see it in this way it has to decrease its length.

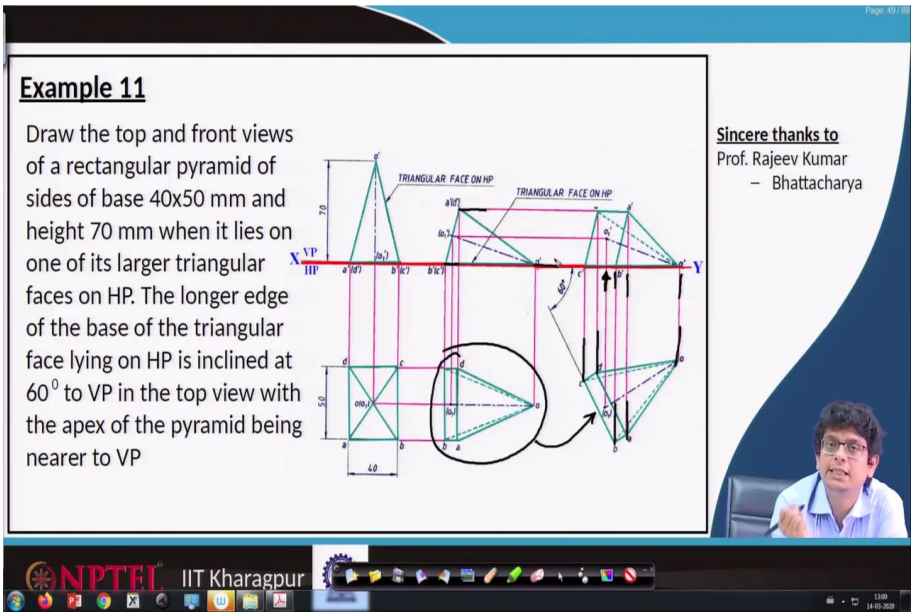
(Refer Slide Time: 27:00)



It is more like this is the one we want to decrease when we are rotating longer edge length decreases in your view. For example, this is the longer one, we want to decrease that length, so that it makes an angle with the vertical plane, that we can see only in the top view.

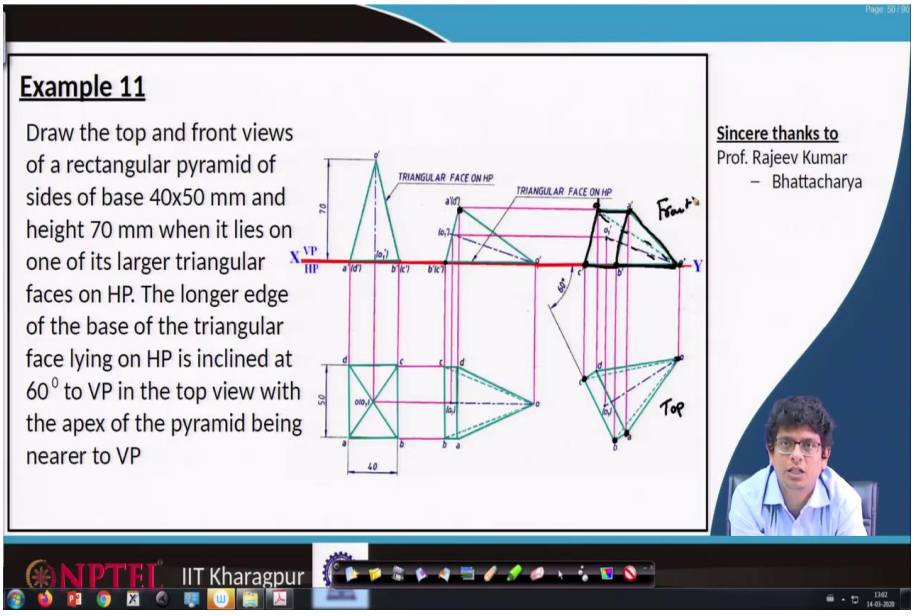
So, what we do is when we are doing in the top view, we construct in such a way that it makes an angle. So, this entire object is rotated in such a way that the same thing rotates it, draw it, and transfer this lens. When we do that the inclination angle, we can sense the longer edge how it is going to make with the vertical plane.

(Refer Slide Time: 28:19)



So, this one we rotate it with a certain angle. Then, we project those points in the upward direction towards this and this one what we are rotating. So, project these points.

