Optimization Methods for Civil Engineering
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Lecture - 31
Introduction to MATLAB software

Hello student welcome back to the course on Optimization Methods for Civil Engineering. So, in today's class we will learn about MATLAB. So, basically it is an introductory lecture on MATLAB. So, I will show you how you can register on MATLAB or how you can work on MATLABs, how you can write a simple equation in MATLAB. So, that actually I will explain in this particular class.

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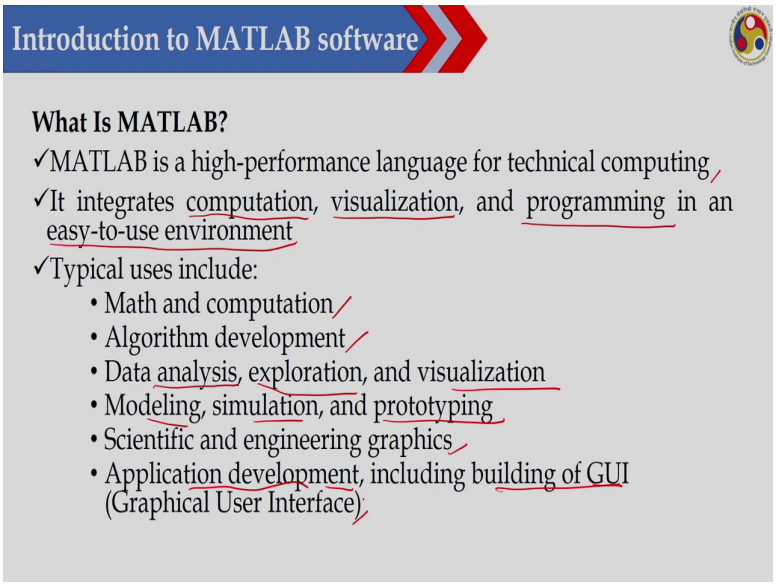

Now what is MATLAB? So, MATLAB is a high performance language for technical computing it integrates computation, then visualization and programming in a easy to way

environment. So, already you have learned R programming. So, MATLAB is like R MATLAB is also a programming language. So, its a package basically. So, and easily you can do lot of programming here.

So, we generally use MATLAB for maths and computation algorithm development, data analysis exploration and visualization. So, we can also visualize the data, we can analyze the data, we can also do modeling, then simulation and prototyping, then we can also use for scientific and engineering graphics. So, it has a very strong graphical package. So, we can also use for application development including building GUI Graphical User Interface in MATLAB.

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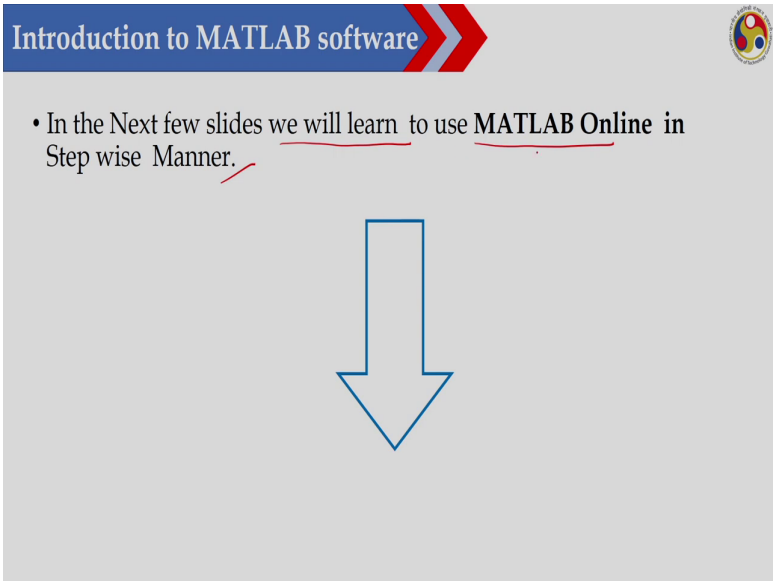

So, we can develop graphical user interface in MATLAB now let us see how you can download MATLAB or how you can work in MATLAB ok. So, in the next few slide. So, I

will show you how you can register in MATLAB online in a stepwise manner ok. So, in next few slide we will learn to use MATLAB online in a stepwise manner.

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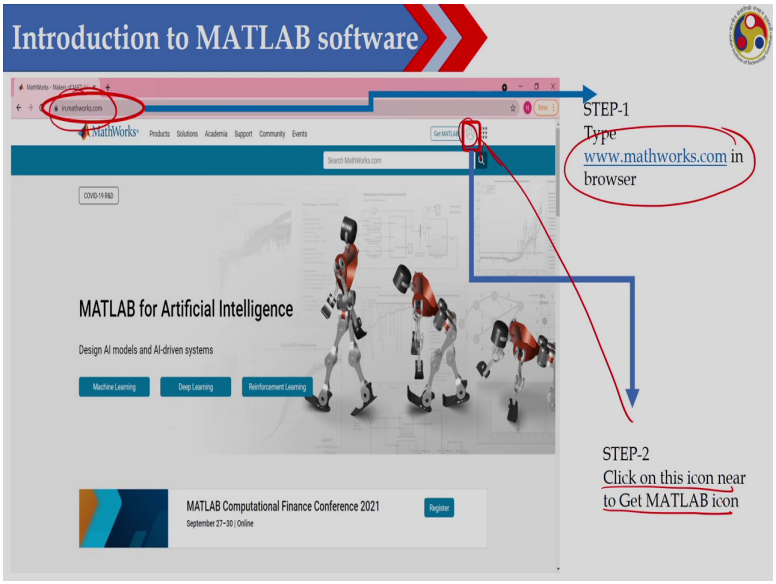

So, to do that. So, you please. So, you have to go to this particular website that is in dot mathwork dot com. So, once you are going that one. So, this is the, this is the website. So, you have to go to this particular website and here you can register or you can create a account in MATLAB. So, you click on this particular icon. So, this icon. So, you in this icon you click to get the MATLAB icon.

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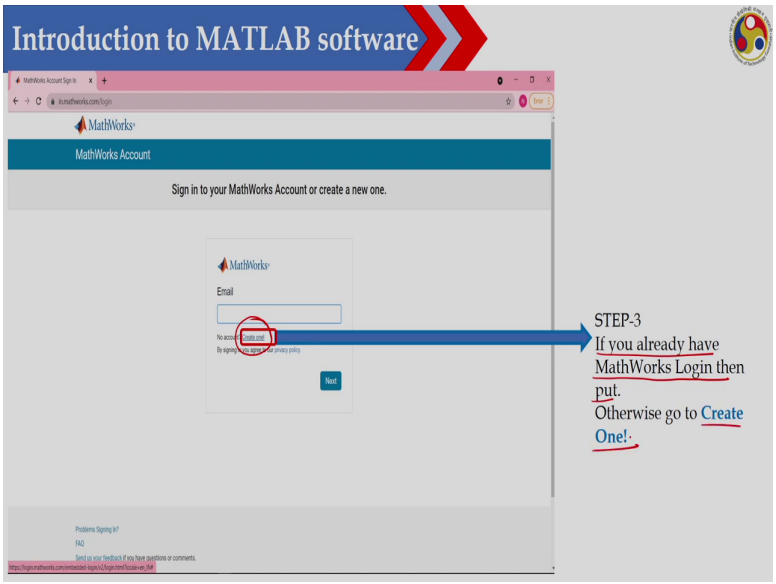

Now here. So, if you have already an account. So, you can write your email id and then you can give your password or otherwise you create one. So, you just click on Create One. So, you can create an account. So, if you already have a MathWork login then put it otherwise you go to Create One.

