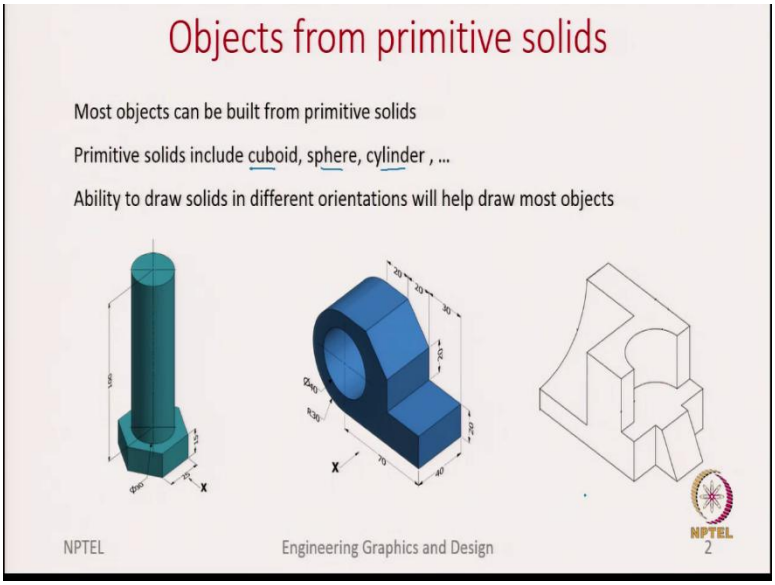
Engineering Graphics and Design
Professor Naresh V Datla
Department of Mechanical Engineering
Indian Institute of Technology, Delhi
Lecture 18
Types of Solids

Welcome back we are on week 4 of the NPTEL course on engineering graphics and design. In the previous week, we looked into the basics of orthographic projections by looking at what a drawing sheet is the scales and the sizes used, we also looked into the various lines used and the dimensioning. And towards the end of the last week, we also looked into how to project simple things like a point, line, plane and simple objects.

In this week what will be looking at is, we will extend those projections to regular solids, so in a while especially in this lecture we will show, why we are interested in solids and how this is relevant to the regular products as well as objects we have in daily lives.

(Refer Slide Time: 1:14)



So, here we start by saying that objects can be formed from primitive solids, for example, in this slide you can see a bolt, what you see at the bottom is a hexagonal prism because the cross section is a hexagon and prism because the cross section is uniform. On top of it you can say that there is a cylinder lying on it.

So, if you look at these two separately, these are basic primitive solids. Primitive solids are something we call it as simple as cuboid, spear, cylinder, hexagons and other polygons and solids which we will discuss more in today's lecture. But the point to be made is either doing

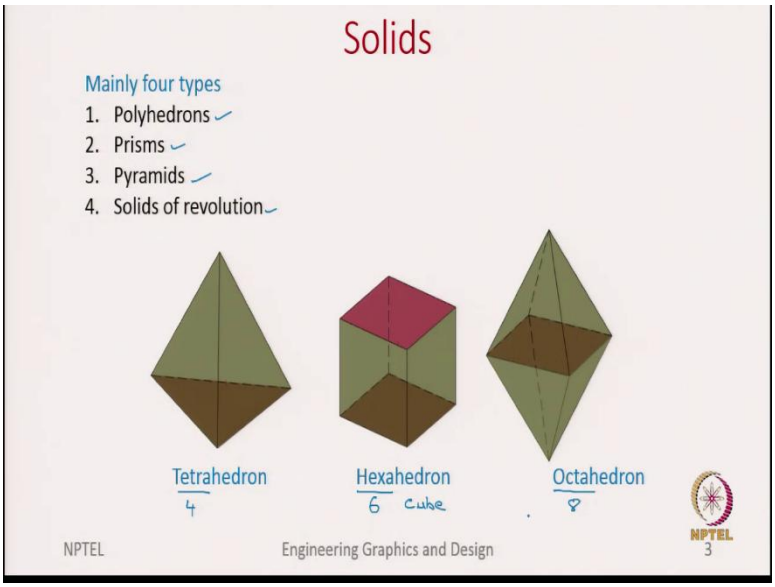
Boolean operations such as like union, intersection or subtractions, we can form more complex objects just by starting by these simple objects.

