Physics through Computational Thinking
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Lecture 1
Introduction to Mathematica, Wolfram Language

Welcome to Physics through Computational Thinking. In this very first video, we will tell you a little bit about the toolkit that we are going to use to learn this course. The toolkit that we will use to learn this course is called Mathematica.

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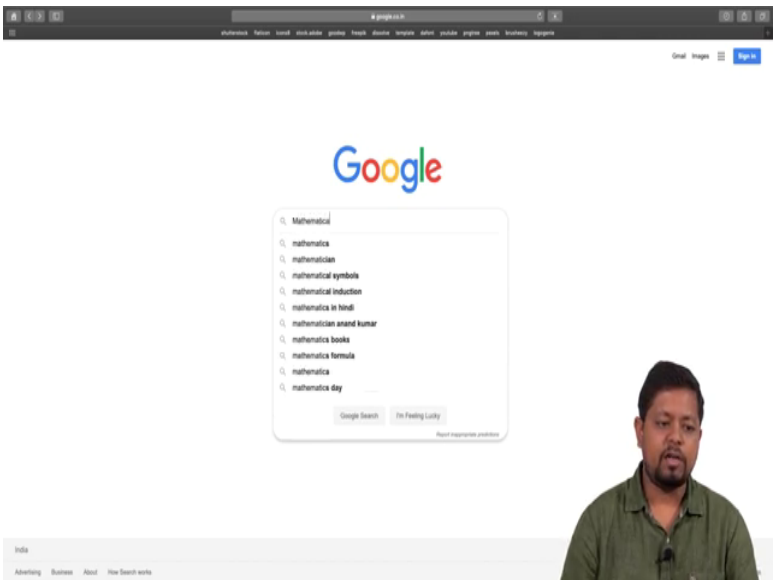

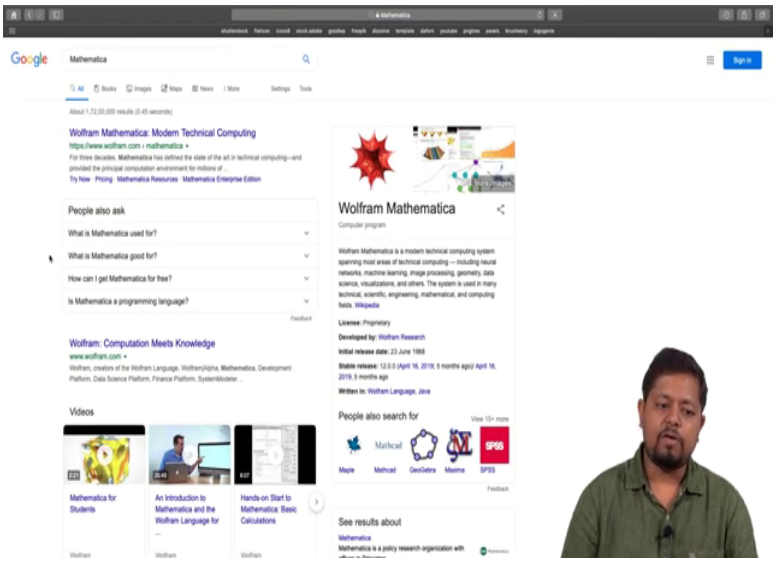

We can do a quick search about Mathematica. Mathematica is a software that allows you to do symbolic computing and a lot of other technical computing. What we will use in this course is a free version of Mathematica that is available online.

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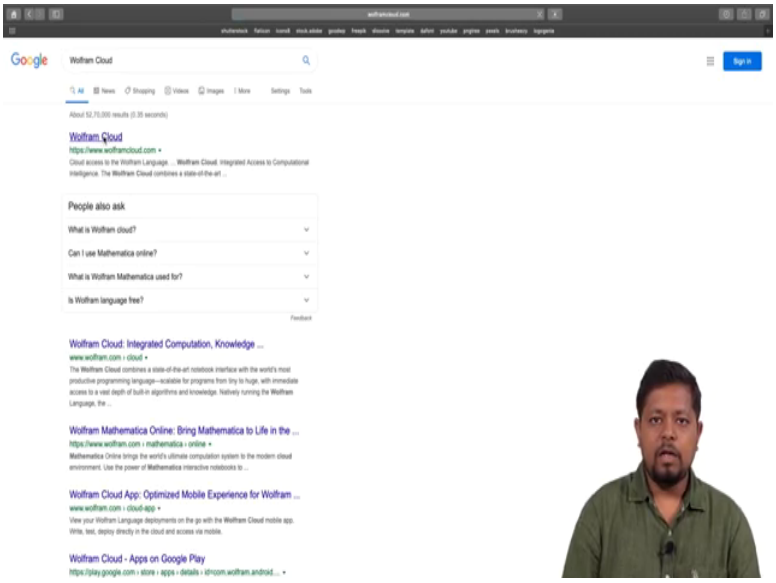

So, what we will do for that is search for Wolfram cloud. When you search for Wolfram cloud, click on the first link Wolfram cloud over here.