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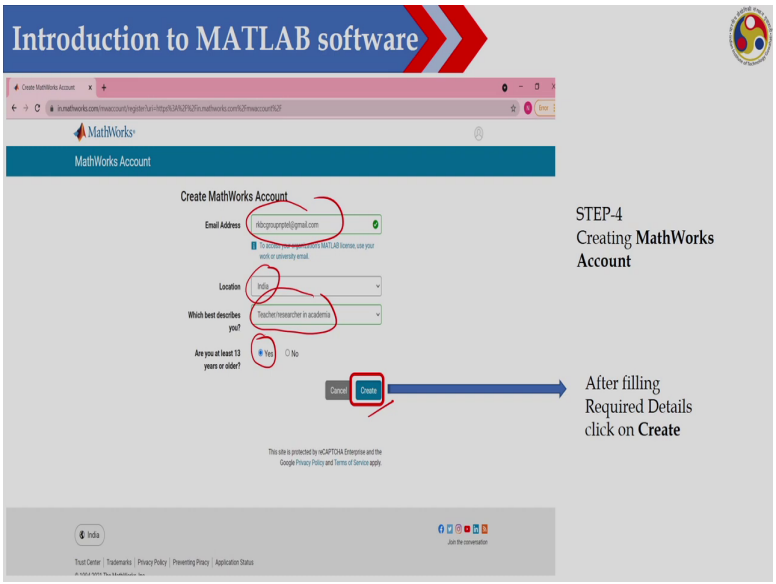

Now here you give your email id and then you give your location, then you give your for what purpose you would like to use suppose you are a student. So, you just write a student or otherwise I am a teacher. So, I will write teacher and research in academia. So, here you have to select whether you are 13 years or older. So, you select yes here and then you create and then a account will be and a basically a link will be sent to your email id.

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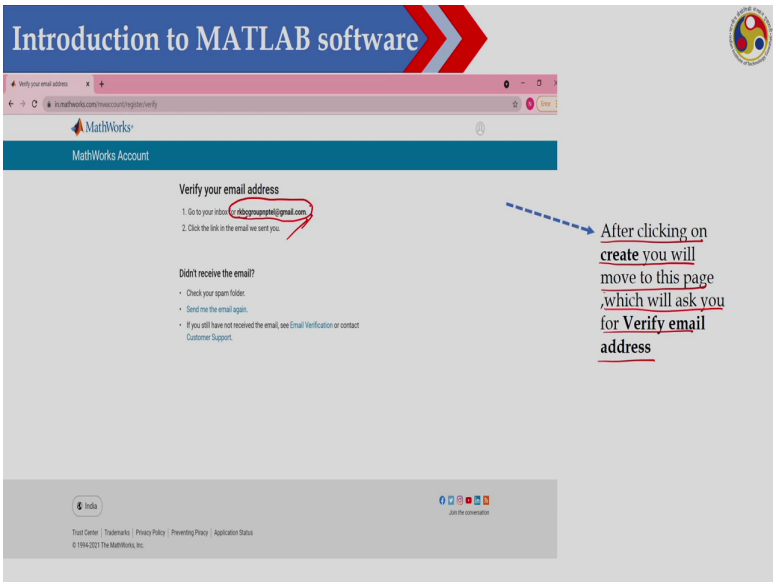

Its showing that a link has been sent to your email id ok. So, to email id and after clicking on create you will move to this particular page which will ask you to verify your email address. So, you have to verify your email address and you go to your email id and you will get a link for verification.

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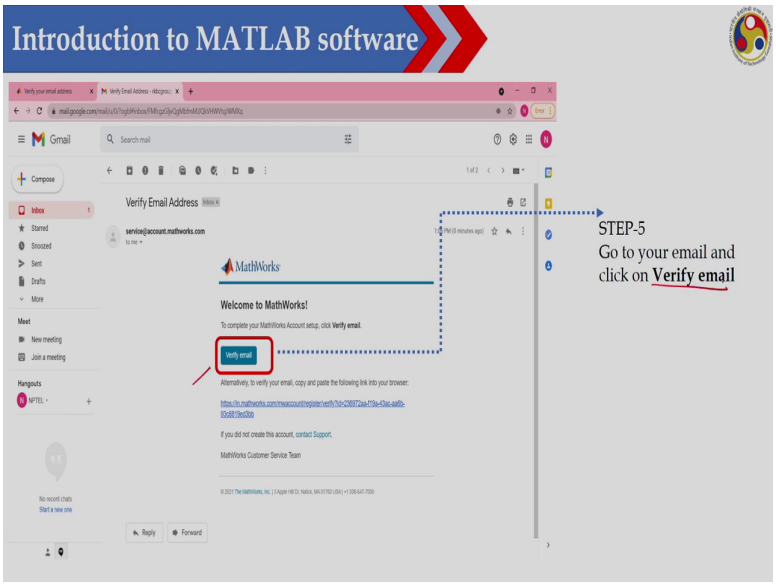

So, this is the email I have received. So, here you just write verify email.

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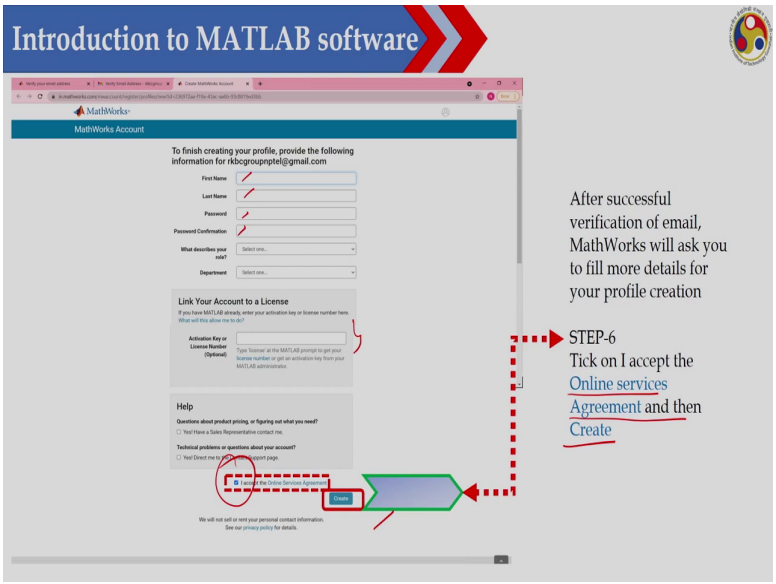

So, once you are you have verified that your email id and then you have to put your details. So, you have to put your first name, last name, then you have to choose one password then confirm password and then you describe your roles and finally, if you have any activation your key. So, you can write it here or otherwise you leave it. So, you go to you accept here and then go to Create. So, that will create an account or you create a login credential on mathwork ok. So, you have to accept the online service agreement and then create your login credential.

