Engineering Graphics and Design
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Week 6: Isometric Drawings
Lecture 02
Construction of Isometric Drawings

Welcome to lecture 2 of week 6 on isometric drawings. In this lecture, we will be looking at how to construct isometric drawings. In the previous lecture, we have looked at different pictorial drawings and concluded by saying that isometric drawings are the most commonly used drawings.

So, usually what happens is you need you already have an object, and you need to prepare the isometric drawings, that is a relatively easy task because you have the object in front of you. So, you do not need to struggle with capturing the mental picture of it. The other challenge is, you are given the multi view drawings and then asked to draw the isometric drawing, then there is an intermediate step where you need to first base on these multi view or the orthogonal views, you need to have a mental picture of the object and using that mental picture, then you need to draw the isometric drawing on paper.

So, that is a relatively more challenging task, because then it depends on how well you are able to get that mental picture based on the multi view drawings. So, in this lecture, what we will do is we will take 4 examples, each with a different feature of it and try to explain how to start drawing these isometric drawings in a systematic way. So, that after a while you get it becomes easy for you to draw the isometric drawings.

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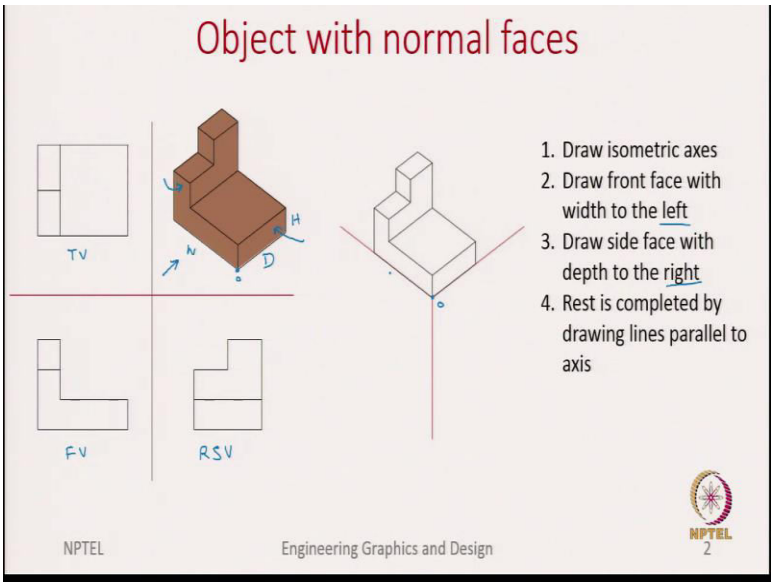

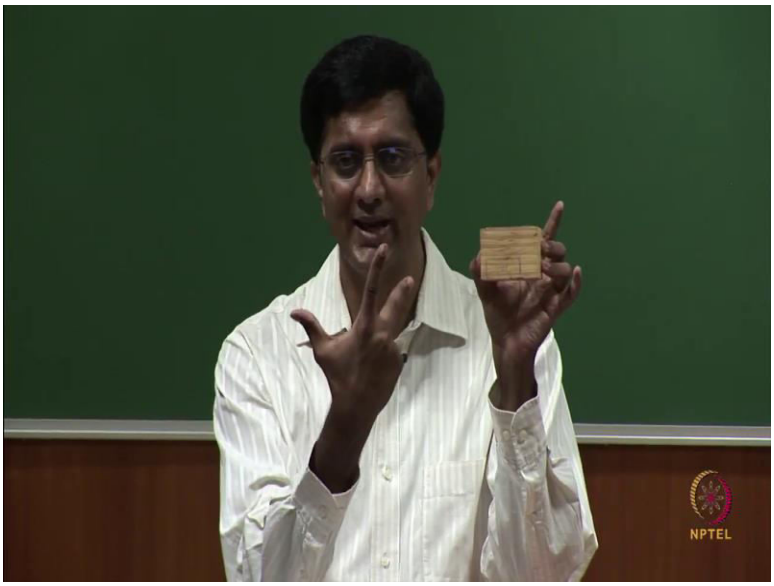

So, let us start with a simple one. Where we say that the object has normal faces what I meant by normal faces saying that all faces of the object are parallel to at least one of the principal planes, what do I mean by principal planes, we said the object is in space and we define the object in space using three axis's.