So, for example, in the second figure, what we see is the whole what is there in the object can be created with a cylinder so if you have a cylinder and subtract it from a bigger object, we create a hole and similarly in the third figure which appears to be more complex but again this can be built by starting with a cuboid, for example and then dealing with cylinders by using operations like union, subtraction and intersections.

(Refer Slide Time: 02:52)

And as an example, here I have, this we can call it usually a square prism and here what I have is a triangular prism. So, if I add both of them together it gives an appearance of a object which is not as simple as the one which we started with. For example, this can be used as a to depict a house, the point being any complex or most complex objects can be represented by a combination of these simple solids. Therefore, if you are able to know the projection of these solids then we can extend that knowledge to go and create projections of more complex objects.

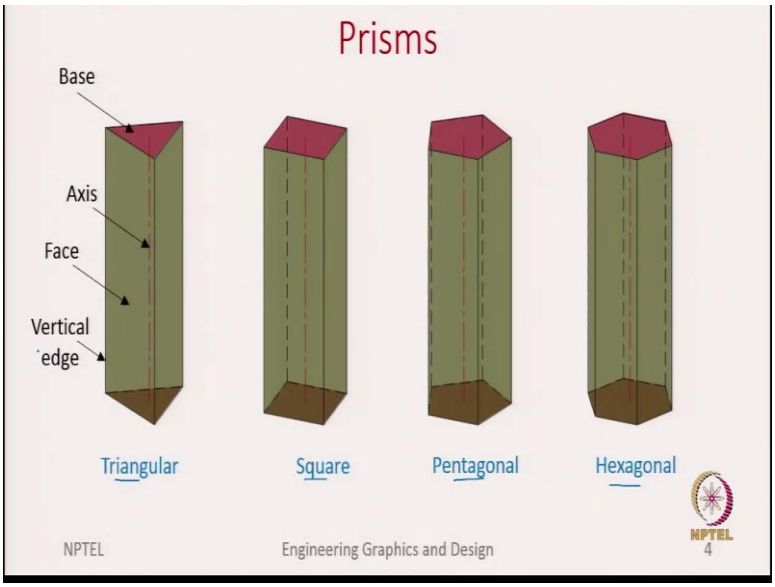
(Refer Slide Time: 3:37)



So, let us look at what are the different kinds of solids. There are many ways to classify but we are looking at one way of classifying where we say solids can be classified as polyhedrons, prism, pyramids, and solids of revolution. The reason why we are look at it is to introduce new terminologies probably you might have already heard about it, but the reason is to get uniformity with everyone. So, we are introducing these terminologies such that we will be using these in the next few lectures where we will actually look into projection of these solids. In this lecture we are only introducing these solids and this terminology.

So, let us start with polyhedrons, so here what we see is the tetrahedron which means it has 4 faces which are all equal. The next one is the hexahedron which means it has 6 faces where all faces are equal sized and shaped. This you can also call it as cube as we all know. And lastly the octahedron where it has 8 faces all being the same.

(Refer Slide Time: 4:51)