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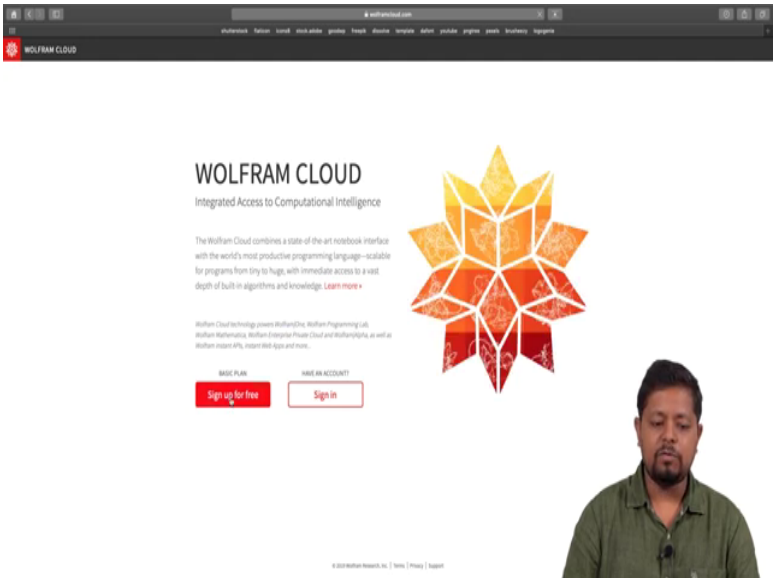

In this Wolfram cloud link, you go ahead and click on sign up for free and create a free account. This account will allow you a basic plan. When I click on sign up for free, it opens me a short form.

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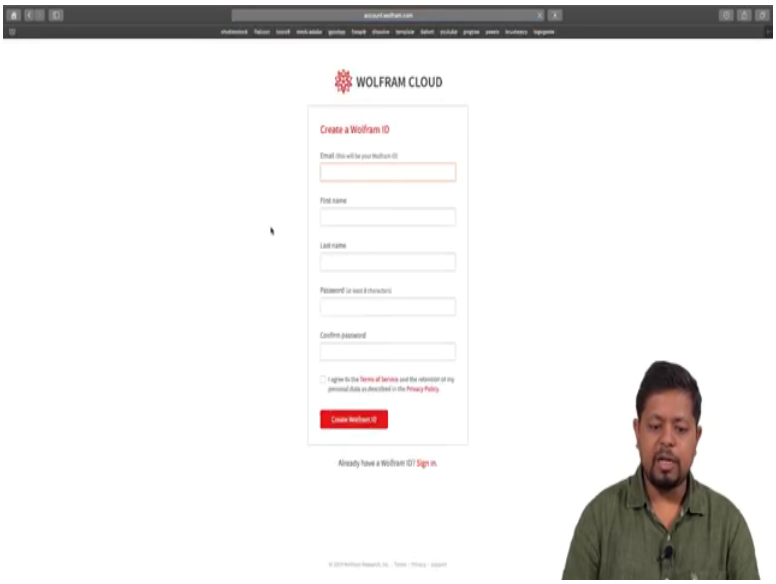

You put your email, your name and other information and then you go ahead and click create Wolfram ID, this will create your Wolfram account. Since I already have a Wolfram ID, I will just go ahead and click on sign in.

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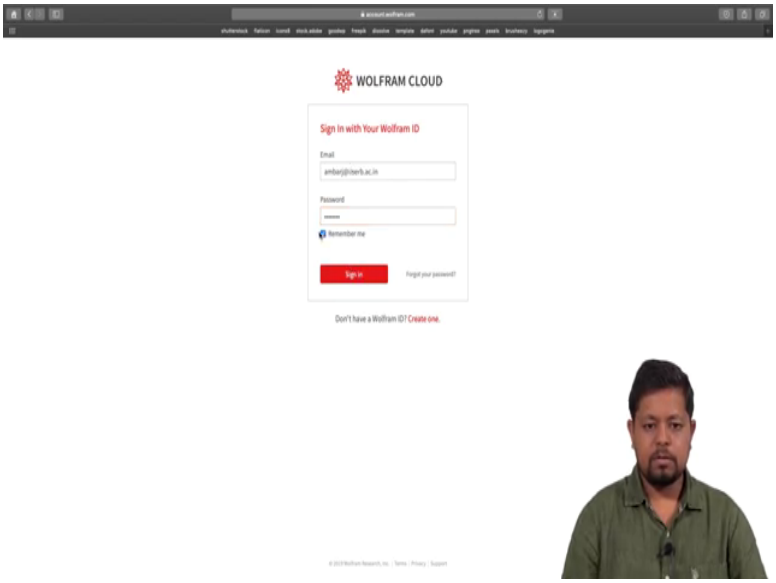

I will input my credentials here. Click on sign in, and this will take me to my wolfram account.