So, because we are using the Cartesian system and these three phases these three axes make three different planes, the horizontal plane, vertical plane and the perspective plane profile plane. So, these three planes are perpendicular to each other. Now, what I am trying to say is, for example, this object, all faces it has 6 faces and all of those faces are parallel to at least one of these horizontal, vertical or the profile plane.

So, for example, the front view is parallel to the vertical plane and the side view is parallel to the profile plane and top view is parallel to the horizontal plane. The point being is, then it becomes easy to draw the isometric drawings and it is also becomes easy for you to understand it from the multi view drawings.

All these faces, when they are parallel to one of those planes, it appears as a area in one of the planes and in the other two projections, it only appears as an edge. So, let us focus on the top view. So, this top surface of this object, only in the top view, it is captured as an area. But in the front view, we only see this edge, and also in the side view, we only see it as edge. So, which

means this surface is captured as area in one view and as an edge in two views, that goes with all the surfaces of this cube or a solid which is shown here.

So, that helps us to identify whether your surface is a normal surface, which is parallel to one of the projection planes or not. So, with a little of intuition, we should be able to see that these multi views will lead to this object shown in the slide. Now, the point is, how do we start to draw this object in the isometric view.

So, the first step is to draw the isometric axes. So, we know that the isometric axes all these axes make equal angle and as shown here, these are 120 degrees apart. So, we do not show those angles. We only draw the isometric axes. So, let us say this is the point where we start from, then what we say is we need to first decide in this object what is the front view.

So, here looking at the orientation of the views, we know that this is the top view, front view and the side view and since the top view is placed above the front view, we know we are in the third angle projection. So, this should be the right side view. So, which means for this object the front view should be shown using an arrow like this.

So, once we show that the front view is this, then we know this is the width the height is here and this is the depth. So, we start to draw this object using this corner point which is placed here. Let us label it as O for convenience. Now, what we do is for example, if I want to capture this front view, especially this face, should I do it to the left of point O or to the right point O.

So, that should be captured to the left the front face with width. So, the front face has the width and the height that is drawn to the left and similarly, how do we capture this side view on this surface which is appearing in the side view that we capture to the right of point O. Draw the side face which has the depth and height to the right.

So, once we capture this front face or the side face, the rest you can draw parallel lines and connect to complete the solid. So, the rest is completed by drawing parallel lines to axis. So, at least in this example, we know all of them are normal faces which means they are all most of them are parallel to the axis. So, with this, we are able to complete this simple object.

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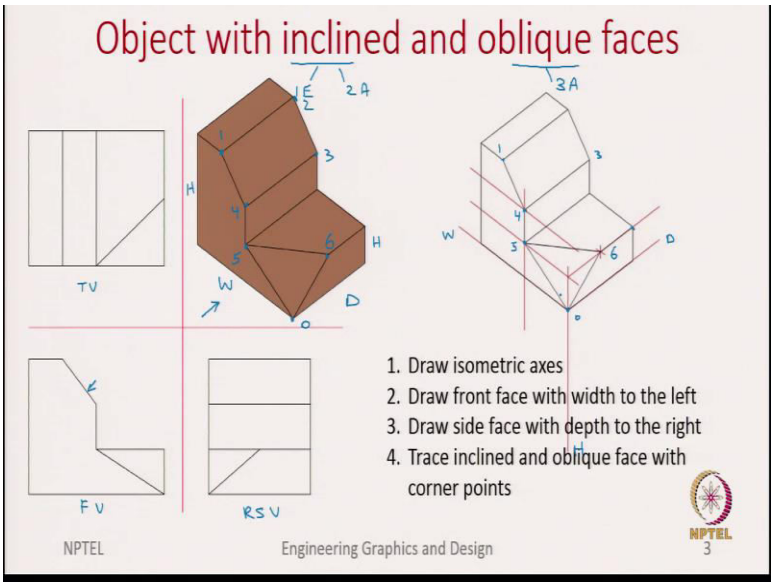

