This video contains module name: Unit cell and Basis, of the Unit-1: Crystal structure of Solid State Physics elective course. Outline of this video as follows: Space lattice and Lattice points, Unit cell and Primitive cell, Lattice parameters, Crystal Systems, Bravais space lattices, Basis of crystalline structure and then, Crystal structure. After learning these topics, students will be able to identify different types of space lattice, they'll be able to identify different types of two-dimensional unit cells, will be able to differentiate between in unit cell and primitive cell, will be able to identify different types of crystal systems both in two-dimensional as well as in three-dimensional and they'll be able to differentiate between Bravais lattices. Space lattice and Lattice Points: Bravais was the first one to introduce the concept of three-dimensional lattices. As all of us know, solids have three dimensions. A space like this represents an infinite array of points, each of which has identical surroundings. These point in space about which the atoms are located in a crystal are called lattice points, and the totality of such points form a space lattice. Now coming to an example of three-dimensional space lattice and lattice points, a unit cell: Let's concentrate on this figure. If you can see there are network of straight lines and their intersecting and the intersecting points are called lattice points. And one shaded part of this space lattice is unit cell. The lattice points are at the intersection of this lines as I mentioned, and the smallest unit of a space lattice is called unit cell, and it is presented here. This cell is presented here. If we concentrate on the space lattice been drawn here. If you notice carefully, there are 8-unit cells present in this space Lattice. Repeated unit cells form the space lattice. Now, there are few examples of two-dimensional space lattice and unit cell. This picture represents a square lattice and these 2 squares represent 2 different unit cells. Different in the meaning: if you focus on this particular unit cell, it has four lattice points at four corners of the square, whereas this unit cell doesn't have any lattice point on the four corners, rather, it has one lattice point inside the square. Similarly, rectangular lattice. And now come to this rectangular lattice: centered rectangular unit cell. There are four lattice points in four corners of this rectangle and one lattice point inside. That's why it's called centered rectangular unit cell. Some more examples of space lattice and unit cells. This picture represents the hexagonal lattice because of its geometry, and this is the unit cell. And this one represents. Parallelogram lattice and this is the unit cell. So, coming from this slide to this slide, what we see different space lattice having different unit cells, even for a single lattice we have seen here in this case to different unit cells. So what is important in this case is the geometry of unit cell, and when space lattice is divided, there should not be no volume excluded to obtain an unit cell. But in case of 2D it is, there should not be any area left, to obtain an unit cell. Coming to unit cell and primitive cell: what is that primitive cell? Unit cell having one lattice point is called primitive cell, and all unit cells may not be the primitive cell. A lattice can be characterized by the geometry of its primitive cell. The figure here, we can see there are A, B, C, D, E, F: 6-unit cells. And all those 6 cells are of different sizes and different shapes. But to focus out of these 6 which are primitive cells and which are non-primitive cells? Let us try to understand. Let's take an example of unit cell A. All four corners of the unit cell have four lattice points and every corner of this unit cell or this lattice point is shared by 4 such unit cells. Therefore, its contribution is one fourth, and like this one, there are 4 corner lattice points. Each will contribute one fourth, 1/4th into 4 = 1. So, it is 1 lattice point in unit cell. Therefore, the cell, unit cell A can be called as a primitive unit cell. So also, the unit cell B, so also the unit cell C. No matter their shapes are different. But now coming to the unit cell E: if you see there are 4 lattice points at 4 corners, so all 4 of these lattice points will contribute 1 lattice point to the cell and there is one at the center, therefore, 1 + 1 = 2 lattice points per unit cell. So, the unit cell E is not a primitive cell, rather will name it as a non-primitive cell. So also, take the example of D: These all 4 corner lattice points, they contribute only 1 and there are 2 edge lattice points, each one contributes half. Because they've been shared by adjacent ones, this consecutive or adjacent to unit cell. So also this one, and therefore, they contribute half into (two such lattice points) 2 equal to 1. And the corners plus the edge together, they contribute 2 Lattice per unit cell. So, the unit cell D is a non-primitive unit cell. Now coming to unit cell and primitive cell of three-dimensional lattice: I have presented here cubic cells, and these two are monoclinic. This is triclinic and these two are tetragonal, and these two are orthorhombic. The idea behind presenting all these seven different unit cells, is to bring to your attention that they are all of different shapes. But this one is a primitive cell where this one is a non-primitive cell. So here in case of monoclinic, this one is a primitive cell, this one is non-primitive cell. Triclinic is again a primitive cell. So, the primitive cell: the unit cell which can be called as a primitive cell basically will have the lattice points at the corner of the cell. Just to give an example, let's take the cubic unit cell. Yeah! It has 8 corners, and 8 lattice points. Each lattice point contributes 1/8, because this point is shared by 8 such unit cells, and (1/8th into 8 such lattice points) 1/8 x 8 = 1. So, one lattice point in unit cell. Therefore, it is a primitive cell. Then coming to the lattice parameter: The lattice parameter is nothing but the unit vectors a, b and c along three crystallographic axes; as well as alpha, beta, gamma, the interfacial angles constitute lattice parameters. Any lattice is defined with help of these six lattice parameters. Coming to Crystal system in two-dimension, again, if you see there are different shapes: square, hexagonal, rectangular, centered rectangular, oblique. In case of three-dimensional, lattice parameters: there parameters are 6: a, b, c and alpha, beta, gamma. but we're coming to 2 dimensional, the lab. These parameters are 3 only: a_1 and $a_{2,}$ and the angle between that, which is presented here. Now coming to the crystal system: three-dimensional crystal systems: Because the real solids are of 3-D nature, but for the simplicity case, we give example of the 2-D systems. These are seven basic crystal systems called cubic, tetragonal, orthorhombic, monoclinic, triclinic, trigonal and hexagonal. Most of the common metals and some important alkali halides have cubic structure. Bravais was the first one in 1848 to come up with 14 different lattices, which arranges the atoms, so that almost all the solids can be presented using those 14 different lattices. The 4 different types of repetition are seen in Bravais space lattices are called Simple cubic, Side centred, Body centred, and Face centred. Here is the picture, which is presenting all that 14 Bravais lattices. And this table present the all the information about Bravais space lattices. Now coming to the basis, if you see associated with the lattice point, there are two atoms: one big round and one small round shown. The two atoms associated with the lattice points, that is called the basis of the crystalline structure. It is in 2-D presentation of Basis of crystalline structure. Now coming to the lattice point plus the basis, it gives you the space lattice. Here is a square space lattice and this is the basis of that lattice. And lattice point and basis define the crystal structure. If there are more than 2 atoms at a lattice point, we need to define the number of atoms and its kind, interatomic spacing, and orientation in space. And just for your information, there is 3-D crystal structure: Rock salt, Perovskite (Barium titanate) and Diamond presented here just to have an idea about the 3-D crystal structures. With this, we come to the end of Module 2.