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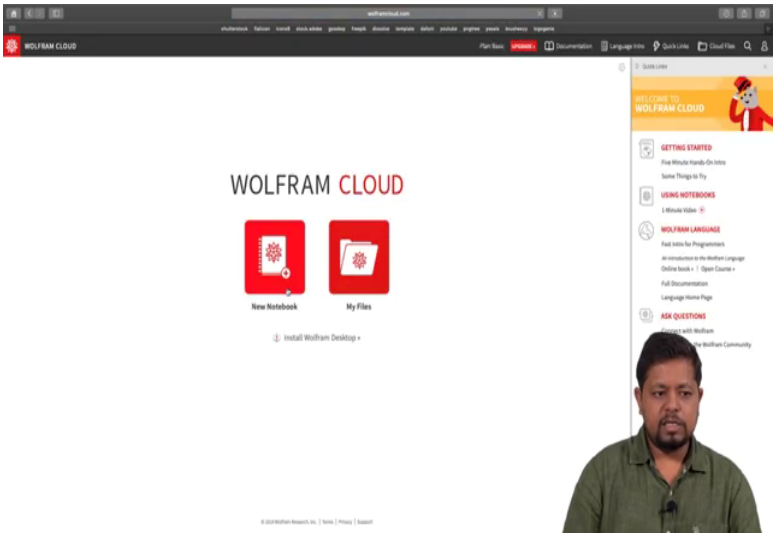

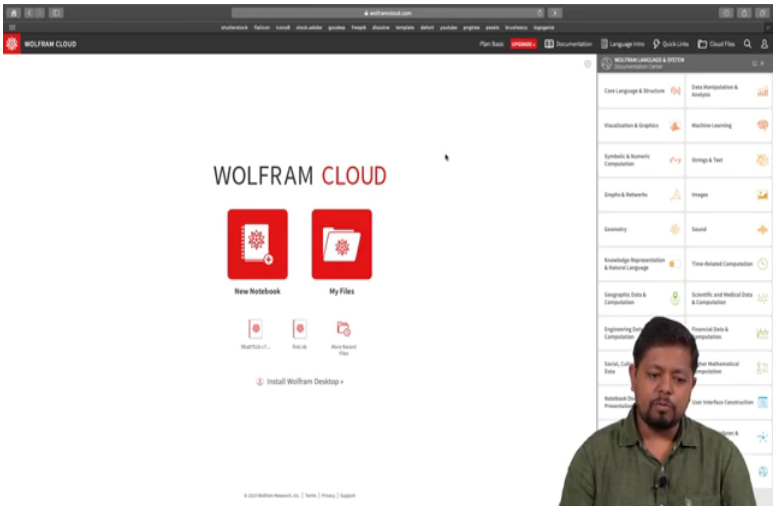

This says over here Wolfram cloud and it allows me to do two things: I can create a new notebook or I can go and check out my files. So, what I will do is, I will create a new notebook today and this is what we will start exploring, what is the software about and how we can use this for computational thinking and use it as a toolkit to understand and solve physics problems.

When you open this interface, you will see on the right-hand side you got this panel, which gives you tips about getting started using the notebook, it gives you a short 1-minute video of how to get started with that. I will also cover some of the basics, and gives you details about Mathematica or Wolfram language. There is online book and open course, there this documentation, and various other things that you can explore over here. At any point, if we need to refer to any of the library, we can click on the documentation over here.

Once the documentation loads it gives you information about various kinds of functions and features that are available in the software. Rather than, right now exploring all of these things, I would suggest that we start learning how to use the software and start doing some very basic and simple things. So, the purpose of this intro is to focus on some of the very basic and simple things. I will go ahead and click here - 'New Notebook'.