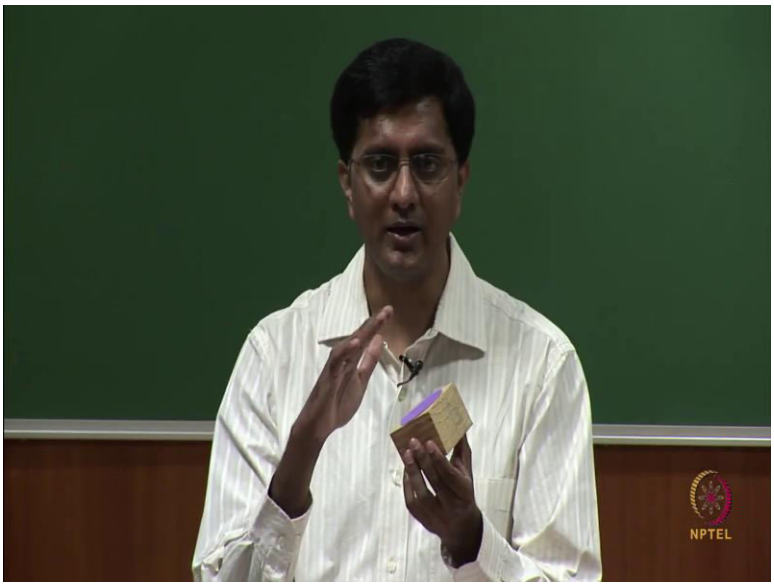

Next, in the next example, we will introduce a slight complication the object has both inclined and oblique face. Now, let us first explain what is an inclined surface and then oblique surface. So, let us say one of the face is perpendicular to the vertical plane. So, this surface the surface where I have this circular patch, when it is oriented in this direction, it is perpendicular to the vertical plane, but it is at an angle to the profile plane as well as it is at an angle to the horizontal plane.

So, this we call it as the inclined face because it is perpendicular to one of the planes. But let us say if I tilt it in a way that this surface is neither parallel nor perpendicular to any of the three

principal planes, the horizontal, vertical and the profile planes, then we call it as the oblique faces.

The reason why I am emphasizing this is now let us first start with an inclined face. So, now we said this, the one with the circular patch is the inclined face. So, when you capture the front view, what do we see this surface is captured as an edge. What about the side view? Side view we will see it as an area. How about the top view? Top view also we see it as an area. So, which means for an inclined surface you capture 1 edge and 2 areas.

Similarly, now, let us look for the oblique phase for the oblique phase we said this is neither parallel or perpendicular to any of the axis. So, let me place it in this fashion. So, if it is placed in this fashion, how will you it look in the front view in the front view, you will look it as an area. How about in the side view? Side view to you will look at as an area similarly in that top view, you it comes out as an area.

So, which means in none of the views it comes out as an edge and all three principal views it comes out as area. So, three areas in the three principal views. So, now let us look at this multi view drawing and try to identify if we can see any inclined or oblique phase. So, if you notice this triangle, we see it in all three views.

Since an oblique face we know shows up as an area in all the three views, we can assume that this triangle is an oblique surface. But let us say let us focus on this edge. So, this edge in the let me first write it as top view, front view and right-side view. So, this edge is an edge in the front view.

But whereas if you look at the top view, it is an area and if you look at the right-side view, it is an area so that should give us a clue that what we are looking at is an inclined surface. So, with this small clues we should be able to identify that this object has one inclined surface and one oblique surface.

So, this is how the object looks like. But now let us see step by step, how do we draw the isometric view like previously, we will start with an isometric axis, we will first draw the isometric axes and since we said this captures the front view, so, we have the width here, the depth here and the height here of course, all the vertical lines are hide.

So, this should capture this axis should capture us the width, this should capture us the depth and this should capture us the height the vertical line the height. After we are done with the isometric axes that is when we start with capturing the front face. We can also do the right face to the right of this centre point let us say O we call it as the centre point, which is this bottom point O. We start with this bottom point O because that is relatively much closer to the viewing place.

