Hi everyone, welcome to Vector Mathematics 1.

Let's start with a review of vector math. So, the variables we work with in fluid mechanics we can divide into two different categories scalars and vectors. What's the difference? Well scalars have a magnitude only, whereas vectors have both a magnitude and a directionality to them. So, some examples of scalar quantities that we'll work with in fluid mechanics would be things like temperature or pressure. Some of the vector quantities that we are going to work with are velocity, force, or acceleration. And you'll notice that when I wrote the variable name for the vector quantities, we've got these little notations above them that define them all or identify them all as vectors.

So, let's talk about the unit vectors. i, j, and k these are our unit vectors respectively in the X, Y, and Z directions. Why do we need unit vectors? So, these um these vector quantities um that I mentioned that we're going to work with in fluid mechanics like velocity, force, or acceleration they can vary each in up to three different spatial dimensions of X, Y, and Z like on our coordinate axes over here. So, for example I could have a three-dimensional fluid flow where velocity, V, looks something like this and my velocity vector could be varying in the two different horizontal directions, X and Y, and in the vertical dimension Z. So, if I was going to express this in vector notation, I would write it like this. So, this notation specifies that I have three components to my velocity vector each with a magnitude given by V sub x, V sub y, and V sub z. And then a directionality which are given by my unit vectors i. j, and k. So, the purpose of that unit vector is to specify the directionality, they each have a magnitude of one and that's why we call them the unit vector. So i has got a magnitude of one in the X-direction, so if I wanted to draw the i unit vector over here on my axes right it might look something like this, my j unit vector would look something like this, and then my k unit vector like this. So, let's say that our velocity had a magnitude in X, Y, and Z with a magnitude 3, so then I would rewrite my vector putting in my magnitudes of my X and my Y and my J components like this. So now my X component of velocity, I'll draw my velocity components here in a different color, I have a magnitude now of three that's being multiplied by my unit vector i, so it has a directionality of i with a magnitude of one. So, my combination of Vx and i looks like that. And the same thing for my y component of velocity, has a magnitude of three and is being multiplied by my j unit vector. And then in my vertical I've got a magnitude of 3 multiplied by my k.

There's one more set of unit vectors that I'd like to introduce and that is the unit normal and tangential vectors. So just like the spatial unit vectors i, j, k the unit normal and tangential vectors also have a magnitude of one. Um so here is my unit normal vector and my unit tangential vector, that's a Greek letter tau. Um so instead of my normal and tangential vectors being aligned to my coordinate axis system and the spatial dimensions of X, Y, Z the unit normal is always going to be normal to some surface. Like for instance we've got this ellipsoid um three-dimensional object that has a surface anywhere that's tangent or normal to that surface. Uh that would be the directionality of my tangent and my normal unit vectors so let's say I have a force that's acting on this surface that looks something like that and let's say that I want to decompose this force into components that are normal and tangential to the surface where it's acting. So, I'm going to draw out our normal unit vector. It would look something like this, normal to the surface and then our tangential unit vector might be something like that. And then the angle that is operating between my normal vector and my vector I'm going to call angle theta. So if I want to compute the component of force that is normal to the surface it's going to be the dot product of my force F and my unit normal vector where my dot product is you know, my absolute magnitude of my force the absolute magnitude of my normal vector, which of course is going to be one, and then cosine of the angle between them and that's going to give me the magnitude of that force that is normal to the surface.

Good for you for making it to the end of the video. You can reward yourself with a nice picture of mangrove vegetation. I study fluid mechanics because I love water and healthy aquatic ecosystems. Whatever your passion is, I hope that it motivates you to continue your study of fluid mechanics.