This video contains the contents of model number 9 titled Brillouin Zones. Of Unit one titled crystal structure. In this presentation we include concept of Brillouin Zones. Construction of Brillouin Zones. Then construction of Brillouin Zones for square lattice. Then construction of Brillouin Zones for cubic lattices. For example, Simple cubic lattice, Body centered cubic lattice and Face centered cubic lattice; for all these 3 cubic lattices we would like to see how the first Brillouin Zone looks like. After studying this content, the student will be able to understand the concept of Brillouin Zones in Crystal Lattice. And also, they will be able to construct Brillouin Zones for a given lattice. Let's move on to the concept of Brillouin Zones. The first Brillouin Zones is defined as the Wigner-Seitz primitive cell in the reciprocal lattice. It gives a geometric interpretation of the diffraction condition. Diffraction condition let me remind you it is 2 d Sine(Theta) is equal to n times lambda, where d represents the interplanar spacing, Theta represents the angle between the incident X Ray and the crystal plane, Lambda is the wavelength of X Ray, n is the integer which decides the reflection. So, it gives geometric interpretation of this direction condition. As I said, Bragg's diffraction condition: 2 d Sine(Theta) is equal to n times lambda in terms of reciprocal lattice. The Brillouin construction exhibits all wave vectors *k* that can be Bragg reflected by the crystal. The constructions divide the reciprocal space into fragments, out of which The First Brillouin Zone is of the greatest importance. Now let's go to the construction of Brillouin Zone. And let us focus on 2-dimensional reciprocal lattice. To construct the Brillouin Zone for 2-dimensional reciprocal lattice or 2-dimensional lattice, let us determine all the perpendicular bisecting lines in 2-dimensional reciprocal lattice. The area enclosed by those perpendicular bisecting lines give rise to the Brillouin Zone. So, with this, let us construct and see! The picture here presents the First Brillouin Zone of square lattice. This area is called the first Brillouin Zone of 2-dimensional square lattice. These points are the lattice points, yeah! And the two sets of lines are drawn. If you see this, is one set, they are horizontal parallel lines. This is another set or vertical parallel lines and the enclosed area between these two sets of lines is our first Brillouin Zone. Now coming to the construction of 2nd Brillouin Zones. If you see on this, another two set of lines are drawn. This is 1 set of parallel lines and there is another set of parallel lines. And these two sets of lines are perpendicular to each other. When that way we construct, what we get? We get again some enclosed areas where it is written "2". Yeah! These 4 enclosed areas represent second Brillouin Zones for 2-dimensional square lattice. Similarly, we can draw various set of parallel lines, and then they are perpendicular parallel lines, and then we can look into the enclosed area, and that will give us the next and next higher order Brillouin Zones. To summarize, let's focus the first 4 Brillouin Zone of a 2-dimensional square lattice. The Red coloured area represents the first Brillouin Zone, whereas, these 4 Green coloured triangles represent the second Brillouin Zones. And this 2 + 2 + 2 + 2 (2, 4, 6, 8) 8 Blue coloured triangles represent third Brillouin Zones, and whereas the black shaded areas represent the fourth Brillouin Zones. Again, going back, to the construction of Brillouin Zones for 3-dimensional lattice,

let us follow the method. Let us first determine all the perpendicular bisecting planes in 3-dimensional reciprocal lattice, the volume enclosed by those perpendicular bisecting planes give rise to the Brillouin Zones. With this method to construct Brillouin Zone for 3-dimensional Lattice let us first construct for Simple Cubic lattice. So, over here we have discussed the Brillouin Zone of Simple cubic lattice. The reciprocal lattice of a Simple cubic lattices itself, a simple cubic lattice of lattice constant $\frac{2\pi}{a}$. This fact we have studied in the previous module. The six planes bound a cube of edge $\frac{2\pi}{a}$ and of volume $\left(\frac{2\pi}{a}\right)^3$; this cube is the first Brillouin zone of simple cubic crystal lattice. Let us now study the Brillouin Zone of a Body centered cubic lattice! The construction of this is a tedious one. At this stage, it is necessary for you just to know what will be the geometrical shape of that first Brillouin Zone of a Body centered cubic lattice. Because the first Brillouin Zone of any lattice decides most of its properties. Look here in the diagram! What you see, is the first Brillouin Zone of a Body centered cubic lattice, which is a Rhombic dodecahedron. What do you mean by Rhombic dodecahedron? That is, a polyhedron with 12 flat faces. Where are those 12 flat faces? If you see, some you can see here and the remaining the backside. Altogether it is 12 flats faces and therefore, it is called Rhombic dodecahedron. So that's the first Brillouin Zone say, for a Body centered cubic lattice. Similarly, the first Brillouin Zone of a Face centered cubic lattice. You look at here! If you see this to figure, these two geometrical shapes are overlapping. So, with this the first Brillouin Zone of a Face centered cubic lattice is a truncated octahedron. To construct, it is very tedious. At this stage, from your learning point of view, it is just important for you to remember the first Brillouin Zone of a Face centered cubic lattice is a truncated octahedron. With this, we come to an end of the Model 9.