So, and then, for the features seen in the front view captured it to the left and those seen in the side view we capture to the right. So, we start proceeding with this and the important point is how do we capture the inclined and the oblique faces. So, we always do this by focusing on the corner points.

So, for these inclined surfaces, we focus on these four corner points. Let us, just for convenience, let us name it 1, 2, 3 and 4, and for this oblique surface will again focus on the corner points. So, O is already there. So, let us say that 5 and 6. So, once we are able to trace where these points 1 to 6 go in the isometric view then it becomes easy to develop the solid because then you just need to join those points.

So, first you only need to focus on where these points are lying on the isometric drawing. So, with red lines here are the construction lines. So, with these red lines, we are able to find points 4 and 5 essentially, we draw intersection of vertical lines and these lines parallel to the width axis to capture these points 4 and 5. Similarly, we continue see, point 1 is already captured let me also name this point 4 and point 5 here.

Similarly, we keep continuing and capture the point 3 and the rest. Now, we are left with how we capture the oblique's surface or the oblique face for that again as we said we are already captured two points of the oblique O and 5 we are left with capturing this point 6. How do we capture point 6?

So, we first draw these lines parallel to the width and the depth and try to capture this point and then we just need to draw parallel lines to the depth. Once we draw parallel lines and measure the length, we are captured this point 6. So, once we capture points 5, 6 and O we can simply draw the oblique surface by connecting these points. So, with this we are able to capture both the incline and the oblique faces on a object.

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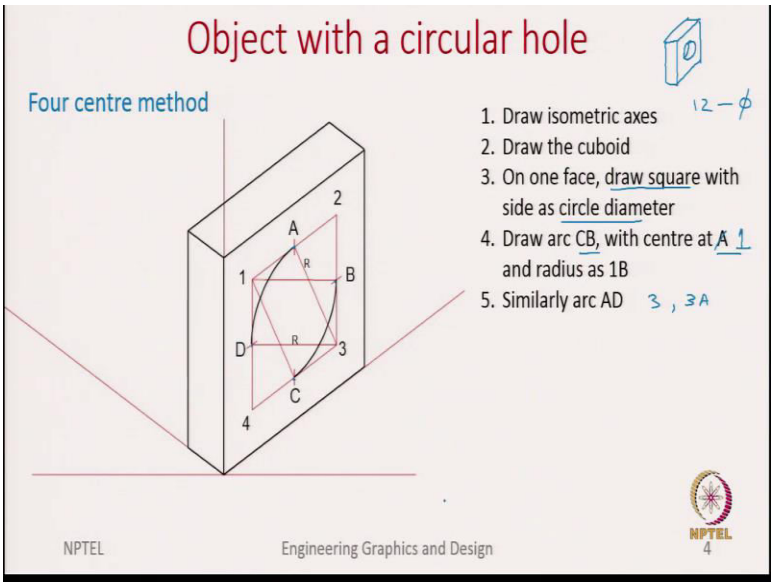