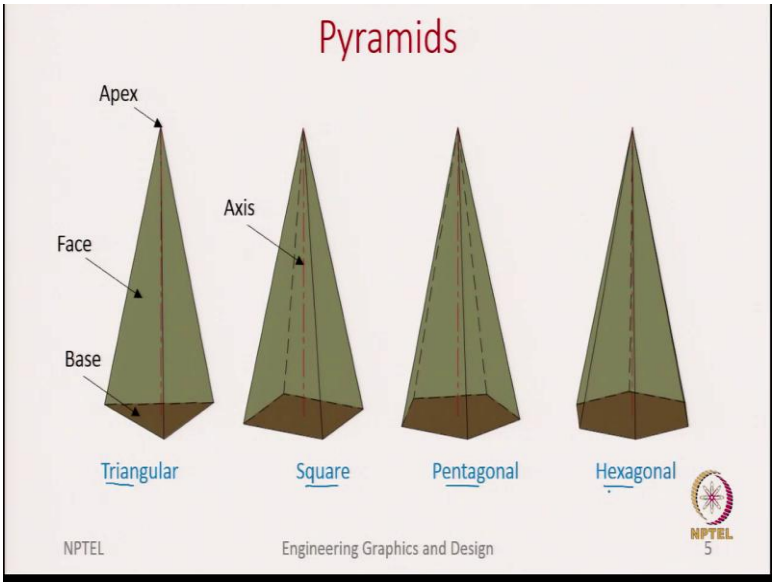
So, in addition to this, we also have the prisms and pyramids so these are typical prisms depending on the base we name them as triangular, square, pentagonal and hexagonal prisms. But let us look at the terminology. So, what we see at the top and the bottom, both are called the base and next is the axis, so this is the axis running along the length of the prism. So, it passes through the center of the base on either sides of the prism and once you connect it, you have this imaginary line called the axis. Next is the face so for example triangular prism will have three faces, in the standing position of this prism we have three vertical faces.

So, these edges which connect the points on the base, the corresponding points on the base are called the edges or most specifically the vertical edges, of course, vertical only is applicable when it is standing and if it is inclined, you might have to call it the inclined edge. So, similarly, the same things and the same terminology goes with the rest of the prisms.

(Refer Slide Time: 06:08)

So, for example, here what I have in my hand is a pentagonal prism so if you look in this direction you see it has 5 sides and, in this direction, you see that this cross section of a pentagon is uniform along the length of the prism so the imaginary line passing through the center is what we are terming it as the axis of this prism.

(Refer Slide Time: 6:31)

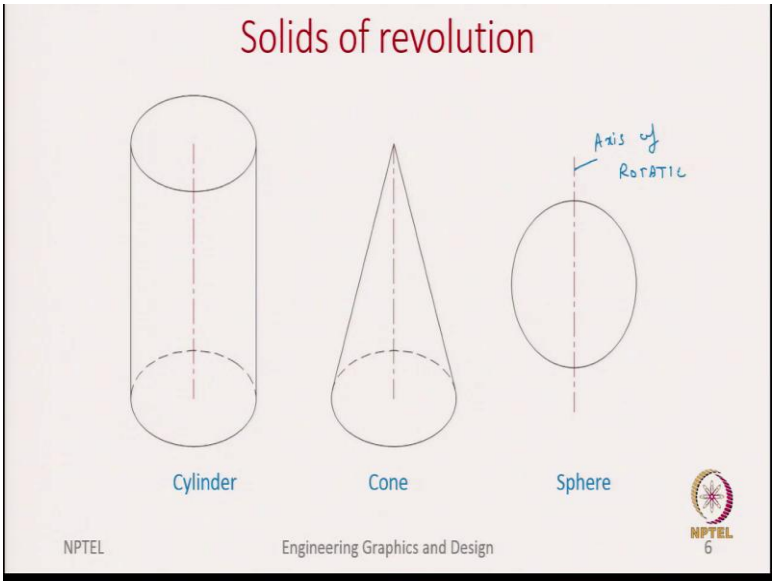


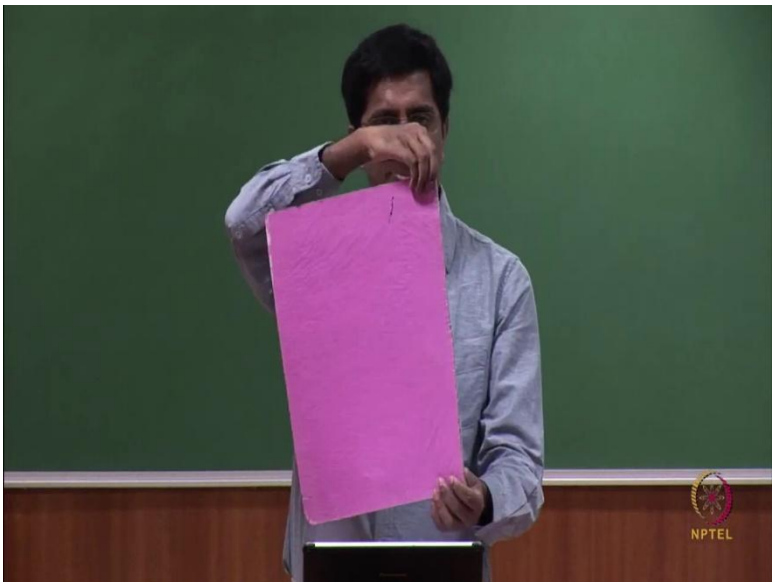
So, now let us look at the other category which are pyramids. Again, they are defined by the base as in prism so if the base is triangular, you call it as a triangular pyramid, square pyramid, pentagonal pyramid and hexagonal pyramid. So, the difference between a prism and pyramid is, in the pyramid you start with the base which is at the bottom and then gradually