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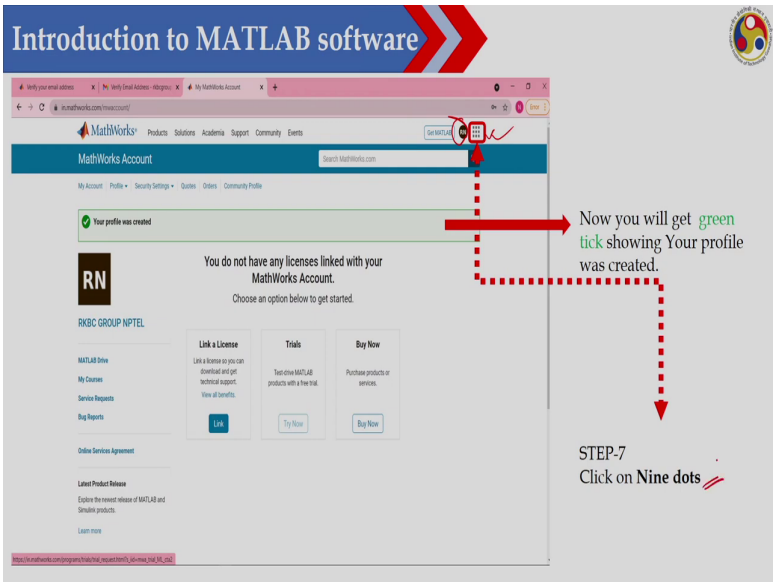

So, after that. So, you just see. So, I have created an account. So, now, this is my account. So, I have login and then you just click on this particular 9 dots. So, there are 9 dots and you click here and once you are going. So, you can see this is the MATLAB.

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So, now, if you have the license already. So, you will get your MATLAB or otherwise you can also use the free version. So, 1-month free version also you can use ok. So, otherwise you can go to directly you can go to MATLAB.

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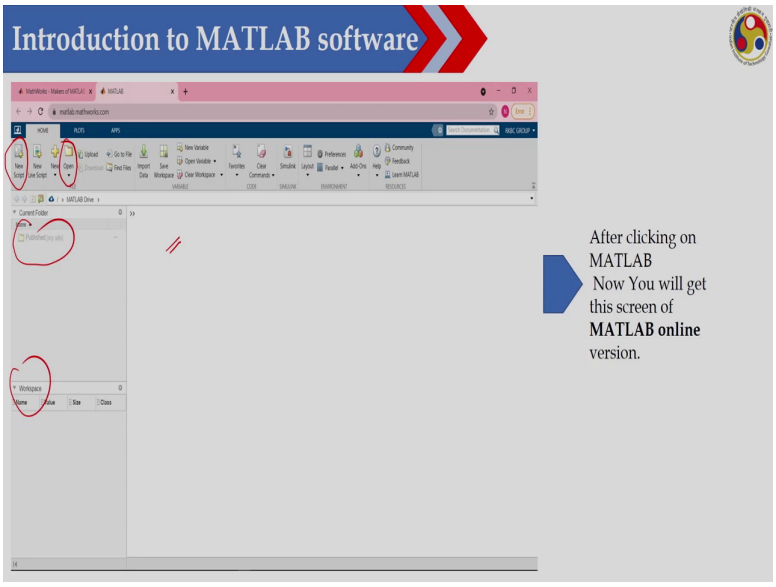

So, then. So, I am running MATLAB online now. So, I am getting this particular interface ok. So, you can see here. So, there are so many things. So, anyway so you need not learn all those things today, but what I can do? I can create a script using this one. So, this is the new script and then you can open a file ok.

So, you can open a file from here and there are lot of windows here suppose this is showing current folder and this is workspace ok and this is the command window. So, you will get this particular your interface ok. So, we will learn one by one what is this interface.

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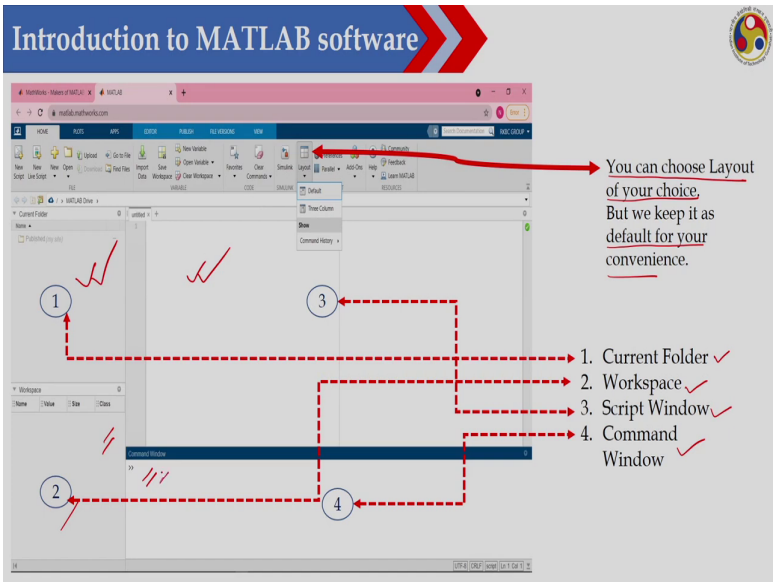

So, we have used here the default your layout. So, you have different layout version, but I have used here default layout. So, you can choose layout of your size, but I have used here default layout ok. So, in the default layout. So, I am getting this particular windows. So, one is current folder, one is workspace, then script window and one is command window ok. So, the first one this one is your current folder.

So, here all the files of this particular folder will be shown, then the second window is the workspace. So, here you will get the name of the variable and then value, size and class. So, you will be getting here and this is the script window. So, here this is 3 is the script window. So, I can open a script or I can open a m file and I can write the code and the fourth one so will be the command window ok. So, here actually you can run your the function or you can run the commands here.

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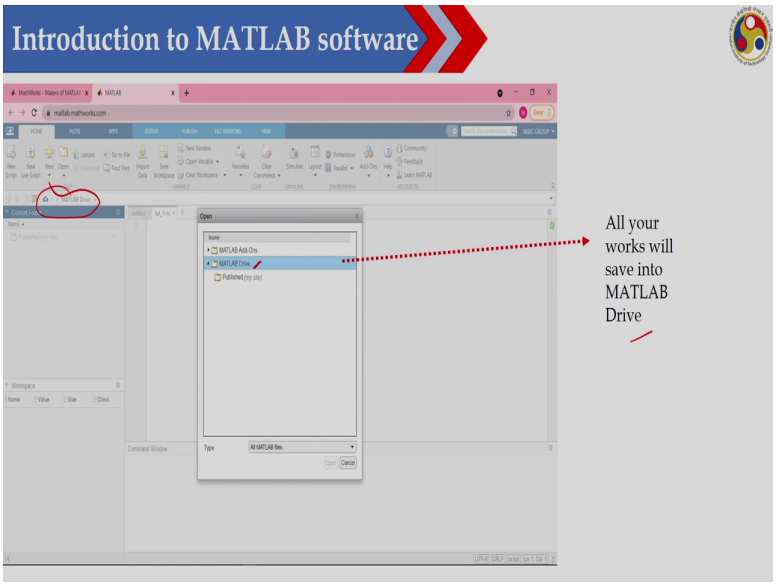

Now, what you can do? So, first you have to select the drive where you want to store your file. So, I have used here the MATLAB drive. So, where my files will be stored ok. So, from here you can select the drive. So, here I can use. So, I have used MATLAB drive or you can also create the another your folder and where you can store your file.