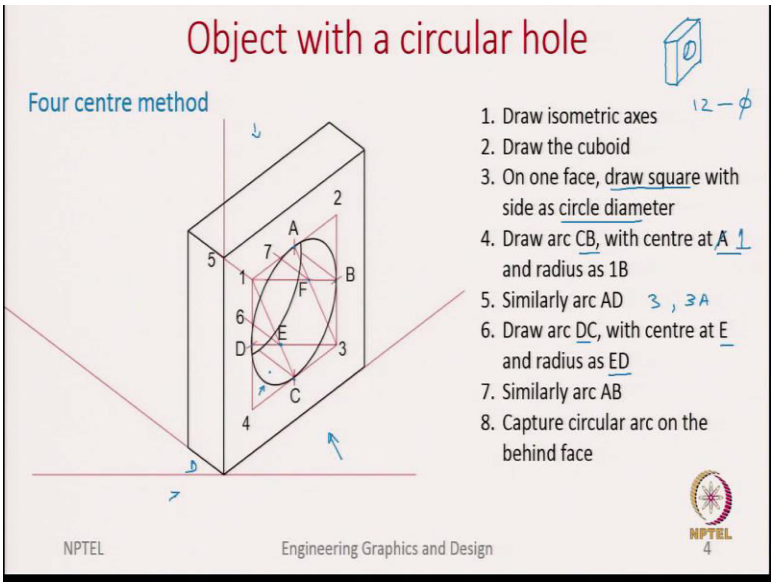

And later, we will now move to the next example, where we are trying to capture a circular hole. So, I think we have already discussed previously saying that if you are focusing on this circle, and if I hold it in this fashion in the front view, it looks like a circle. But the same circle, if I am now, oriented in this fashion, where we are trying to capture the isometric view, this circle now looks like a ellipse, but how do we draw an ellipse in an isometric view. So, we do that by following one method called four centre method.

There are other methods too, but the four centre method is more commonly used. So, the example I take is something like this here the final object looks like a block and on this face, I want to capture the circle. So, since the width of the block is not too much, in this example, what happens is we should we will also be able to look at this circle from the behind surface, not on the front surface, but at the back surface also. So, that will be captured with another arc like this.

But now let us look at how do we do that in a step-by-step manner. So first, we will again draw the isometric axes and second, I will draw the block because we already have seen in the previous two examples how to draw a simple block. So, we will draw this block which I call here as a cuboid. Because all the 6 faces of this block are parallel to at least one of the principal planes. Next is the point where we try to start capturing the circle as an ellipse in the isometric drawings. For that, what I do is first identify what is the diameter of this circular hole and then draw a square in the face.

So, that size of the square is the circle diameter. So, let us say D is the circular diameter then this length 1, 2 is the diameter. So, what I have done is first located the centre of this phase and using that centre I have no constructed a square, of course the square is depicted as this parallelogram in the isometric view.

So, the points 1, 2, 3, 4 captured the square and I also have done captured the midpoints of the square, which are these points A B, C and D. Now, what we do is we join points 1 to points B and C. The reason we do it is we need to measure this length from 1 to B we measure it is arc and using a compass we draw an arc.

So, what we do is we draw these arc CB with centre at A, sorry, this should be 1 with centre at 1 and radius as 1B. So, now we are able to draw these arc BC using the same method we should be able to draw the arc AD. So, for here the centre will be at 3 and the radius will be the same A radius 1B you can use or just to show it here, these arc what we say show it is 3A.

So, now we have completed two arcs, we need two more arcs to complete this ellipse. For that, we locate these central points where these construction lines meet and name them as points E and F. What are point's E and F? Those are the points which are intersected by these construction point.

Now, I take another radius. So, my radius is small r here, which is ED that I can measure with the compass and with centre as E, I draw this arc DC. So, this is the arc I have just drawn. Similarly using the same radius, but now with centre at F, I can draw another arc AB. So, once I draw these four arcs with four centres. That is why we call it as the four centre method, we are able to completely capture that ellipse.

So, as we said, this circle is now captured as an ellipse in the isometric view of course, you can use the same method to capture the ellipse, not just on the, let us say this is the, let us say in this case, this is the front view, we can use the same method to capture it either in the side view or the top view.

But we are left with one last point, how do we capture the circle from the surface back face of this block. For that, what we need to do is we need to just draw parallel lines from point CF, EF and B and then use the same method to draw the arcs. So, if you use the same method, basically, we are just drawing parallel arcs.

To draw the parallel arcs, we use these depth axis and draw parallel to the depth axis and the width of this depth axis is given by this depth of the block. So, using the same method, we are also able to capture the second arc which captures the circle or the hole in the back face. So, with this, we complete the third example.