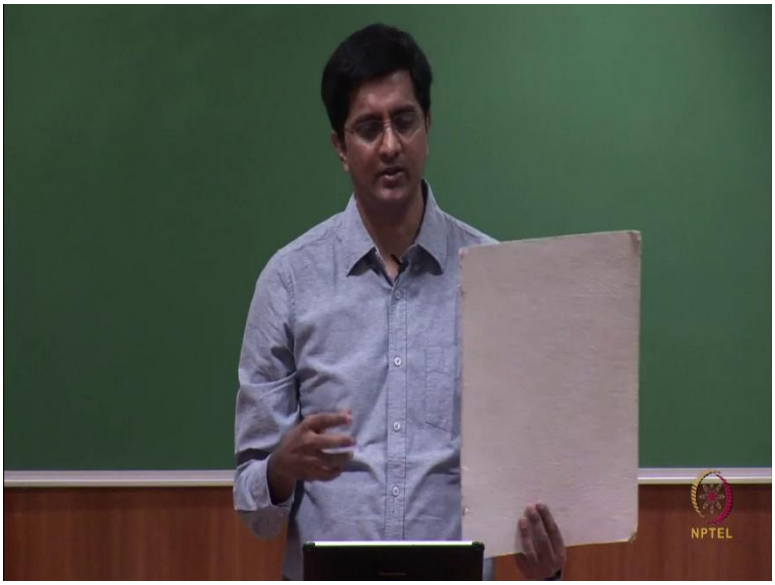
the cross section decreases but the shape remains the same which is the pentagon in this example and it ends with a sharp point which we call it as the apex.

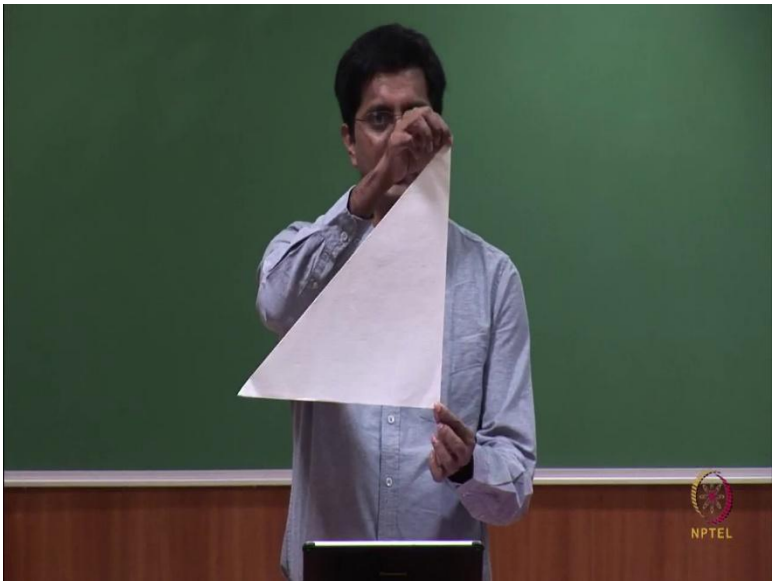
So, we start with the base and then end with the apex. And here too we have this imaginary line joining the apex to the center of the base, we call that as the axis and of course it has faces so for example, a pentagonal pyramid will have 5 faces and now you can see these spaces are all inclined. And these edges which are the intersection of 2 faces are this slant edges. So, to contrast, in my right hand I have a pentagonal prism and to the left hand I have a pentagonal pyramid. The only difference is, here the cross section remains constant but, in the pyramid, the cross section decreases to a sharp point which we call as the apex.