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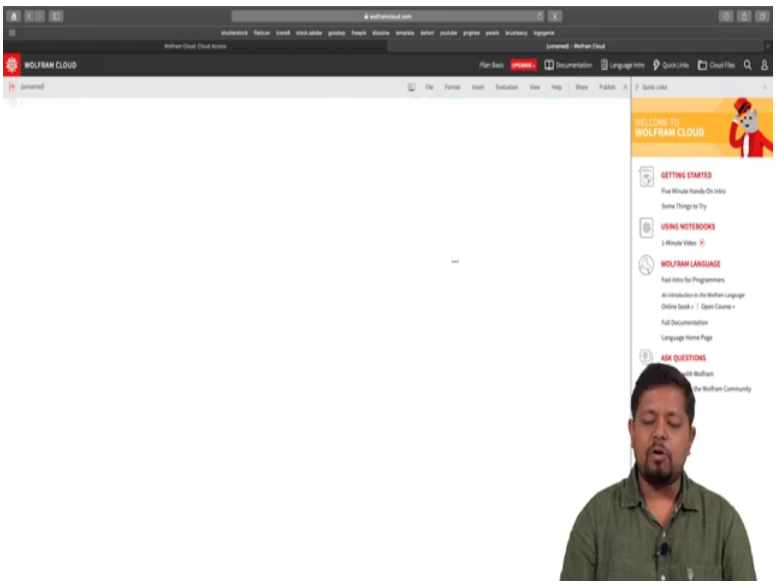

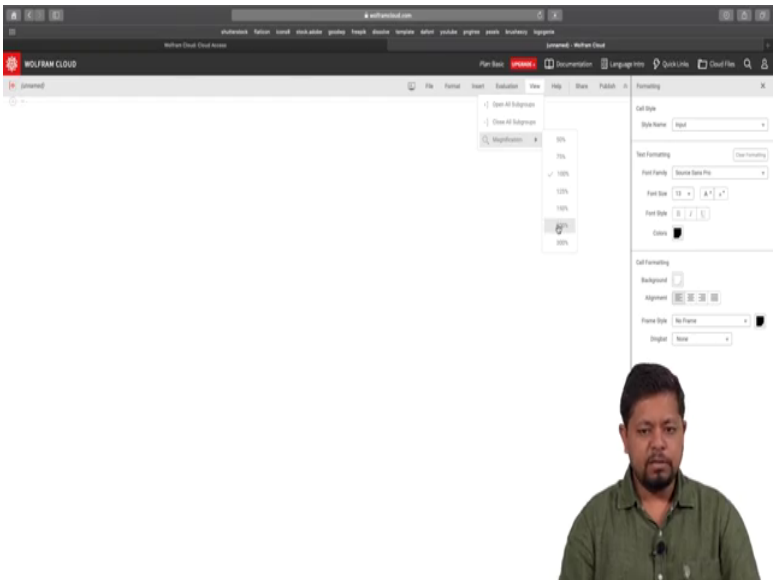

When I click on the new notebook, a notebook interface will open. Since this is not a web browser but a cloud-based application, anything that I calculate here will be sent to over the internet to the Wolfram cloud, computation will be done over there and the information will come back, and it will be presented over here just like any other cloud computing platform.

This is a very straightforward interface. You will get familiar with this interface very quickly. I want to point out to you that you see a Mathematica logo over here and it says Wolfram cloud on the top and over here. In front of the plan, it says you are right now registered for a basic plan. If you click on upgrade, you can upgrade but you will have to make some payment for that.

I would recommend that we will stick to basic plan. You do not have to take an upgraded plan. We should be able to do everything that we want to do with the basic plan. Basic plan comes with certain limitations such as the amount of file space you will have is very limited, you can only create about 5 files.

But, in that case, you can just download the files whenever necessary on your computer, keep them saved over there, and whatever file you are computing with, you can upload it. So, that way you will not need to make any payments to upgrade and we will be able to use the free basic version to learn the essentials of computational thinking, using Mathematica. Just like your browser, you have got file interface over here, which allows you to do various options.

I will suggest that you explore these options on your own. What I will do here is: I will go to the view and set the magnification to 200 so that you can actually see what I am typing.

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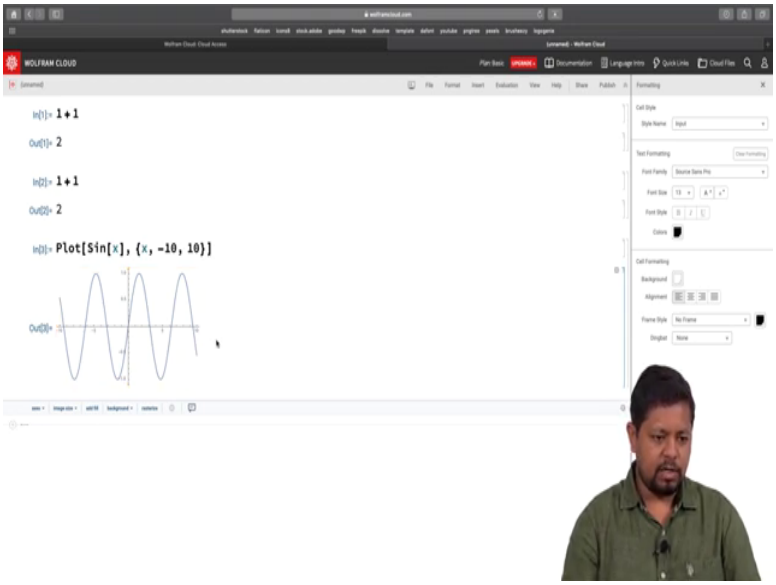

