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SPEAKERS

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Welcome. In this lecture, we're going to go through how to use the definition of the derivative with the limit in it to compute the derivative of G of X equals X squared. Okay? So this is computing a derivative from definition example. So computing the derivative from the definition example. So this is what we're doing in this example. And then what is the function and so as I wrote above, this is G of X equals X squared. And then what we're looking for is this derivative, okay? Again, I'm going to use a lot of different kinds of notation so you get used to that. Okay, so let's go ahead and do this. So what happens when I take G prime of X? Well, I have this definition, which is that this is going to be the limit as, and then I'm going to have H goes to zero of, and then I have G. And then I'm going to have, the first one is going to have X. The second one's just going to have X, but this one is going to have X plus H, right? And then this is all going to be over H. So H is something that's getting very small. And then I'm looking at values close to this X. So adding something really small gives me values that are close to that. Okay, then I'm kind of looking at this slope or secant. Okay, so let's just kind of go ahead and get started. So this is like looking at the limit as H goes to zero, and now I'm just going to put in my function. Okay, I know that my function is G of X equals X squared. So what does it mean to do G of X? So as I usually like to do, do everything and then put in your variable, right, G of X is X squared. So every time I see X, I just do the parentheses. This time, I have X plus H. So I go ahead and put that in.

And this time, I just have X so I put that in. Okay? The function just squares whatever you have, so I did that correctly. And then I'm going to divide by H. And I'm looking at this and I have no clue what to do. Okay, and often a kind of useful thing to do at this point is to kind of expand things out and look to see if you can find anything that cancels. Okay, so that's what I'm going to do in the next step is to expand things out to see if I can find anything that cancels. So let's first expand out this. So first I'm taking, you know, I keep telling you don't forget to write the limit each time so that you don't get confused as to whether you've taken it or not. Okay, so let's first expand out this part. So I'm going to get X squared plus 2XH plus H squared. Okay, so that's what I got from this one. And then I'm going to subtract off, I don't know how that ended up orange, but we're just going to go with that, I'm going to subtract off X squared.

Okay, now I want to rearrange it in a way so that I can actually see some kind of canceling going on. I

still need to divide this by H. So let's go ahead and kind of rearrange things so I can see the cancellation better. So this is going to equal the limit as H approaches zero of, right, so let's go ahead and rearrange this. So I've got, right, so if I, if I put these together, I'm going to be able to see those cancel, so I have X squared minus X squared. Okay, those are from those two. Okay, and then the, everything that's left has an H in it. Oh, that's good, because I have an H on the bottom. So that could be really helpful. So I'm also going to do, I'm going to pull out the H of everything left. So I get 2X plus H once I pull that out. Okay, and then I divide by H. I'm using a lot of colors for some reason. Okay. Now the first thing that we see that happens here, so this part becomes zero, right? So we're just left with this. So we'll go ahead and write that part. So this is going to equal the limit as H goes to zero. So that part's zero. So I've got, hopefully this is H. Okay, so I've got on the top I've got H times this 2X plus H.

On the bottom I have H now because H showed up in every single thing on the top, so I could pull it out, I can actually cancel these H's. Okay? And so I'm going to get the limit, oops, the limit as H approaches zero of, so once I cancel these H's, so cancel these like that, I get 2X plus H. Well, now there's nothing wrong with just substituting the zero in. Okay? So I go ahead and substitute the zero in, and what am I left with? So this is going to equal and at this stage, I've taken the limit, so I don't write that anymore. So this is going to equal 2X plus zero, which is going to equal zero. So what is my conclusion here? That this derivative function that I wanted, so is that this G prime of X is equal, oops that should be a 2X sorry, equal to 2X. So this G prime of X is equal to the function 2X. Okay, that's kind of like my conclusion of that. Okay, so let's kind of play with this a little bit and draw it and see what's going on. So we have my function, so we have here. So this is Y, and then I have my X axis, okay? and then I have the function, so the function is G of X equals X squared.

So this is Y equals G of X, which is equal to X squared. Okay, now let's look at the slope at a few places. So let's look at one here. Okay, and if I look at one, so and then also we know we go up, so what is this point? This point is one and then I have to put G of 1. Okay? So this is G of 1. Right? And so this point is equal to, what is this point? This point is equal to a 1 squared, so I just get 1, 1. Okay, that's what this point is here. Okay? And then my slope. Okay, so what's going on with this slope? Well, this slope is going to equal, I'm going to take this G prime, I have to sub in 1, right?

Well, what happens when I put 1 into here? So I get 2 times 1, because it's 2X, right? And that's just going to equal 2. Okay, so my slope here is 2 at this particular point. Great. Now let's look at kind of another point. So maybe half of that. So now we're at minus 1/2. So this point here is going to be minus 1/2, and then I have to put that into G. So G of minus 1/2. For some reason, this is orange here now, doesn't matter. So this is going to equal minus 1/2. What happens when I put minus 1/2 into G? Well, G is X squared, so I get 1/4. Right? That's what happens if I square minus 1/2 is I get 1/4. Okay, so that's just this point. And then if I look at the slope of the tangent line there.

What's going on here? So this slope is going to equal G prime of this minus 1/2. Right, which then is going to equal, right, so we have to take 2 times minus 1/2, right because this is this function Y of X, so I put parentheses. And then I fill this in. So this is minus 1/2. So the slope is actually going to equal minus 1. Which it looks like maybe possibly it is, okay? So what are the kind of the key takeaways from what's going on here, okay? When we're taking the derivative, we're taking this limit. For your function, I find particularly when you've got like X plus H, which is confusing to know how to deal with.

Just every time you see your variable, stick parentheses and then at the end, you can stick in what you need to stick in, okay? And it might even help to have some kind of parentheses here, so you know that you're looking at different pieces. This goes to here and this goes to here. Okay? So do your parentheses and stick these in. We do have to, you're going to hit something and you'll be like, I don't know what to do with this. The key point is to try to kind of expand things out so that maybe you can see like, try to expand things out, group things together, find things that cancel. You have cancellation on top, when you have like something minus itself. You're also going to have cancellation when you do the same thing on top and bottom. A key thing to make sure you do here is you can't cancel what's on top and bottom unless you're able to do these parentheses things like this, where actually, because it actually showed up in each term there, okay? But then you are actually able to cancel it. And then once we got to here, this function, there's nothing wrong with sticking zero into it, it's in the domain. Okay, it's a polynomial where zeros is in the domain. You can stick that in and you get out 2X. Okay? So, I hope that made some sense, and I will see you in the next lecture.