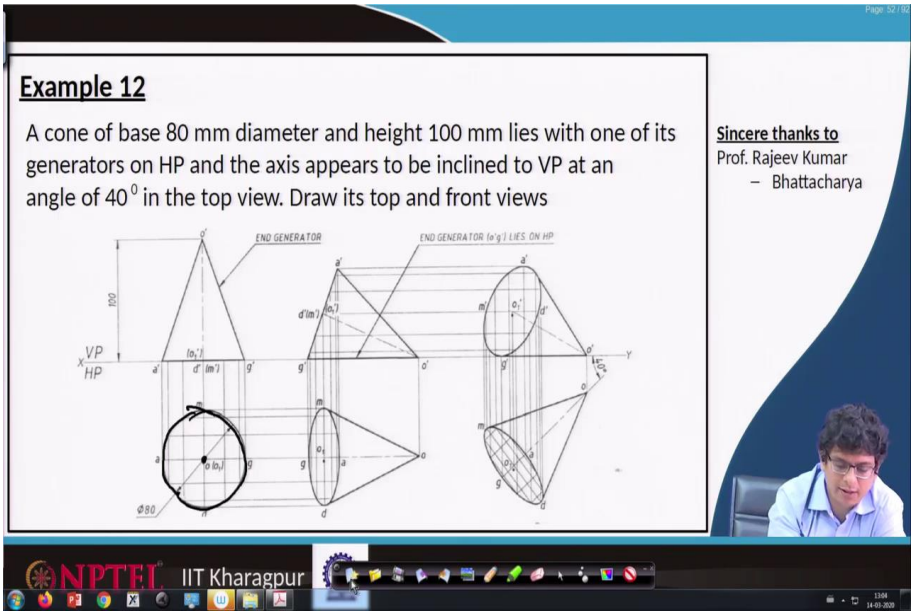
(Refer Slide Time: 28:49)



When we do that c point and c point coincides there, b point and our b point coincide there, so join by a line. Similarly, a point and a point coincide there, connect that. Similarly, d point this one and this d point coincides, so join by line.

Now, this o maps to there, that means, we have a front view where this long edge makes an angle with the vertical plane, and the remaining lines it will always be dashed lines. This is the way we construct this top, this is the top view and this is the front view of a pyramid whose longer edge is making an inclined angle with the vertical plane and is longest edges resting on the horizontal plane also.

(Refer Slide Time: 30:07)

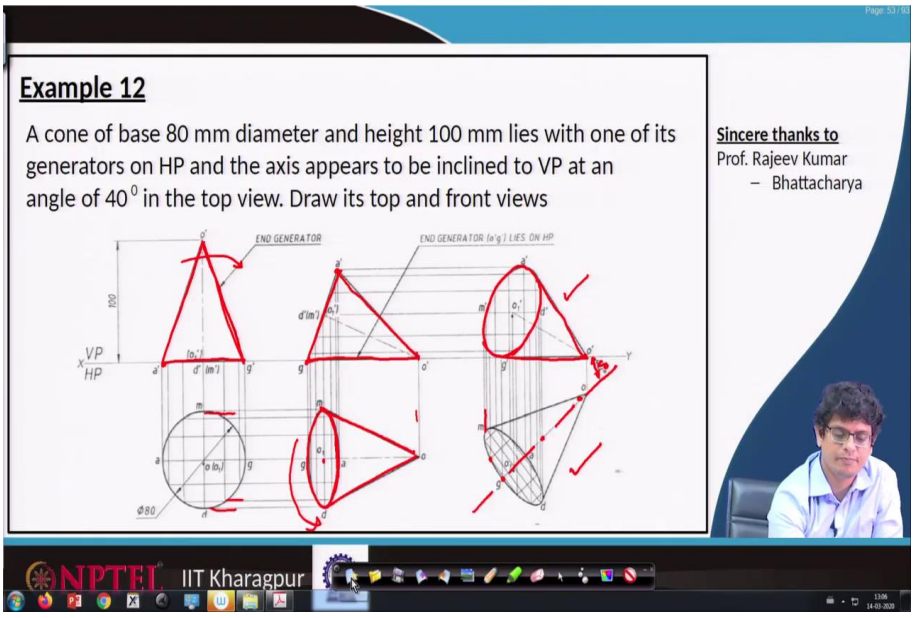


Now, let us look at the loss example. Here a cone of base 80 mm diameter and height 100 mm is lying with one of its generators on the horizontal plane. So, a cone generator has to be on the horizontal plane and its axis appears to be inclined to the vertical plane.