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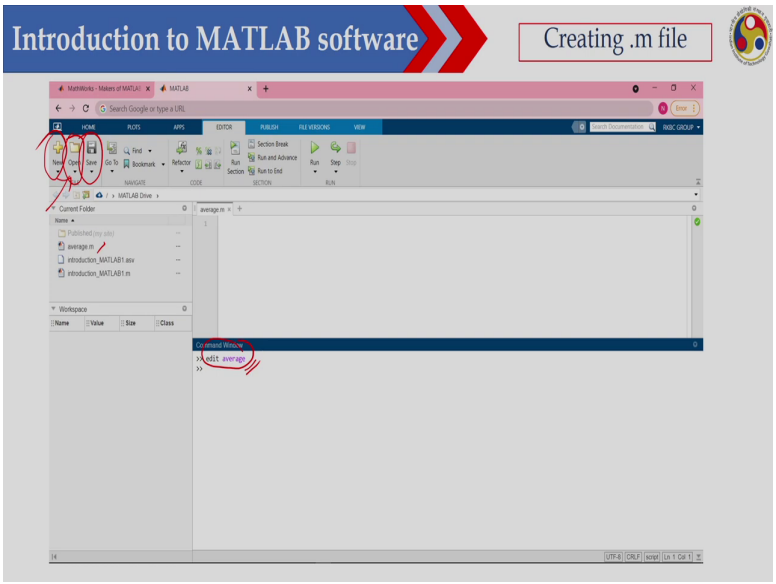

Now, let us see how we can open a script or open an m file. So, for opening an m file so what you can do? You can use the open buttons here. So, you can use this one or if you want to create a new script. So, you can use the new script this button. So, you can create a new script and if you want to save that one so you can use the save button or otherwise I can also use the I can also use this edit command to open an m file.

Suppose, I would like to open this average m so what I will write? So, I can either open from using this button or I can also write edit average. So, this file will be open ok,

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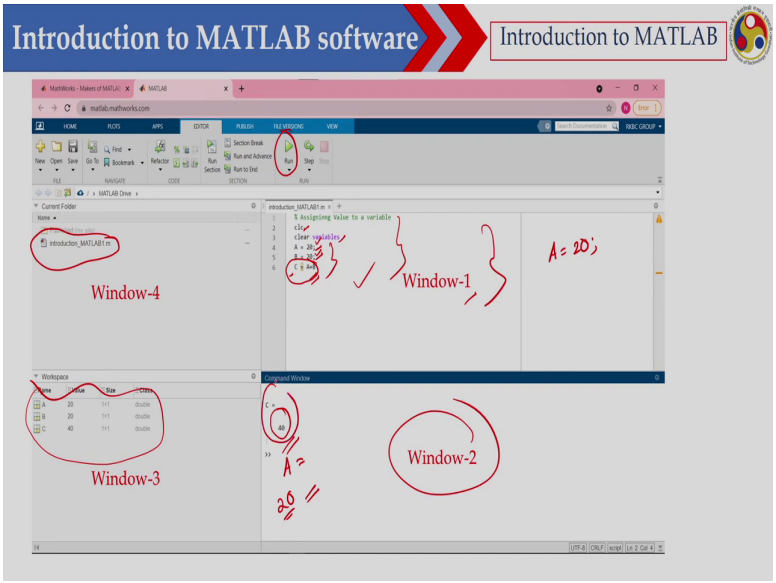

So, now you just see. So, here I have shown the all the 4 windows ok. So, this is the window 1 so, you can write a script and here I have open a file introduction MATLAB 1 dot m. So, this is the script I have open or this is the name of this particular file and you can see this script has been open here and here so you just see. So, these are suppose if I want to clear the command window.

So, I can write clc. So, if I write clc and execute this particular one, this particular window will be clean and then clear variable. So, here all the variables will be clean. So, if I write clear variable ok and then here I have assigned that A is a variable which value is 20 and B is a variable which value is 20 and C is equal to A plus B.

So, you just see its very simple. So, I have assigned 20 to A, then 20 to B and then I have executed this particular line to get the value of C which is equal to A plus B. So, therefore,

what I should get? I should get 40. So, if I execute this particular m file. So, how to execute that one? By clicking on the Run button. So, I can just click the run one and then this file will be executed and I should get the value of C and that is 40.

Now, you just see I would like to mention here that I can write A equal to 20. So, then what will happen? If I execute this particular line then here in the command window. So, you will be getting that A equal to 20 ok and if I put this colon semicolon. So, what you will what will happen? Then you will not see this particular variable here ok. So, in the command window.

So, here if you look at it that after A. So, in the in this particular line 4 I have put semicolon here then a semicolon here, but at c in this line 6 I did not put any semicolon. So, therefore the c will be display here that C equal to 40.

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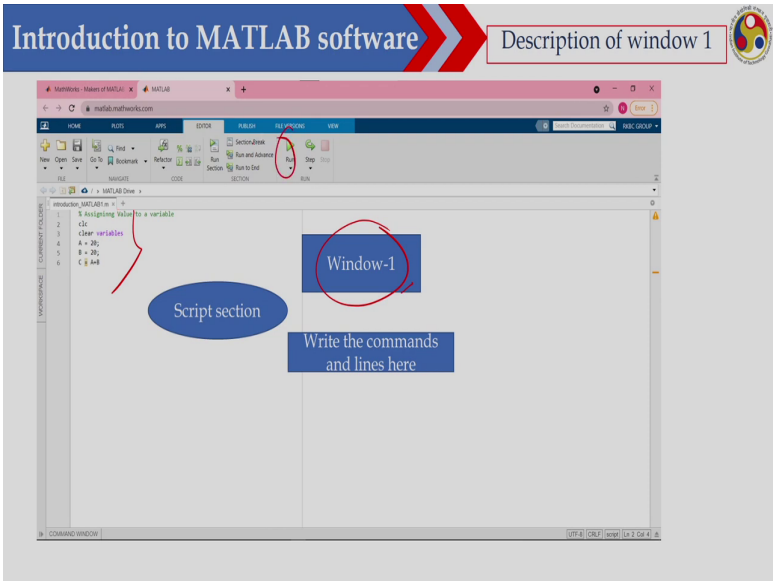

Now as I have shown here the windows-1 is the script window. So, here I can write the m file. So, just like the R programming. So, already you have learned the R programming. So, there also I can write the script and then I am running that particular script. So, here also here you know windows-1 so, I have open an m file and I have written this particular code and this code can be executed using the run button.

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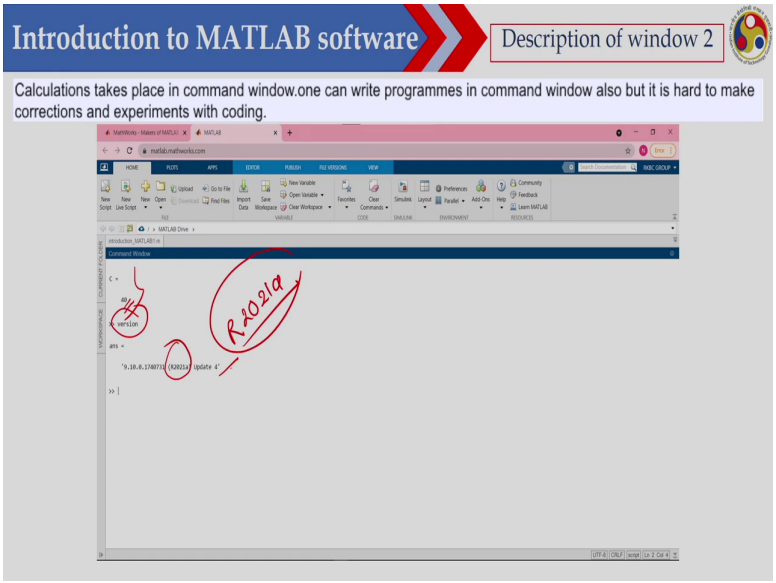

And in the command window once you are executing that one so you are getting C equal to 40, ok. So, in common window you can see that this has been executed and if I write the other command suppose I would like to see the version here. So, this is the version of this particular MATLAB. So, the version is this is R 2021a the version is R. So, this is R 2021a ok. So, this is the version of this MATLAB.

