In this video, we present the content of the module number 7 titled Miller Indices Part 2 of Unit one titled crystal structure. Outline of the presentation goes as follows. Important features of Miller Indices will be discussed 1st and then we derive the separation distance between their lattice planes in a cubic crystal. Learning outcomes are as follows. Students will be able to apply concept of Miller indices to identify different planes in cubic crystal and they will be able to relate interplanar spacing with Miller indices of the plane and edge of the cubic crystal. Important features of Miller indices. A plane which is parallel to any one of the coordinate axes has an intercept at infinite and therefore the Miller indices for that axis is always 0. A plane passing to the origin Is defined in terms of a plane. Parallel plane having nonzero intercepts. By changing the sign of all the indices of a direction, we obtain the opposite direction. By changing the signs of all the indices of a plane, we obtain a plane located at the same distance on the other side of the origin. The normal to the plane with indices hkl. Within the round bracket is the direction. hkl within the square bracket. So, for example, here this is the plane is 100 and this is the vector direction. Arrow is drawn 100 that is perpendicular. Normal to the plane 100 is represented by the direction 100. Similarly normal to the plane. 101 the direction. Presented it is 101. All the parallel equidistant claims have the same Miller indices. For example. 844 the plane represented by 844 is parallel to the plane represent by 422 and also parallel to the plane represent by 211. The most important feature of Miller indexes. Are as follows. The planes with low index numbers have wide interplanar spacing compared with those having high index numbers. Moreover, lower index planes have a higher density of atoms per unit area than the higher index plane. In fact, it is the lower index planes which play an important role in determining the physical and chemical properties of solids. Now let us derive the separation distance between the lattice planes in a cubic crystal. You see here the Axis X Y & Z three crystallographic axes, the plane ABC with Miller indices, hkl is touching at point A. Here at Point B here, and at Point C. Here, OP is a perpendicular drawn from Origin 0 to that plane ABC. That is, OP is equal to D1. Let us consider and then the respective angle is Alpha prime, beta prime, and gamma prime be the angles between the coordinate axes XYZ and are OP the normal to the plane ABC OP that is making angled Alpha prime, beta prime and gamma prime with respective. Coordinate axis. With this we can always write down the intercept of the plane on the three axes. That is, OA, can be written as a /h. a is the Edge distance, or cubic edge a/h Miller indices similarly OB ca be written as a by k and C will be written as a by l. now coming to the right-angle triangle OPA OPA. cos alpha prime can be written as d1 / a upon h. Similarly, cos beta prime can be written with reference to the right-angle triangle OPB. OPB it can be written cos beta prime is equal to d1 / a by k and similarly with respect to right angle triangle OPC we can always right cos gamma prime equal to D1/a by l. OP square can be written as $X^2 + y^2 + Z^2$. With that we have expression here. And we will substitute. d1 square is d1 square cos square Alpha prime. d1 squared Cos square beta prime. D1 squared, cos square, gamma prime and from this equation it is in for. Cos square alpha prime plus. Cos square beta Prime Plus cos square Gamma prime is equal to 1. And substituting the values of Cos Alpha prime, cos beta Prime, cos gamma prime from this slide and equation over here what we get this equation we get and from this we can rearrange it to get an expression for d1 in terms of lattice constant a or the edge length a divided by sqrt $h^2 + k^2 + l^2$, where hkl represent the Miller indices of the plane A B & C. Let's go to the next step, let's draw. a plane A prime B prime C prime are passing through the point Q along the same direction. OK, OQ let us name OQ as d2 O origin to point Q as d2. OK. And OA prime. OB prime and OC prime can be defined as 2a/h, 2a/*k, 2a*/l using the Intercept.

Then from the angle OQA prime. OQA prime, A prime has to be somewhere here. B prime has to be somewhere here and C Prime should be somewhere here because A prime, B prime, C prime is a parallel plane to the plane ABC. Therefore, ABC as well as A prime, B prime, C prime They have the same Miller indices hkl. So, we can write down cos Alpha prime, cos beta prime, cos gamma prime in terms of d2. In this way, this equation represents that. Now let's again take OQ squared will be. d2 square cos square alpha prime, d2 square cos square beta prime plus d2 square cos square gamma prime and from that is obvious that square of cos square Alpha prime plus cost square, beta prime plus cos square gamma prime is 1. And substituting these values. Finally, what we get d2 is equal to 2a / sqrt h ^2 + k ^2 + l^2. We had an expression for d1 over here. And we have expression for d2. Then interpreter spacing is nothing but the distance between two adjacent parallel planes. For example, in our case it is a plane ABC and the plane A prime, B prime and C prime. Having the same Miller indices hkl in a cubic lattice so. d hkl represents that distance and that is nothing but the distance between the two planes are nothing but OQ minus OP, and when you do that substitute that we get a / a square sqrt h^2 plus k^2 plus l^2. Let's look into this example. So, this plane is 010 plane. And its opposite plane is 01bar0 plane, the distance is or can be considered as a. That is the cube distance or cube edge. OK now let's draw another plane right in the middle: midpoint between these two planes. This particular plane which is drawn, that has Intercept for Y axis a /2, whereas it is parallel to X axis as well as Z axis. So, with that, the plane could be presented as 020 and, in the formula, when we substitute that, Miller Indices 020. What we get a divided by (0 ^2 + 2 ^2 + 0 ^2) raised to half that is a / 2, Exactly what we have the Intercept for the b, and that is the distance between this plane and this plane or, this plane and this plane. These three are parallel planes. With this we come to an end of the particular module.