So, when we are looking at that let us pick a cone, maybe first fix in such a way that the entire circle in the front view we can see that, that turn it in that direction, so the generator will be resting on the horizontal plane, then rotate that cone in such a way that that axis line makes an inclination angle with the vertical plane. So, how to construct that? Let us look at that example. That we have to do step by step.

First, what we are doing is a cone resting on the horizontal plane this is the thing if we can construct it then we will make a rotation, so that generator will be lying on the horizontal plane. To do that first of all make a cone resting on the horizontal plane so that its axis is perpendicular to the horizontal plane. So, axis passes through that passing perpendicular to this plane.

(Refer Slide Time: 31:59)



Have a front view which looks like a triangle, then rotate it in such a way that one of the generators may be og' resting on the ground. So, use once we draw og' resting on the ground, we can always locate a point by compass.

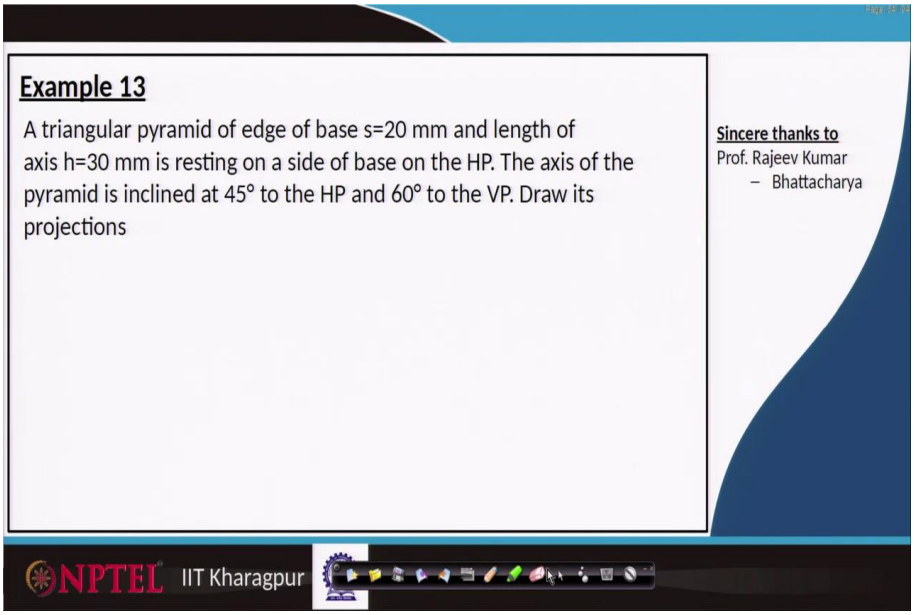
Once is done, we can project this point down the project down. It is a circle, so we divide that into 12 equal parts, 8 equal parts and project these lines. So, that when we are projecting, projecting this line also into 8 equal parts, finally, we will be in a position to construct an ellipsoid. Join that, so that we got a cone resting with its generator on the horizontal plane.

Once it is done, its axis if we are seeing that is still making an inclination with a horizontal plane, but it is parallel to the vertical plane. So, we have to rotate that apex or perhaps that cone on the generator, so that axis itself makes an inclination angle with the vertical plane, that means, rotate that in this direction, so that axis is inclined to the vertical plane. This inclined to the vertical plane we can see only in the top view. So, perhaps the inclination angle 40 degrees.

Now, again transfer this is ellipsoidal the points, whatever those 12 points or 8 points we made on the circle, now it looks like ellipsoid transfer these points up. Similarly, transfer these 12 points, then we will have the projected one as an ellipse and join this line. This is

the way we draw a top view and front view of a cone whose generator is resting on the horizontal plane and its axis is making an inclination angle with the vertical plane.

(Refer Slide Time: 34:44)



And this problem, work it out as a homework, where a triangular pyramid of the edge of the base 20 mm and length 30 mm is resting on a side of the base horizontal plane. The axis of the pyramid is inclined at 45 degrees to that horizontal plane and 60 degrees to that vertical plane, if that is the case draw its projections.

Thank you very much.