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SUMMARY KEYWORDS

derivative, nth derivative, notation, function, equal, $6x$, respect, put, f prime, prime, squared, velocity, orange, nth, bit, second derivative, f double prime, write, lecture, acceleration

SPEAKERS

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Welcome. In this lecture, we're going to, we're going to talk about higher derivatives. There's, a lot of this is just notation, but these are a real thing. For example, this is just like taking the rate of change of the rate of change. So the rate of change of position is velocity, the rate of change of velocity is acceleration. So that's something you've heard of, okay? But this happens in other settings. Also, it also can tell you, higher derivatives can tell you things about the shape of the graph of the function, which has meaning in it also. Okay, so what is, so this is kind of notationally, so what is the second derivative of a function F ? I'm going to kind of introduce you to several kinds of notation at once here. So the second derivative of a function F . So we're going to get F , and then we're going to take the derivative twice. So one way to denote it is to put two primes there. So this is going to equal, it's going to look like the derivative of the derivative of the derivative of F . Right? So this is the, right, so we're kind of writing that out. This is the derivative of, derivative of the, and then we have here the first derivative of F . So the first derivative of our function F . Okay, so what we're doing here is we're just taking the derivative with respect to X twice. Okay? So we are, what are we doing here is we're taking the derivative, so taking the derivative. And then it's important to note that each time we're taking the derivative with respect to the same variable, so taking the derivative with respect to X twice. Okay, so the N th derivative of F , you might guess, is it take the derivative N times, so the N th derivative of F .

For this, you start out with F , and then you take the derivative of that, and then you keep on going. And then you take the derivative, keep on going, take the derivative. Right? So I'm taking the derivative with respect to X N times, right? So I'm taking the derivative with respect to X N times. So taking the derivative always with respect to X . So with respect to X , and we're going to do that N times, right, where this N is the same as that N . Okay? So the N th derivative, so let's do a little bit more notation. More notation

Okay, so suppose that we have, suppose that we have Y equals F of X . Y equals F of X , okay, then the N th derivative. And maybe I will, I know I used red like there for something else, it's always a little bit dangerous, but I want to, maybe I want to use it here for something different. Okay. So the N th, so

the Nth derivative is going to be written, right, we're going to want to have, so we have Y and then we have in parentheses up here we have that N. So that's one way to write it. Another way to write it is that we'd write, so we'd write F here, and then we would put, so we put N here.

And then this X here. Another way to write it, which is a little bit funny, but it's what we do. So we put D, and then we put DX. And then we put, this is one of the funny parts, we put the N there and here. I don't exactly know why that is, but that's just how it goes. And then we put a Y there. Okay? And then, so let's look at an example. So example is suppose that we have, so suppose that we have Y equals F of X is going to equal $2X^3$. Then our first derivative, so our first derivative, or our F prime of X is going to equal the derivative with respect to X of F. So that's going to equal the derivative with respect to X of that function $2X^3$. And then this is going to equal, and I'm going to write this in red for a reason. So this is $6X^2$. So that's my first derivative, and I'm doing this so that we can kind of keep track. Okay, so in the next stage, I'm going to take the second derivative with respect to X. Right, so what I'm doing here is actually I'm going to take the derivative of, so this is equal to, I'm taking a derivative with respect to X of, and then I need to do F prime of X. So F prime, right? And here's my F prime. So that's what I'm going to put inside. So the derivative with respect to X, this is kind of why I gave that a color. So this is $6X^2$.

And then you can compute that out and you'll get $12X$. And then we're going to do that in orange, just to keep track of what we're doing. Right? So now if I wanted to take the third derivative, I'm going to take, oops, this is still of X, do let's do that the same color still. So now we're doing the third derivative of X. Oops, I forgot I'm probably going to want to underline that in orange, so you can see that that's what we have there. So this is equal to the derivative with respect to X of, and now this is this F double prime of X, right? F double prime, which is going to equal, so I have the derivative with respect to X of, and I can just put in this $12X$. I take the derivative, and what do I get, I just get 12. Okay, and then you would keep on going like that. So if I wanted the fifth derivative, I'd have to do that five times, okay? And then I kind of want to put a warning here, because there's something that gets a little bit confusing to all of us.

So this is going to be, this is like our warning, which is going to be that each, each of these is a function. So it's going to be a function until some X value until some X value is subbed in to get a number. Okay, so until some X value is subbed in to get out a number. To get out a number. That's going to be very important for when we're doing things to realize. This is something that a lot of students get by confused by. I shouldn't just say students, I've done that before in my life, too, is to not realize that when you are taking the derivative, right, what you're getting out even if this derivative is 12, what you're getting out is a function, and then you're going to stick in your value, that your value you're sticking in an X value to get out a number. Okay? So, I hope that made some sense and I will see you in the next lecture.