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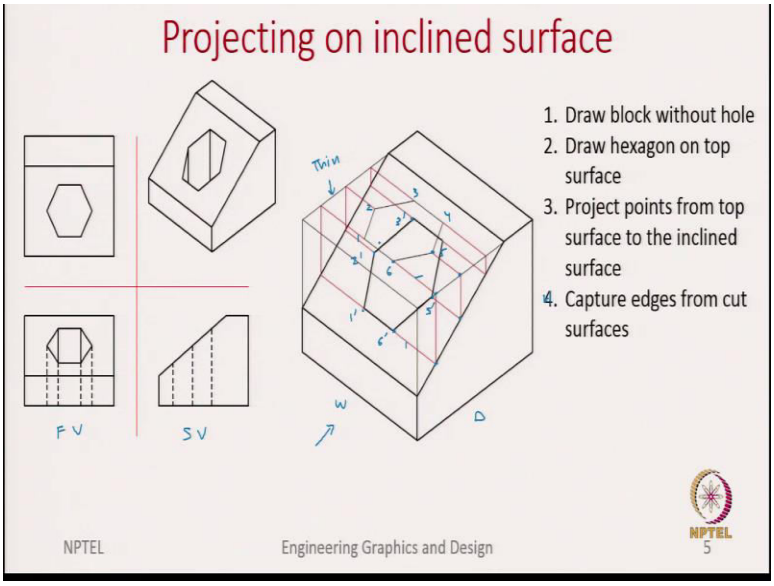

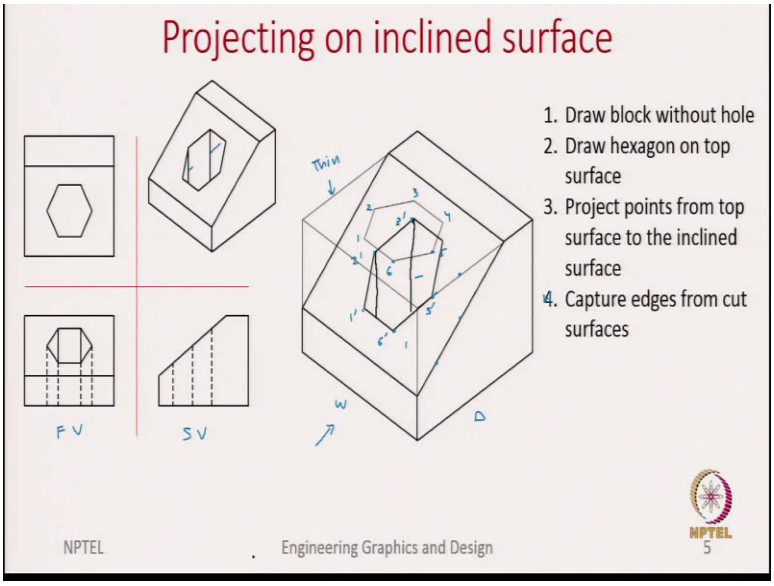

And now let us look at the last example where I want to show how do we project onto an inclined surface. So, these are the orthographic projections are the multi views of an object. As you can see here, I hope you can see that in the top view, you can see a hexagonal cut. But once you look at the front view, and the side view, this hexagonal cut is shown using hidden lines.

So, as you can assume that this is how the final object will look like. In the final object, you see that on this inclined surface, we have this hexagon. But will it be the same hexagon that we see in the top face? No, it is slightly distorted. But how do we capture this distortion? For this, what do we what we do is we focus on the 6 corners of this hexagon.

And then let us say if we are able to pinpoint where the 6 points of the hexagon are there on the solid, then we just need to connect those points to capture these distorted hexagons. So, essentially, what we are saying is, we need to first draw the hexagon in the isometric view. First, now, let us draw the block without the hole.

So, this should be relatively easy now, because we have already covered how to draw object with normal faces or with inclined on oblique faces. So, let us assume that we are done with constructing this block. Now, we need to capture that hexagon on the inclined surface. So, we said that let us first draw the true size of this hexagon on the top face of this object.

So, if you notice, I am drawing these with construction lines which are thin. So, what I am now drawing is this hexagon in the true size on the top surface of this object. Again, I am repeating that I am drawing these with thin lines, because these are part of construction lines. These are not how it looks like in the final step, but I am using this to construct a distorted hexagon on the inclined surface. So, now we have this hexagon in this true size and size on the top face. So, how do I project these points, so let us name these points 1, 2, 3, 4, 5 and 6.

So, these points if I can project it onto the inclined surface, then I just need to connect those points to show you how it looks like. So, for that, what we do is we use this top phase and let us say we are focusing on points 5 and 6. So, on the top face, we draw two parallel lines and note these points where it intersects with the edge of this bigger box.