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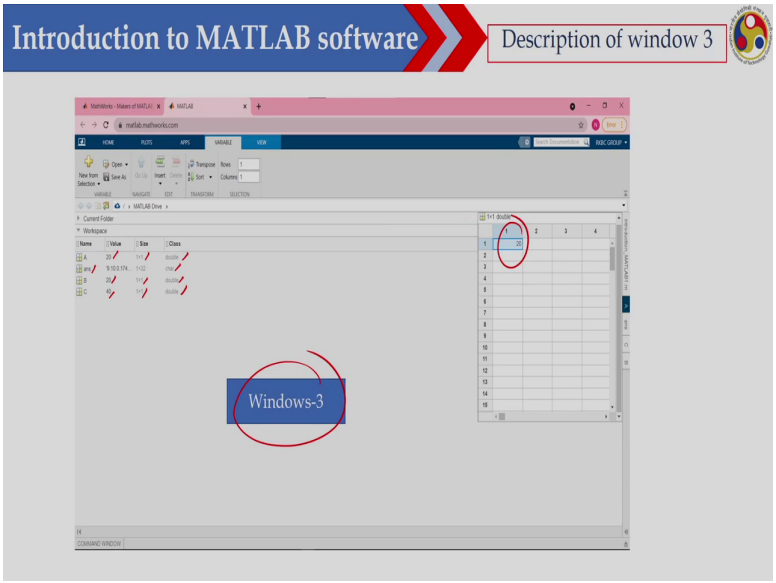

Now you just see in the window-3. So, here you will get the workspace ok. So, we have how many variable we have? So, already we have A, now here what is the value of A, the value of A the A is a scalar and value of A is 20 and size in MATLAB actually either it will MATLAB it will store as an array. So, size is 1 by 1 though its a scalar, but it will store as an array and size is 1 by 1 and this is your class is double.

Similarly, the version I have executed so this is actually as a character it has been stored and B is again a scalar quantity, but it has been stored as an array 1 by 1 and this is double and C is 40 and it is 1 by 1 array and this is double. So, by clicking here. So, you can see that I this is the value of suppose A. So, you can see the value of the variables.

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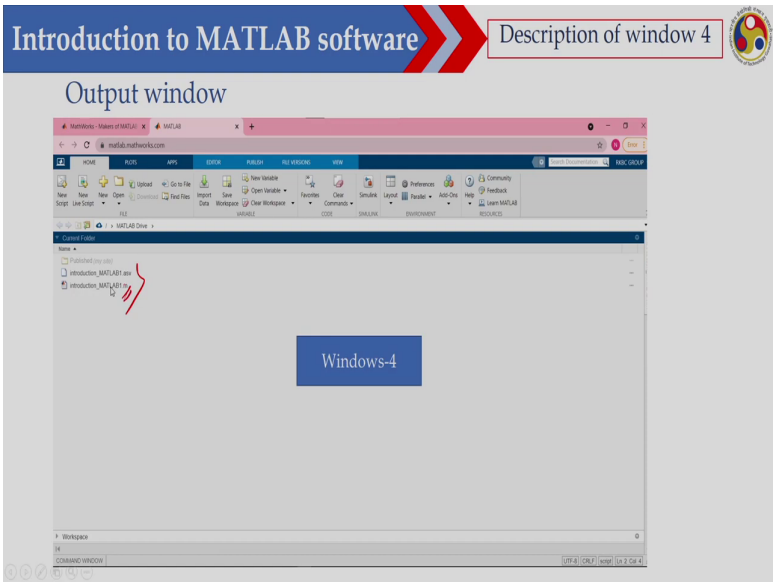

And in this particular window so you can see the files we have. So, we have the file introduction MATLAB 1. So, this is the m file. So, you can see in this particular window.

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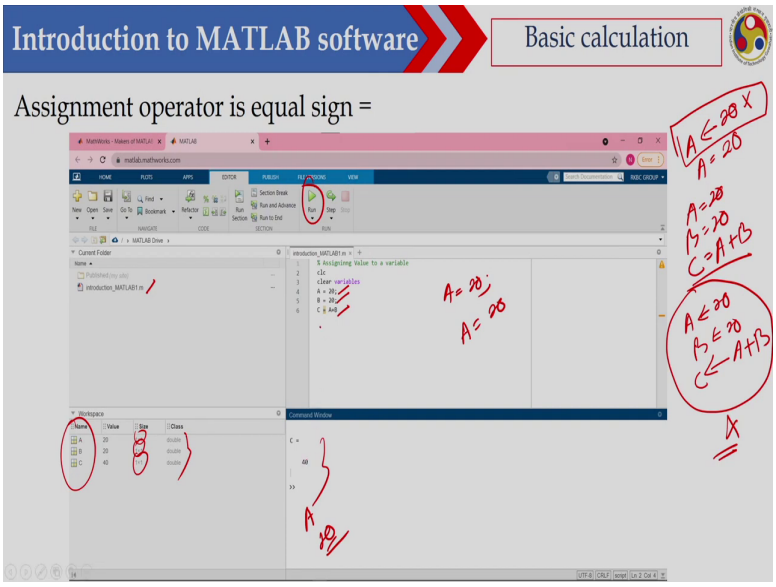

Now, let us do some basic calculation in MATLAB. So, as you have seen. So, we have already learned R. So, there also we did some basic calculation and this is almost similar ok. So, this is similar the way you have written a particular your equation or particular function. So, we are also writing the similar way in MATLAB though there may be little bit of your though the syntax may be little bit different. So, let us see. So, here in case of R so, a variable was assigned like this. So, I can assign that A equal to 20 or I can also write A equal to 20.

So, in MATLAB you cannot use that one. So, this is not acceptable in MATLAB. So, what you have to do that A equal to 20, B equal to 20 and C equal to A plus B. So, this is correct, but I cannot write that A equal to 20 B equal to 20 and C equal to A plus B. So, this is not permitted here. So, you cannot do, but what I can do? So, I have assign A equal to 20, B equal

to 20, C equal to A plus B and if I put that A equal to 20 colon; that means, this will not be display at the command window.

But if I write A equal to 20 and execute this particular line. So, then here it will be displayed ok and once I have executed this one. So, you can see this is the file I have the introduction MATLAB 1 dot m and I have 3 variables here ABC and size is 1 by 1, 1 by 1 and 1 by 1 and class is double ok. So, if I execute this particular file using the run button then I will get the C equal to 20.