So, let us go ahead and get started with this. The first thing I will do is: I will just add 1+1. To calculate it, I will just type 1+1 and then over here, I see this icon, I can click on this and I can say evaluate cell. When I say evaluate cell it calculates 1+1 and shows me, in the output cell, the value is 2. I can also do this calculation by rather than clicking on this button over here. I can also press Shift and Enter on my keyboard and that will also do the same evaluation.

So, let me do that over here: 1+1, I have pressed Shift+Enter and it will do the computation and give me the result. So, this is a very basic interface: I type in my command and it executes and gives me the output. Let us go ahead and do something more interesting. Let us say I want to plot sin(x). So, I can say 'Plot' and inside the square brackets, I will write sin(x), and I will say plot me sin(x) for x = [-10, 10].

Again in order to evaluate, I can click on the evaluate link or I can press Shift+Enter. This gives me a plot of sin(x). Sin(x) is an odd function, it has a period of 2π. So, you see this is an odd function with a period of 2π. I can go ahead and do some more things.

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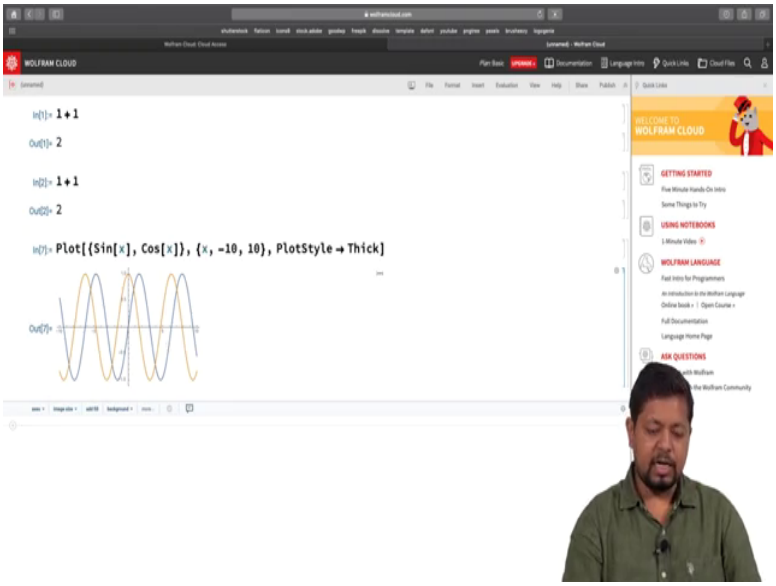