And then we draw vertical lines such that they come and intersect with the inclined line and again we draw parallel lines parallel to the let us say, if this is the this is the front view. So, this is the width, depth, and the height. So, again, we draw parallel lines to the width to capture water points 5 and 6.

So, let us say these are 6 dash and 5 dash, the length of these lines is similar to the length in the top face. So, this length and this length are the same. So, essentially, what we are done is we started with point 6, we draw a line on the top surface, then draw a line on the side surface and

then draw a line on the inclined surface where after drawing these 3 lines, we end up with the projection of these points 6.

Similarly, we are done the same for point 5. So, once we projected points 5 and 6, we can join them to get the one edge of the hexagon. So, we repeat the same procedure for the remaining points. So, for now, let us focus on point 4 and then join the lines. And similarly, we can now do it for lines 1, 2 and 3 when we are drawing these projection lines, I can use the other side of the block.

So, again, this construction lines to project these points, 1 dash, 2 dash and 3 dash and I now I have already projected all the 6 points now I can draw the complete hexagon on the inclined surface. The last thing is I forgot to capture the cut, how do we capture the cut as you can see here, we need to show these vertical lines because we those are still visible in the angle we are looking at.

So, let me select a black surface black colour. So, I just need to draw a vertical line from point 3 dash and vertical line from 2 dash to complete this object. So, with this we are done by capturing this hexagon on the inclined surface. But as you can see, maybe someone might be thinking, can we do these projection lines instead of instead of on the side faces can we do it on the front face.

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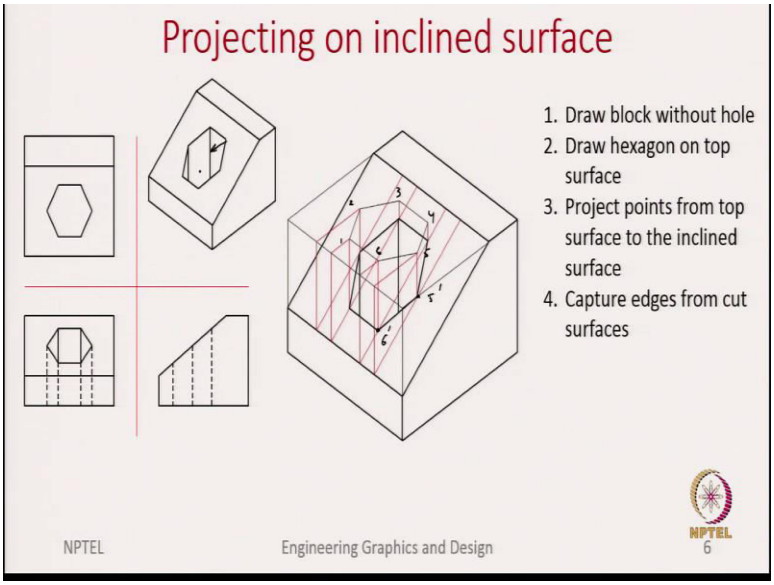

