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derivative, xe, chain rule, cosine, left, rule, parentheses, product, respect, write, colors, x times e, slow, sine, function, unchanged, carefully, d dx, step, careful

SPEAKERS

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Welcome. Something that students often find confusing is how to combine the product rule and the chain rule. And my biggest advice on this is always just like take it really slow, like one step at a time. And this is exactly what I'm going to do, I'm going to do an example. And this is exactly what I'm going to do. But I hope you can see what I mean by that through this example. So example one. So we'll do two examples of this. But, so this is actually example one. I seem to have left that out of there. This is example one. Okay. So this is the one where the chain rule is on the outside in some sense, and the product rules on the inside. You'll see what I mean. Okay, so I'm going to take the derivative with respect to X of the function where I have sine of X times E to the X .

Okay, and so looking at this, we do have an outside and an inside function. So let's make that very clear to ourselves. Okay, so my, I've got this outside function like this, and then I've got an inside function, which is going to be U equals E to the X . Okay, so let's just kind of start and go ahead and start. So the first thing that I need to do, right, is to actually take the derivative with respect to U of, right, of this sign of U , right, so I want to take the derivative with respect to U of the outside. So the outside is this sine of U . And then I need to take the derivative with respect to X . I don't know if this is consistent with the other times I've colored this, but I just wanted to at least be consistent within here, so you can see what I'm doing, of, and then we have here this XE to the X . Okay? Um, so this is going to be the variable here. So maybe I can just even do this. So XE to the X .

Okay. You know, and then this is like, slowly, slowly. Okay, so what is the derivative of sine, okay, with respect to U , so this is just going to be a cosine of U . We'll leave this orange because we know that we have to replace this in the end with what's up there, right? Okay. So I just did this part here. So this part here went right here. Okay, now let's deal with this over here. Now we need to use the product rule. Okay, so for this part, we have to be a little bit more careful. So let's go ahead and do that. So I know I need to take, right, so I have X times $D DX$ of E to the X . I like writing it out first before we kind of actually take those derivatives, it's good to kind of be very careful. And then I have E to the X times the derivative with respect to X of X , okay? so I just took great, I've got a product. So I add together, you know, I keep this the same, then I take the derivative. I keep this the same, and I take the derivative. It's just how we use the product rule. Okay? So what am I doing here? This is a product rule. This is where I'm using the product rule. I can even write that for myself. I'm just using

the product rule. Okay, so now let's continue on. So now I can go ahead. So the first thing I want to do here, before I forget, is I want to actually put back in this E to the X. Oops, that's not an E to the X, this is an XE to the X.

Okay, so I have here XE to the X. And then I can multiply this by, so I can take these derivatives and so on. I know that there's colors here and there's colors, like most of the colors have been used. That's okay, actually, let's make this green because at the moment, we're not using green. So how do we take the derivative of this? So I just get E to the X, right, because the derivative of E to the X is E to the X there is easy one, and this one is one, right? So what do I get here? I just get that this is, so I have XE to the X, right? And then add E to the X times 1, so that's just E to the X. Okay. So, and usually we actually like to move that, and I'm going to do this, I'm going to move that to the other side. I say this a lot of times, why do we move it to the other side? So that we know that this is not something that's inside of the cosine? Okay, so let's just kind of finally, and everything's in terms of X now, so we know that we're done. So let's just kind of go ahead and write this. So this is going to equal, I can with the red too, so I'm just going to write this whole thing in red. So what do I have going on here? I'm going to move this over. So I have XE to the X plus E to the X times, and then I have cosine of X, E to the X. Okay, now let's kind of break apart the different things that are going on here. Okay, so one thing that happened was I took the derivative of the outside, right, so this is where I took the derivative of the outside. You know, just so that you make sure that in the end, you have all the right pieces. So I took the derivative of the outside.

Right, and here I left the inside unchanged, so I left the inside unchanged. And then what do I have going on over there? Is that I have, so here I have the derivative of the inside sits here on the outside, okay? So, the derivative of the inside is going to sit here on the outside. Okay? And that's it. Okay, so you should always kind of have this if you've done this correctly. Okay, oh, yeah, and then kind of my motto is take it slow, right? This is really what I did was to take it slow. One step at a time. So I'm even going to write that here. So we don't forget that, this is take it slow. So what do I mean by that here? What I mean by that here is that, so if you look at this, right, in the first step, like do your, you know I did my chain rule. But in my chain rule, I had to do the product rule. So I just kind of put everything very carefully in parentheses, you know when I'm taking the derivative with respect to X. Right? If you're writing it out very carefully, it's just obvious, oh wait, I have to do the chain rule here. Do that in parentheses, you know, just keep everything in parentheses and keep it very careful. It's good to you know, leave, make sure you're getting everything back in terms of X. I kind of left that in a color to make sure I remember to do it. And at the end, you just want to have, you have a kind of picture where you have the derivative of the outside with the inside unchanged, and then the derivative of the inside kind of sitting next to it. And so that's kind of what you should get in these circumstances. But just kind of take it one step at a time with parentheses and so on, and you should be able to do it. There's nothing actually new in it. Okay? So, I hope that made some sense, and I'll see you in the next lecture.