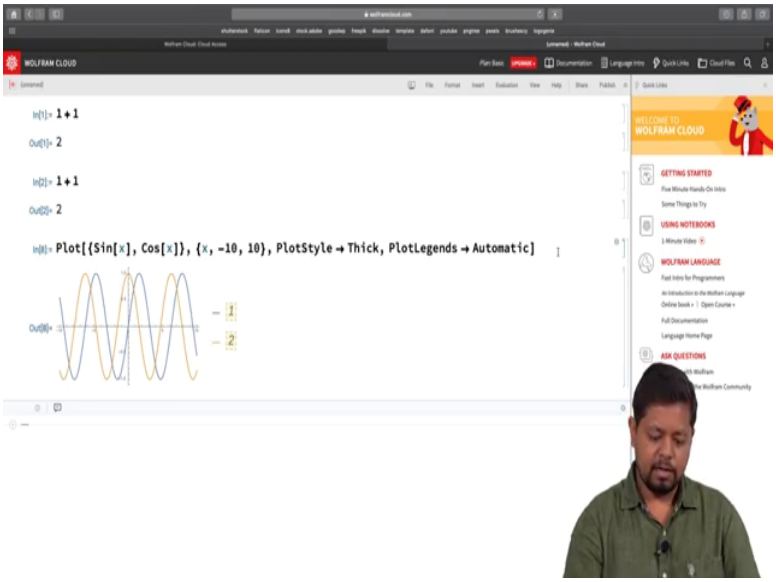

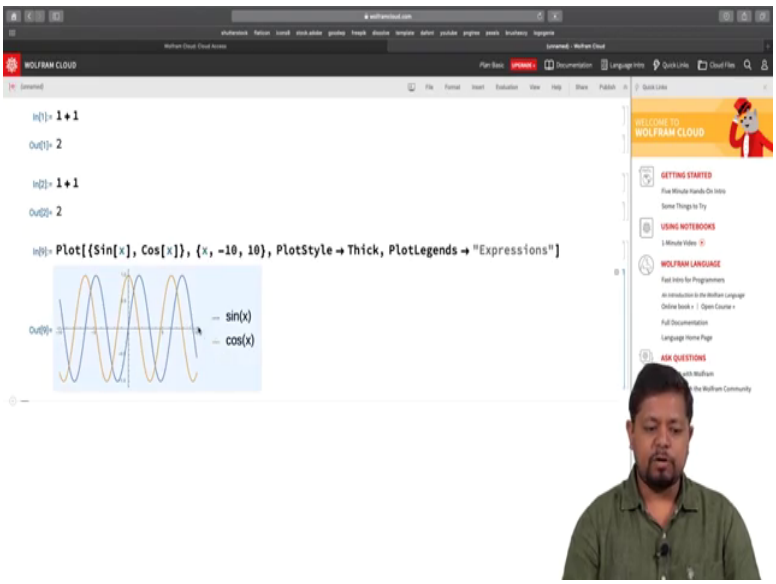

Let me go ahead and actually add two plots on top of each other. So, I will say, I want to see a plot of sin(x) and cos(x). When I do that, I get a plot of sin(x) and cos(x). I can do a few more properties and these properties are usually declared by giving options.

So, I can say 'Plot Style -> Thick' and that will make my lines little bit thicker. Now, I see two curves over here, I want to make sure that each of the curves gets labelled properly. So, what I will do is, I will add legends to this by using the option 'Plot Legends' and then I will press the dash key followed by the greater than sign and the moment I do that, it becomes an arrow and then I will say let this be 'Automatic', i.e. let the Wolfram language decide how to do that and what I see here is the new plot comes up and it says that the curve number 1 is in blue, the curve number 2 is in orange. I can make it a little bit more

interesting by typing sync plot labelled should be 'Expressions', so within quotes, I can type expressions and I can get a plot where each of the plot is labelled by the corresponding function.

Now, at this point, it may look like all of this is magic. How do I know which commands to type or which options to take? How do I know, what is the syntax of a command?

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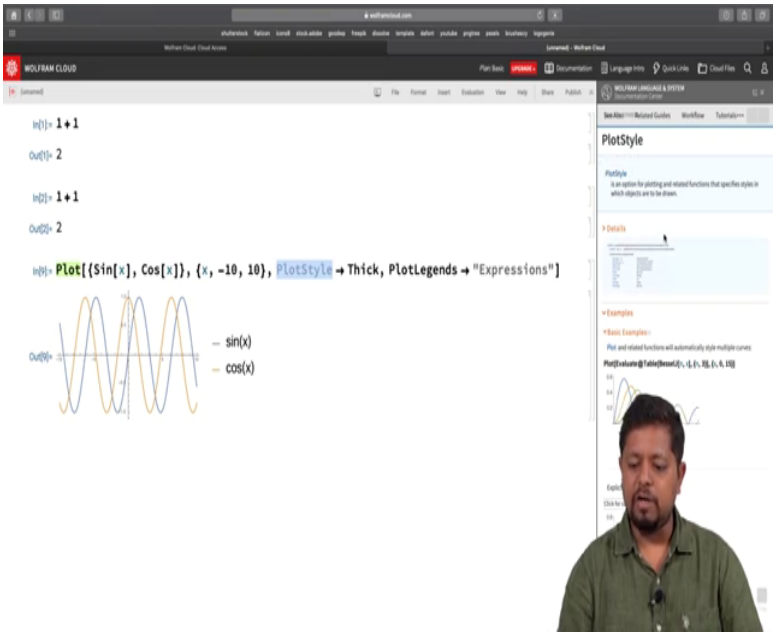