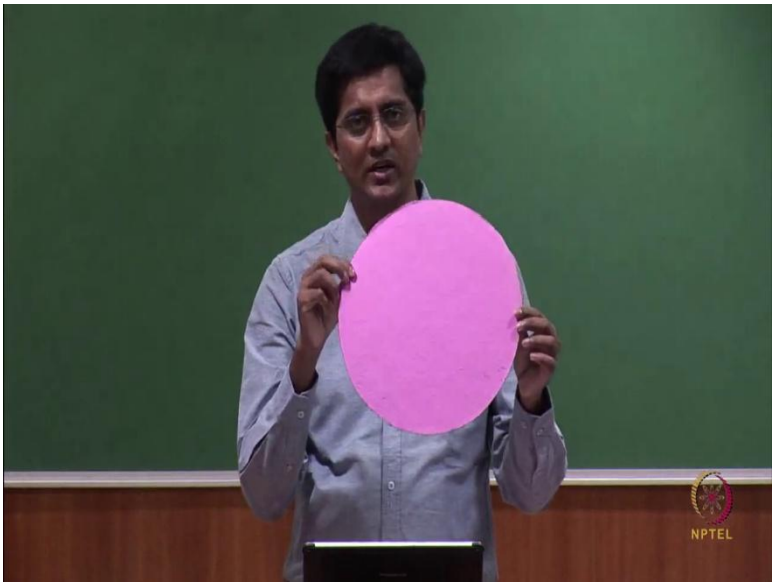
(Refer Slide Time: 08:06)






NPTEL


NPTEL


NPTEL

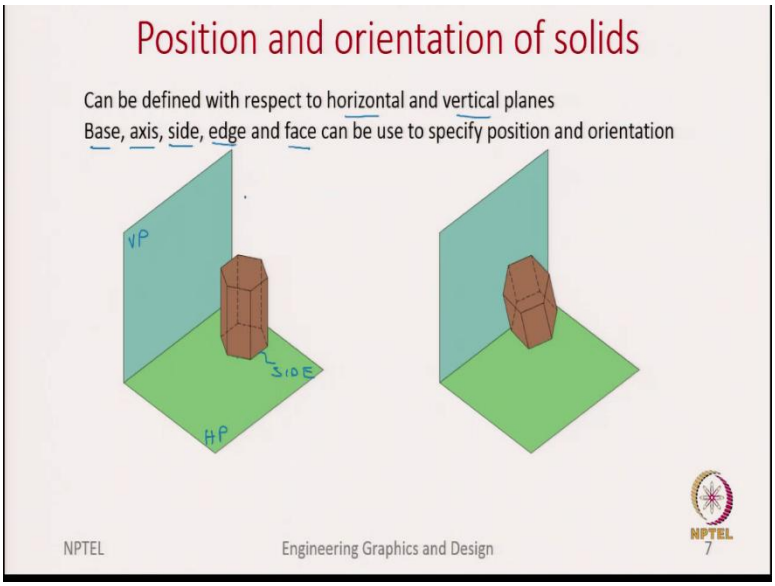
And the last category we ha solids of revolution because there are some solids if you take an axis and rotate them, we get a solid for example, let us start with, to get a cylinder I can take a rectangle like this and maybe by this from this edge I can rotate. So, let us see if I rotate about this edge by full 360 degrees, what I get is a solid which we call it as the cylinder.

Similarly, for the cone we can start with a right-angle triangle and let us say this is vertical edge is the axis and if we rotate about this axis by 360 degree or one complete revolution, we get a cone. Similarly, for a sphere I can start with a full circle and then make half a revolution to get a sphere or the other way is I can start maybe with a half circle and then make a complete revolution to get a sphere.

So, these are the basic solids of revolution of course there are much more complex solids of revolution one can obtain by using the same principle. So, here what we need is, this axis by which we rotate so this we call it as the axis of rotation.