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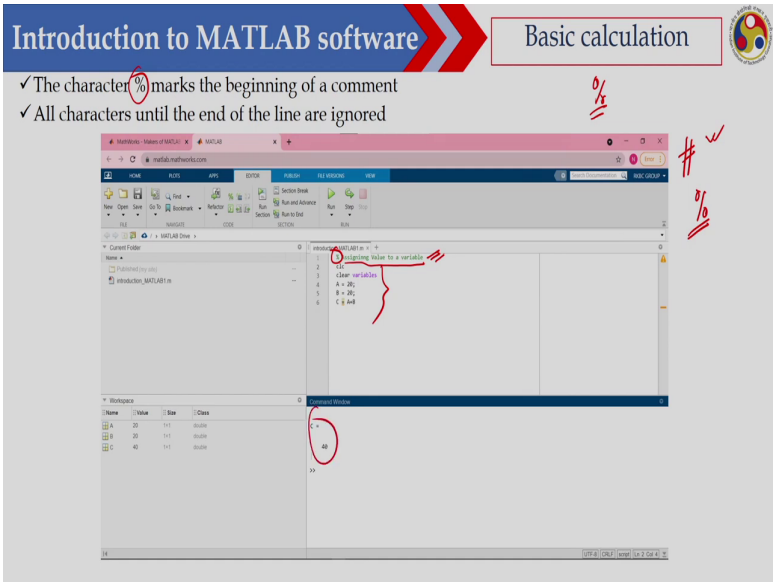

So, if I start a particular line with percentage ok. So, this percentage. So, this is meaning that this is a command line. So, if I write it that this percentage ok then assigning a value to a variable. So, this is the command. So, in case of R we have used this hash to define that a

particular line is a common line. So, if you are writing hash that line has not been executed, but in case of MATLAB. So, what I have to do? We have to use the percentage symbol.

So, then this will not be executed and rest of the lines will be executed this 5 lines will be executed and I am getting the value here.

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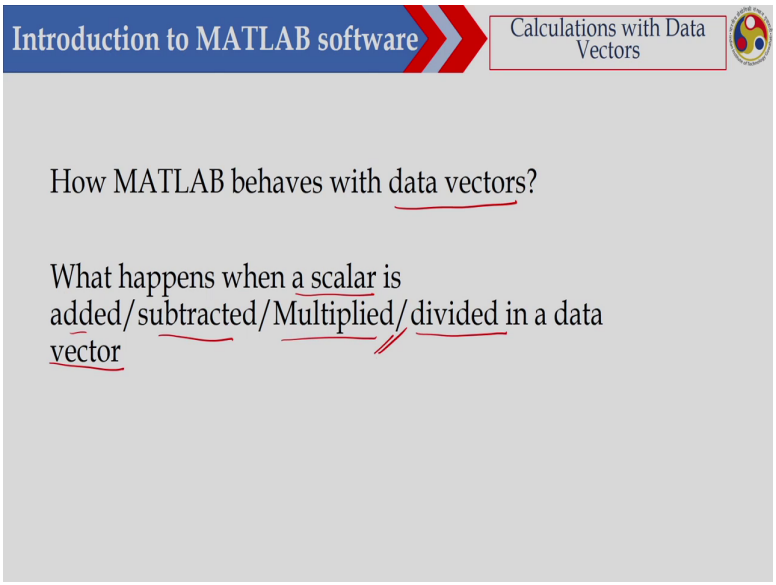

Now, let us see how MATLAB behaves with the data vector. What happen when a scalar is added, subtracted, multiplied, divided in a data vector? So, already we have learned this thing in R. So, let us see how we can do this calculation in MATLAB.

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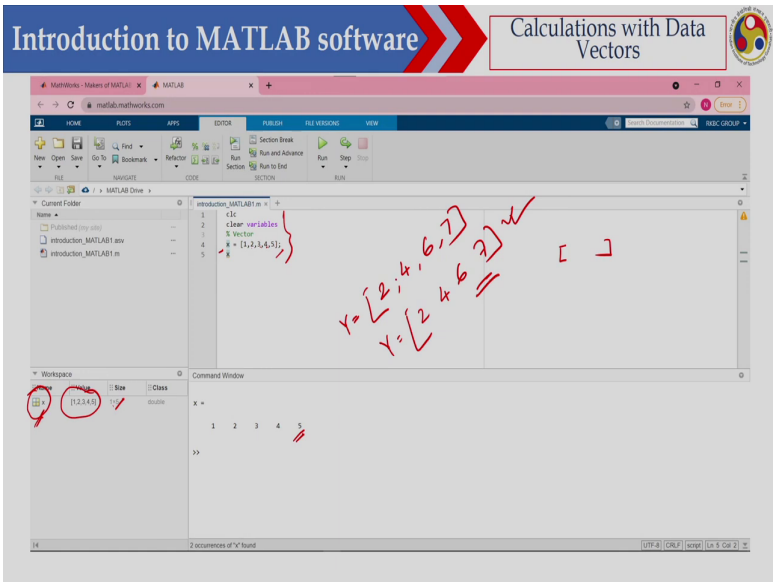

So, let us define a vector here. So, here a vector is defined using this bracket ok. So, x is a vector and the value of this vector is 1, 2, 3, 4, 5 ok. So, if I execute this particular. So, I am getting these values. So, now, you just see this is defined as an array. So, as I said that in scalar also its defined as an array.

So, in case of scalar it will be 1 by 1, but here it is a vector and now you just see this is 1 by 5 ok so; that means, 1 row and there are 5 columns ok and you can see the value here. So, you can see the value. So, this is this way I can define a vector suppose I would like to define a Y vector. So, this is I can also write like this that 2, 4, 6, 7 like this. So, I can give the comma here or without comma also I can write that one 2 4 6 7 this is also acceptable ok. So, or either otherwise I can also give the comma.

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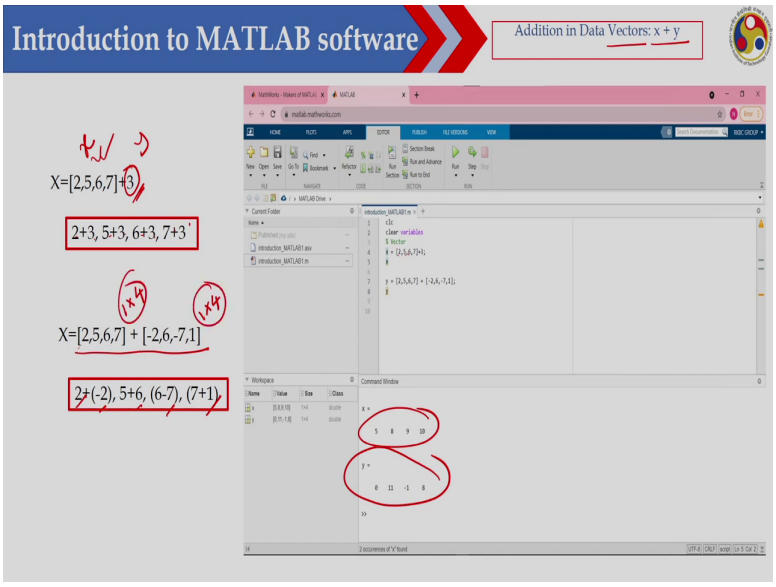

Now, let us see that I would like to add a scalar with this particular vector ok. So, vector here is 2, 5, 6, 7. So, this is a vector and with that I would like to add 3 ok. So, this is addition in data vector that is x plus y. So, here this is an x and this is your y. So, in that case what will happen? The 3 will be added to each element of this particular vector. So, 2 plus 3 then 5 plus 3, 6 plus 3, 7 plus 3. So, I will be getting you just see 2, 5, 6, 7 plus 3. So, I got this particular x factor.

Similarly, if I write that there are 2 vectors the dimension has to be equal suppose this 1. So, the dimension is 1 by 4 and here also it is 1 by 4 ok so; that means, I am adding these 2 vector then the corresponding element will be added that is 2 plus minus 2, then 5 plus 6, then 6 minus 7 and then 7 plus 1. So, I am getting this particular y vector ok. So, this, but you just see that this dimension has to be equal; that means, same dimension.

