Welcome to module three of an Introduction to Engineering Mechanics. Let's look at today's learning outcomes. We're going to learn how to express a two-dimensional force in terms of its rectangular components and also in terms of its parallel and perpendicular components when it's acting on a, on a slope. We're then going to also learn how to apply vector addition to, find the result of more than one force. So let's go ahead and look at a 2D force representation in Cartesian coordinate system.

Here's our Cartesian coordinate system. X and y and we'll have a force acting up and to the right, and I'll label the force as a vector with a line above the symbol. And we'll say that the force has a 150 pound magnitude and let's say that, that force is on a 3 on 4 slope. So, this angle would be theta, where theta would be equal to 36.9 degrees.

And what we want to find now is the rectangular components of the force F along the x axis and along the y axis. So what we're going to do is we're going to draw a perpendicular from the x and the y axis. So this is a perpendicular, and this is a perpendicular. And, this component will be F(x) and this component will be F sub y.

So if I want to find the magnitude of the x component. It's equal to, okay let's consider this by trigonometry. We have our hypotenuse which is 150. This is our adjacent side, and this is our opposite side. So, the F(x) component, rectangular component, is the adjacent side or the cosine, so we have 150 times the cosine of theta, or we can also use similar triangles to find which component is the F(x) component. So, we have a force that's on a 3 on 4 slope so its hypotenuse is 5, our force is a 150 pound hypotenuse and so we want to find the x component and the component. We got to do the x component at this point. So, for the x component. It's going to be corresponded of four sides, so it's 4/5 of F or 4/5 of 150. So, as a final answer I can write that the magnitude, actually not just the magnitude but the force. Sub x, the rectangular component in the x direction would be equal to 4/5 of 150, or 120 pounds. And it would be to the, right or we could also say 120 pounds in the i direction. So that would be the X component.

Similar we can do the, the Y component, and so the magnitude of F of Y now is equal to, the Opposite side over the hypotenuse or the sine. So this would be F sin Ć� or I could put in F as being 150 pounds and using similar triangles, the Fy component corresponds the three side of the 3, 4, 5 triangle so that would be 3/5 of F or 90 pounds. And so if I wanted to write the final answer for F(y) it would be a magnitude of 90 pounds and it would be up, or I could write 90 pounds in the j direction. That's how we find rectangular components in the Cartesian coordinate system.

Let's look next at the parallel and perpendicular components of a 2D Force Representation. So, let's take a force that's on a slope. Now let's say that that slope is 3 on 4. And we'll have a force down and, so it's straight down, let's call it a weight, W. And we want to find, in this case. The component of the force that's parallel to the surface and, the component of the, force that's perpendicular to the surface. So I'm going to label this, w sub perpendicular with a perpendicular symbol and this'll be w parallel, with a parallel symbol. And you should be able to show by, geometry that I can express this as 3 or 4 for a slope and so if I want to now find the perpendicular component, the perpendicular side corresponds to the 4 side of the 3,4,5 triangle so that would be 4/5. Of W, and it's acting down and to the left, and it will be on a 4 on 3 slope again by geometry. So, that's our one component in the perpendicular direction. And then we have our other component in our parallel direction. And the parallel component corresponds to 3 side at the 3 4 5 triangle. And it is down and to the right and it's on a slope of 3 on 4.

So that's, the way we'd express the parallel in perpendicular components of a force. Let's next go on and look at how we would add forces together. We use what's called the Parallelogram Law to find what's called the vector resultant and so we have our resultant force if equal to our F1, our F2, however many forces we want to add together.

And so, I've got an example for us to do together. If we have an F1 force which is 40i and 30j pounds and an F2 force which is -60i + 50j pounds, I would like you to take a couple of minutes and write down what the resultant would be, and then we'll do it together. Okay, let's go ahead and look at the resultant, very simple to do resultant force, let's call it R for the resultant or we could call it F, I mean we can label it whatever we like. But the X component or the I component is 40 - 60 or -20 in the i direction. And then we add the j components. And so 30 + 50 is 80 j, pounds.

Okay, in your module, I've included a worksheet PDF of a worksheet that you should now be able to complete and will help test whether you've learned, the outcomes that are required for this module. And so there are three problems. One is to find the x and y components of the forces shown, and find the parallel and perpendicular components of the forces shown, and then find the resultant of the force system that's shown. And if you can complete those, you should be well on your way to, fully understanding the learning outcomes for this module. See you next time.