So, finally when we are talking about solids, we need to specify two things for us to accurately describe the solid to say that where is this located which we call it as the position and how is it oriented? So, how do we specify especially in this engineering drawings.

(Refer Slide Time: 10:00)



So, for that what we use is this horizontal and vertical plane which we already discussed in previous lectures. So, let us say this is the horizontal plane and the other one is the vertical plane so let us say we are working in the first angle projection which means we place the object in the first quadrant. So, this what you see is a hexagon which is placed in a very

simple orientation. I call it simple because if you notice the axis of this hexagon it is perpendicular to the horizontal plane and parallel to the vertical plane.

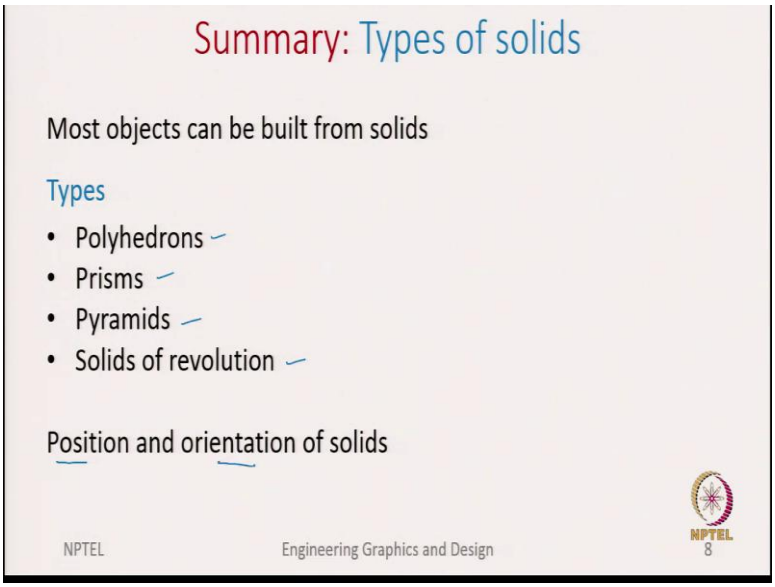
But the object need not be always perfectly oriented. Sometimes it might be in an inclined orientation. So, like this, so here you can see if you focus on the axis of the hexagon in the second figure, that axis is inclined both with the horizontal plane as well as the vertical plane. And let us say now we are asked to draw the front view and the top view, it is not a straight forward job. But if it is the hexagon is neatly oriented as in the first figure, then drawing the top view and the front view are more easy.

So, now what we will do in the next few lectures is, we will first study about how to draw a polygons because let us say, to draw a hexagonal prism, like this you first need to know how to draw a polygon which here is a hexagon. And later we will see how to deal with solids and take the projections not just when they are in a simple orientation but even in complicated orientations.

So, the one point I forgot to mention is, for example, to specify the position and orientation of this solid, I was using the example of axis saying that the axis is either parallel, perpendicular or inclined to the projections planes but you can use any other features like for example, I can say talk about the base, in the first figure we have the base parallel to the horizontal plane, but whereas in the second figure we have it inclined.

And similarly, I can use the side of a hexagon, saying that for example let us see, this side for example, is parallel to the horizontal plane as well as the vertical plane. So, maybe I can prefer to use that to specify the position and orientation of this solid saying that this particular side is at a distance of 10 units or 20 units from the horizontal plane and it is parallel to the horizon. Similarly, I can say the same side is at a distance of 50 units from the vertical plane and is parallel and similarly, you can use the other features like the edge and phase to specify the position and orientation of the solid.

(Refer Slide Time: 13:15)



So, in summary what we have discussed in this lecture, is to say that most of the commonly used objects can be composed of very simple solids and these solids are classified in polyhedrons, prisms, pyramids and surface of revolution. And we have also introduced various terminology related to this like the base, face, edges, sides, axis, apex and axis of revolution.

So, finally we said, we can use all this information to specify the position and orientation of a solid in space by using the horizontal and vertical planes as well as using the features of the solid like the base, face, axis, edge or side. So, in the next lectures, we will be first looking at how to project polygons and then gradually will go into the final step of projection of these solids. Thank you for your attention.