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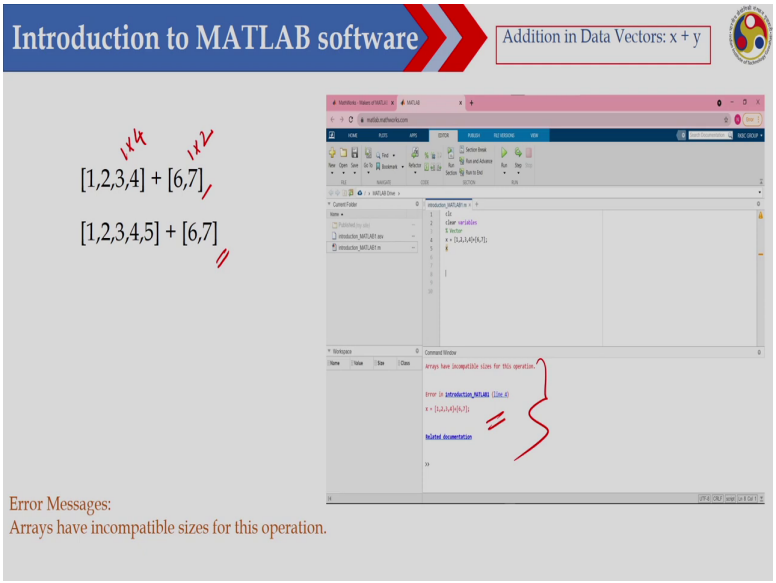

Now what will happen if the dimension is different? So, in case of R you just see this has been executed ok, but here what will happen? This is 1 by 4 and this is 1 by 2. So, in that case you will get this particular error ok. So, this is an error in this particular line four. So, there is an error and this dimension has to be equal ok. So, you will get an error if the dimension are not matching.

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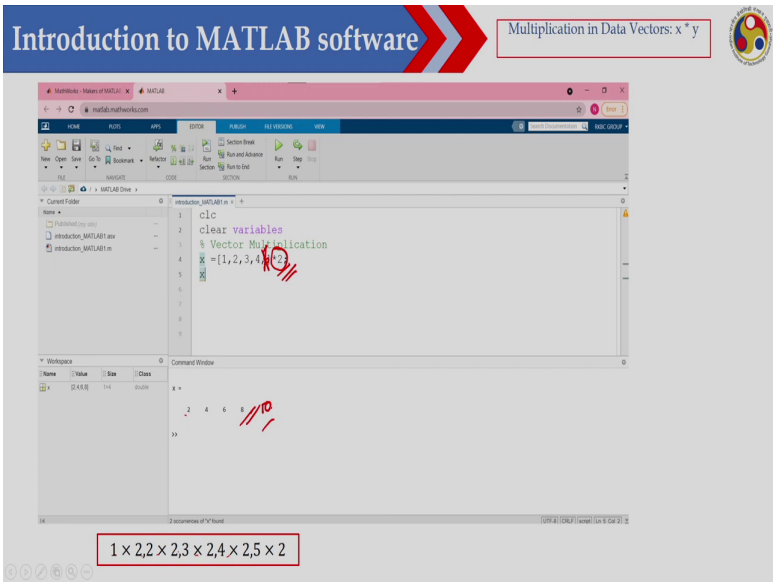

Now, if I multiply a particular vector with a scalar. So, here I have multiplied this particular vector 1, 2, 3, 4 ok by 2. So, what will happen that 1 into 2, 2 into 2, 3 into 2, 4 into 2 and 5. So, there is another one. So, 5 ok. So, you are getting this particular value 2 4 6 8 ok. So, anyway this 5 is not there. So, if you are putting this 5, then you will get another one this is equal to 10.

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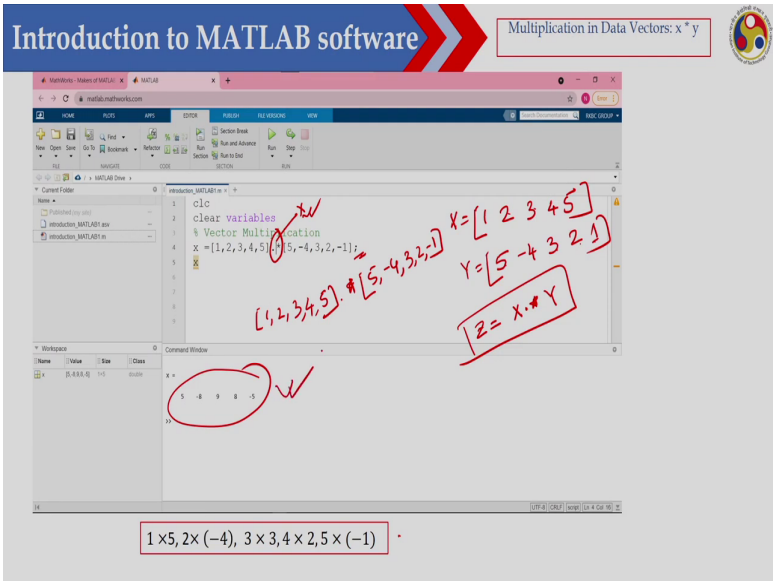

Now let us see if I would like to multiply the corresponding element so that means, I have two vector this is X. So, X is a vector this is 1 2 3 4 5 and there is another vector Y and this is 5 minus 4 then 3 then 2 then 1 ok. So, this is another vector and what I would like to do and what I would like to do?

That I would like to multiply the corresponding element; that means, 1 into 5, 2 into minus 4, 3 into 3, 4 into 2 and 5 into 1. So, then I have to use this one. So, what you have to do? So, I would like to suppose Z and which is equal to X star Y. So, you will get an error. So, you have to put a dot here ok. So, this means that the corresponding element will be multiplied. So, you just see I have written here. So, this is dot into star ok.

So, you have to put a dot then in that case this will be executed. So, this line is not there. So, this is the cursor actually. So, this line you just remove this line is not there. So, this is 1, 2, 3,

4, 5 and then dot and then star and then 5 minus 4, then 3, 2 minus 1 ok. So, then you should get this particular result.

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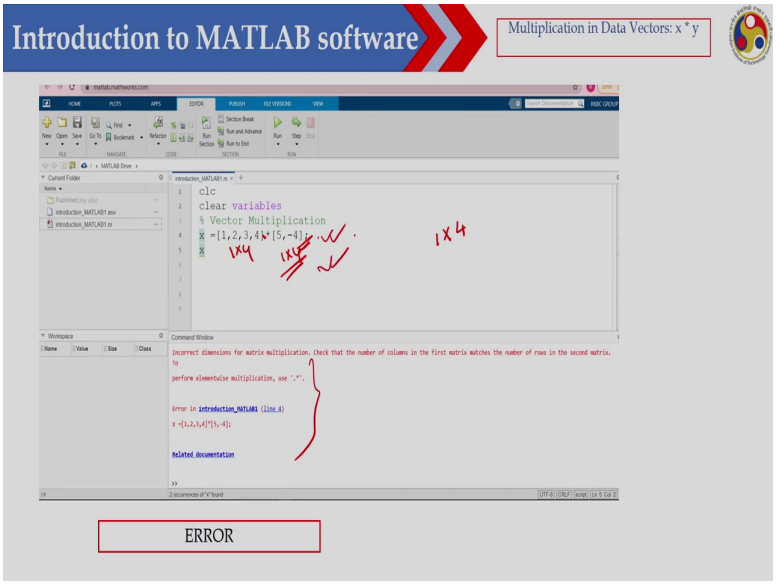

Now what will happen if these dimensions are not matching ok. So, in case of R. So, you will get some result, but here you will not get it and you will get an error ok. So, because this dimensions are not matching ok and dot is also not there. So, if dot is there then corresponding element will be multiplied, but you will get an error in this case. So, this dimension has to be equal; that means, if it is 1 into 4. So, here it is 1 into 4 and this should be 1 into 4 ok. So, then only this line will be executed.