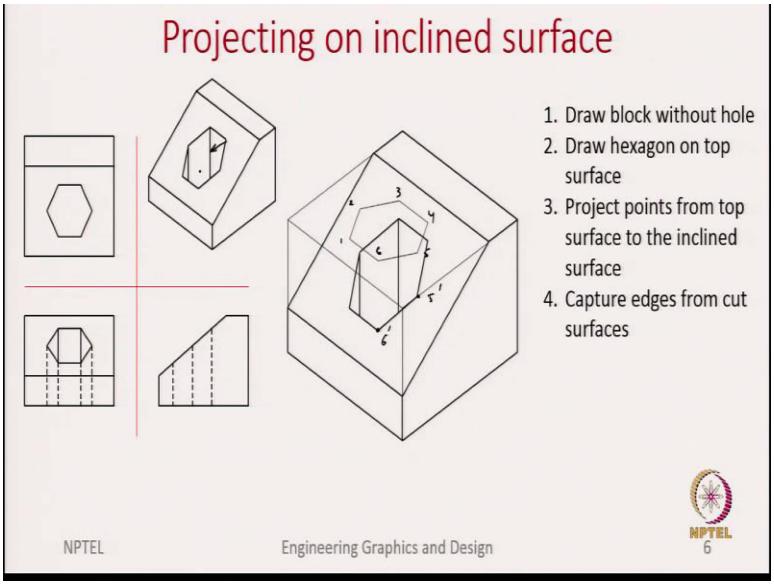

This I will quickly show in the last slide. So again, the same problem so I am not repeating it again. The only difference now I am trying to say is when we draw projection lines, there is one other alternative instead of going to the side view, we can also go into the front view. So, as you can see, we have drawn lines in the top view, then the front view and again the inclined surface and then lastly, we just need to draw vertical lines to project the depth.

So, with these we captured 2 points. Let us, say these are points 1, 2, 3, 4, 5, and 6, this will be 5 dash and 6 dash. So, we join those two points. Similarly, we can use the follow the same method again to capture projections of point 4 and again 1, 2 and 3. So, once you got all the projection, the 6 projection points we connect them to get the projected hexagon and lastly, we also draw these edges, which represents the cut the hexagonal cut, with this, we are done to show the 4 examples.

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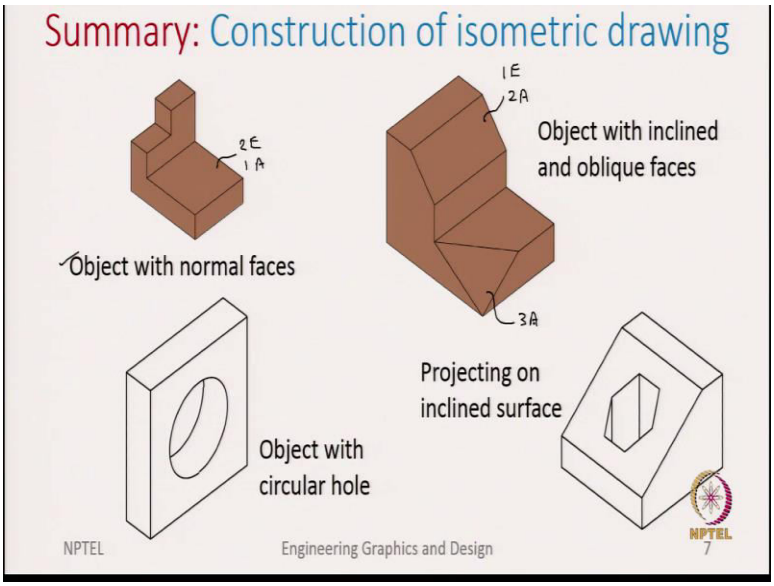

Essentially in summary, what we have seen in this lecture is how do we draw isometric views for an object with normal surfaces, we said a normal surface is one which is parallel to one of the principal planes. So, for example, this surface will look as an edge in two of the principal views but as an area in one of the principal views.

So, it looks two edges and one area and as a inclined surface we said we locate as one edge in one of the principal views and in the other two principal views it looks as area. But for the oblique in all three principal views, it looks as an area. And later we said that the circles, they look as ellipse in the isometric view and we have looked at the four centre method how to draw this ellipse.

And lastly, we said if we need to project something on these inclined surfaces, there is one method, where we first draw the true view or the true shape and then use, we follow the corner points of the shape. For example, in this example, we are looked at hexagon, we have followed the 6 vertices of the hexagon and projected them onto the inclined surface. Once we capture those 6 points, we connected them to show the final view how that hexagon looks on the inclined surface.

Essentially, we can extend these techniques, even for curves. For curves, what we just need to do is we need to break the curve into multiple segments and then focus on multiple points on the

curve. So, if you can project these curve points on the curve on the isometric drawing, then we just need to connect those two points to a period as a curve.

Only thing is these points if they are closer to each other, then you can connect it with a smooth curve, otherwise, it becomes a little tedious. I hope all of you got at least an intuition about how to get started with these isometric drawings and we have looked at few principles so you can understand how you can implement these principles in drawings. As we all know, like drawing comes with practice. So, I would encourage all of you to start practicing and then you will be able to get a hang of these principles, how to apply them in more complex objects as well. Thank you for your attention.