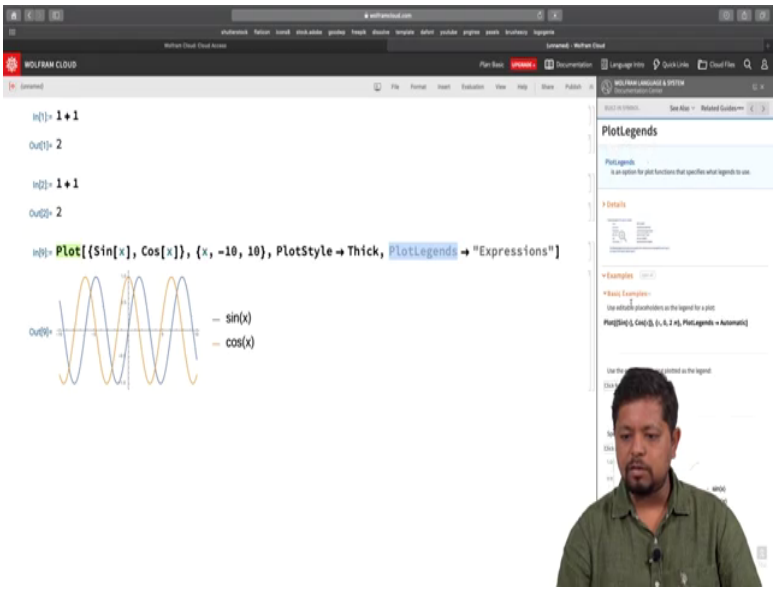

So, for that purpose, what we will do is: anytime you need some help, you select a command or select keyword and press F1 on your keyboard. The moment you press F1 on your keyboard, the documentation for that particular thing will load up on the side panel and you can read the documentation and figure out how to go about it, how to use a particular option or how to use that particular function.

For plot legends, if I do the same thing, the documentation for plot legends will load and if you read through this example, it says here that make a plot of sin(x) and cos(x) like that and says 'Plot Legends -> Automatic' and it will give you the automatic legends. If you say 'Expressions', it will give you plot legend as expression and so on and so forth. You can try these various options.

Mathematica or Wolfram language syntax works in the following way: usually, there is a name of a function, for example, the function is 'sin' and then it's arguments are placed inside a square bracket.

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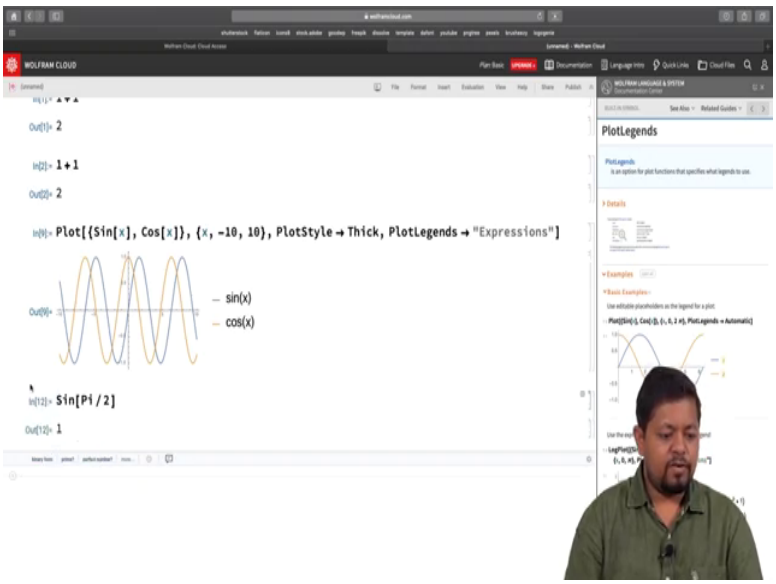

So, sin(x) will be simply 'Sin[x]'. If I want to evaluate sin of something, I have to say what is its value. So I can say I want it to be evaluated at π. I can simply say Sin[π] which of course is 0. Let us try Sin[π/2] which is 1. If a function has multiple arguments, those multiple arguments will again be inside the square brackets and will be separated by commas. For example, in the case of the plot function over here.

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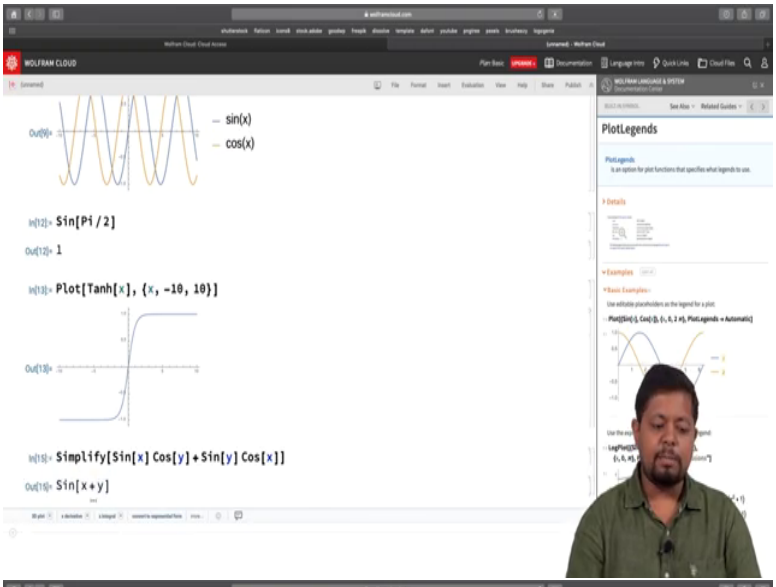

