Hi. Welcome back to An Introduction to Engineering Mechanics.

One of the important skills that engineers have is to take a complex problem or a real world situation and model it so that we can analyze or perhaps design our system in a different way and still have our model. were. We wanted simplest model possible yet we wanted to be giving us accurate or suitable results and so, last class we talked about modelling a or representing a force in a 2 dimensions and x and y or a plane just a single plane. Sometimes, some of the problems that you may have to work with will have to be used 3 dimensional approach. To be more accurate and to provide you a better solution. And so, in this case, today, we're going to look at a 3-d representation in X, Y and Z coordinate system. So, the learning outcome for today is to express a three-dimensional force in terms of it's rectangular and components. And then we're also going to make use of the dot product to find the projection of a force vector. Vector.

So this is the steps that you'll go through in, in, doing a 3D representation of a force. You're going to find the position vector along the line of action of force, you're going to determine a unit vector along that line of action. And then you're going to mu-, multiply that unit vector by the magnitude of force to provide you with a force vector. It's easiest to learn this material by actually going through an example. You can always refer back to this slide to see the steps that we've taken to, to, to do the problem. So here I have a, a worksheet, and I'm looking for a 3D force representation of the force F and then the force P, and Once we have both of those, we can find the resultant of those 2 forces using the, the parallelogram, parallelogram rule that we learned in the last module. And so what I'm going to do is, I'm going to do the forced, F with you together. I'm going to ask that you do force P on your own and then you also do the resultant on your own since you'll then know how to do those steps.

So the first step is to find the position vector along the line of action of the force. In this case, the force F goes from point A up to point B. And so, we're looking for the position vector from A to B. And what we do as I, I mentioned here is we walk from tail to head. The tail of the force is at point a, the head of the line of action for the force is at point b. And so in going from point a to point b we so how far do we go in the x direction. Well in this case we go -3 units in the x direction. That's -3i. And then we go, + 12 units in the j direction, or the y direction. So that's +12j. And then we go three units in the k direction, or +3k. Okay. And here I've written it again. Once we have that now we want to find a unit vector in the direction of that force F. And the way we do that is that we der, we divide the position vector by its magnitude. And so the magnitude, the magnitude of the vector AB can be found by taking the square root of the sum of the squares. So we have the square root of (-4)^2+(12)^2+(3)^2, and that = 13.

And so, our unit vector, which I'll represent with a E, with a vector designation of the e, so this is eAB is equal to the position vector AB over the magnitude of the position vector AB. Or in this case that's going to be -4/13, in the i direction, + 12/13 in the j direction, + 3/13 in the k direction. So now we have a unit vector in the direction of the force, we know the magnitude of the force it was given as 260 pounds and so the final expression of the force F. As a vector = magnitude of the force * the unit vector. So that's going to include both magnitude and direction. And so we have 260(-4/13i+12/13j+3/13k).

And so F= 4/13*260 is -80i. 12/13*260 is +240j. And then 3/13*260 is +60k. So we have magnitude now.

We have direction. And the last thing we need to put on here is units. And since we're in the SI units, this is Newton's. So that's how I represent, the force F in 3 dimensions. Now I'ld like you to do the same thing with force, P. Which a 100 Newton magnitude and you can see p goes from point b to c. And then find the resultant of those two forces, F and P together. And I've included a solution to this problem in your module hand outs. And so I ask that you do this on your own and then check your self out to see that you've learned these outcomes.

Okay. The last thing we want to do this module is find the component or projection over force onto another force or line using the definition of a dot product. So lets take a force F and a force Q. With an angle between them of theta. And we're going to use the definition of a dot product to find the projection. So by definition, F dotted with Q, is the same as Q dotted with F. And that's equal to the magnitude of F * the magnitude of Q * the cosine of the angle between them.

So, if I want to find the projection of F in the Q direction, what I'll do is I'll take the force F and I'll dot it with a unit vector in the direction of Q. And we know how to find a unit vector of Q because we just did that. So we have, we'll call the unit vector u And so u=vectorQ/the magnitude of the vector q. And then we can finally find the projection of F on the q direction by saying F dot u = the magnitude of F * the magnitude of u. If the magnitude of u is 1 times, the cosine of the angle between them. So that's the projection of F in the q direction. So that's this distance here. Magnitude of F cosine of theta. And that's where we'll finish up for today's module. Thanks.