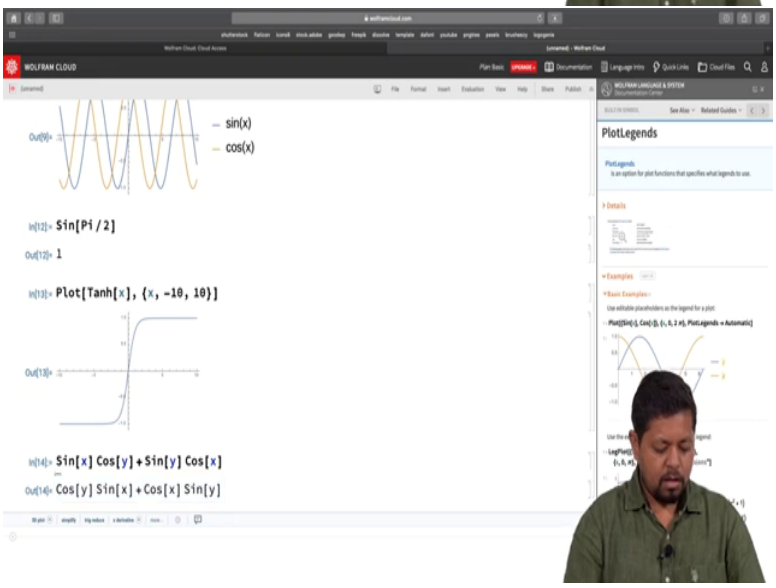

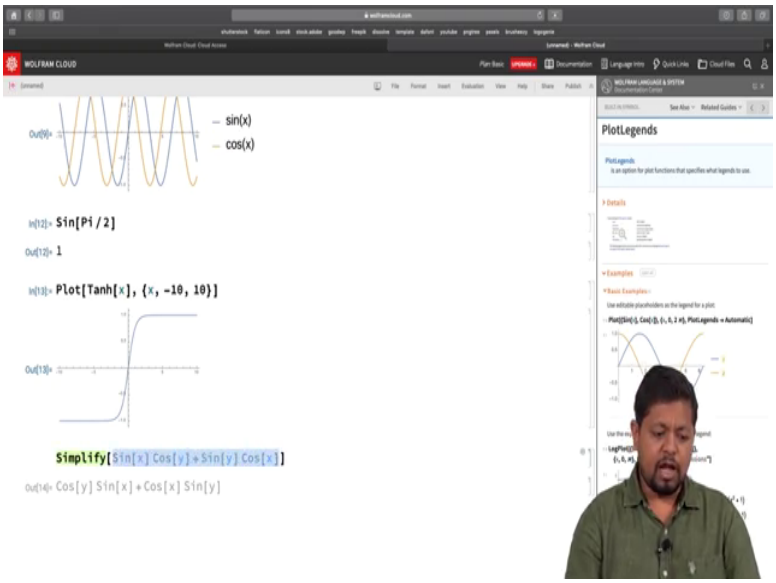

Let us do that again, let us this time plot tanh(x). As I am plotting this command it shows that it is expecting another argument over here, that is why you see a red correcter and I place a comma and the next argument is the range of x, which is specified by a list, which is a set of curly brackets and information inside those curly brackets.

I am going to type in x which declares that x is the argument with respect to which I have to plot this function. Then I will say the range of x is [-10, 10]. When I execute this using Shift+Enter, I get the plot of tanh. We can do many interesting things with Mathematica. Let us go ahead and explore another example. This time I will 'simplify' something, let us say sin(x) . cos(y) + sin(y) . cos(x). Now, we all know what is this? This is sin(x+y). Let us go ahead and execute this. So, I will press Shift+Enter again and I just get what I typed in, nothing changes apart from some shuffling of the order of these expressions. What I will do is, I will wrap this entire expression inside the 'Simplify' command or 'Simplify' function.

Here is my expression which is inside the 'Simplify' function. So, the argument of the 'Simplify' function is the expression, let us go ahead and execute it and I get sin(x+y). So, Mathematica that way is able to do a lot of algebraic calculations as well. As we go along in this course, we will explore more of these things in detail. This was a quick introduction of Mathematica for you.

I would suggest that you click on the quick links over here and go ahead and explore some of these options and in the next session, we will start with some more commands and functions in Mathematica and we will start applying them for various maths and physics problems such as visual thinking and solving physics problems. See you in the nextsession.