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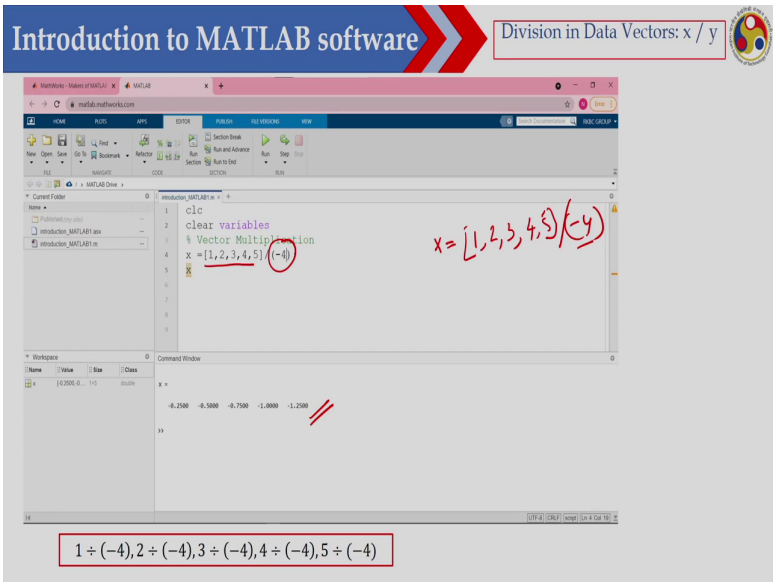

Now if you are defining a particular vector by a scalar here suppose I have divided this particular vector. So, this particular vector with this scalar and scalar is minus 4. So, what I have done here? This is X which is equal to 1 2 3 4 5 and then I have divided it by minus 4 ok. So, in that case you are getting this particular answer; that means, corresponding element will be divided.

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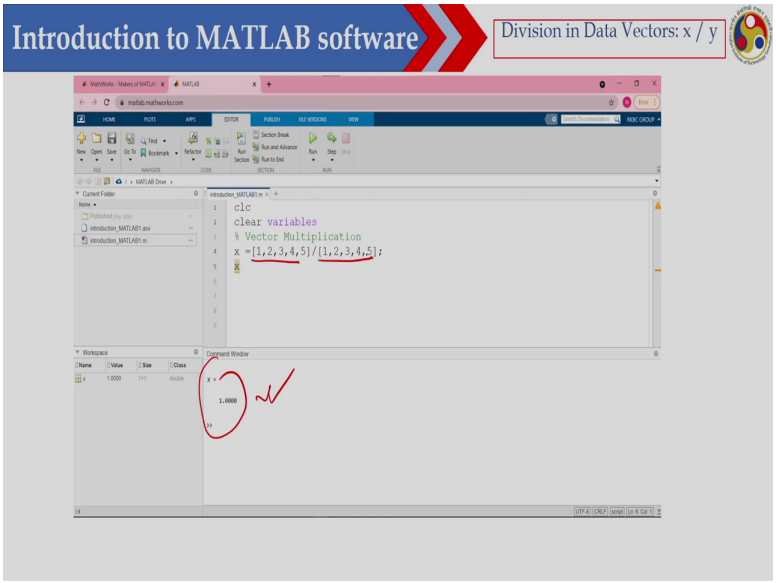

Now, if suppose this is a vector and this is also a vector. So, and if you are not putting dot. So, in that case this will be the your result. So, you will get 1 and this vector has been divided by this vector.

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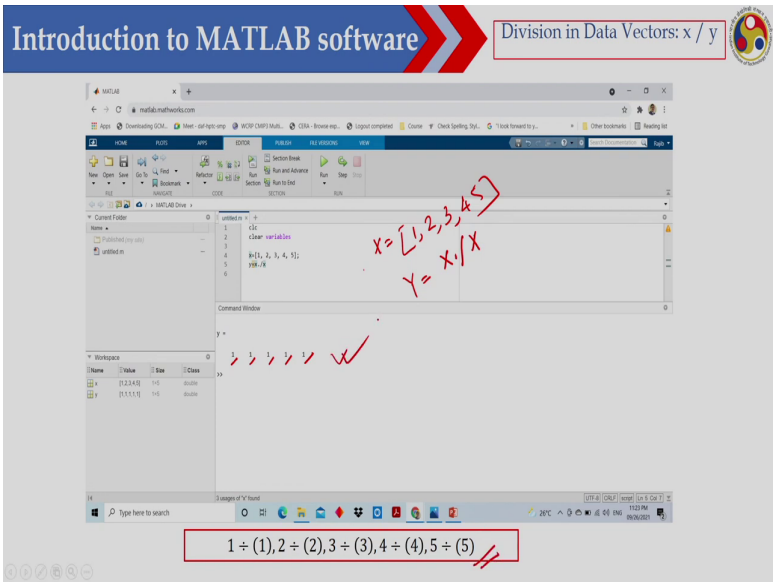

And if I want to divide the corresponding element. So, then what you have to do? So, you have to do. So, I have defined X here, X equal to 1, 2, 3, 4, 5 and then Y equal to X dot slash X ok. So, in that case corresponding element will be divided; that means, so, 1 by 1 you are getting 1, 2 by 2 you are getting 1, 3 by 3 you are getting 1, 4 by 4 you are getting 1, 5 by 5 you are getting 1 ok. So, this is the results you will get.

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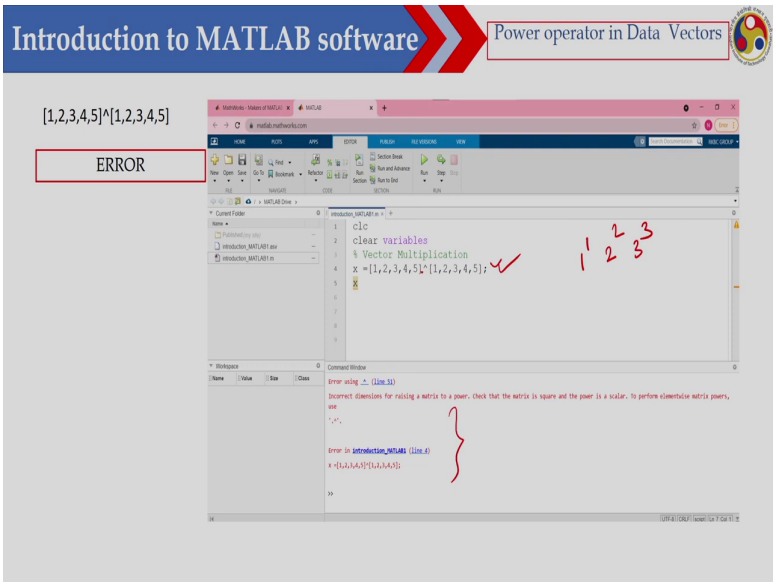

Now, if you want to calculate the power ok. So, here what I am looking for that I am looking for 1 to the power 1, then 2 to the power 2, 3 to the power 3. So, in that case you can use cap, but you have to use a dot sign also I have not used here. So, therefore, I am getting this particular error line ok. So, this particular error I will get.

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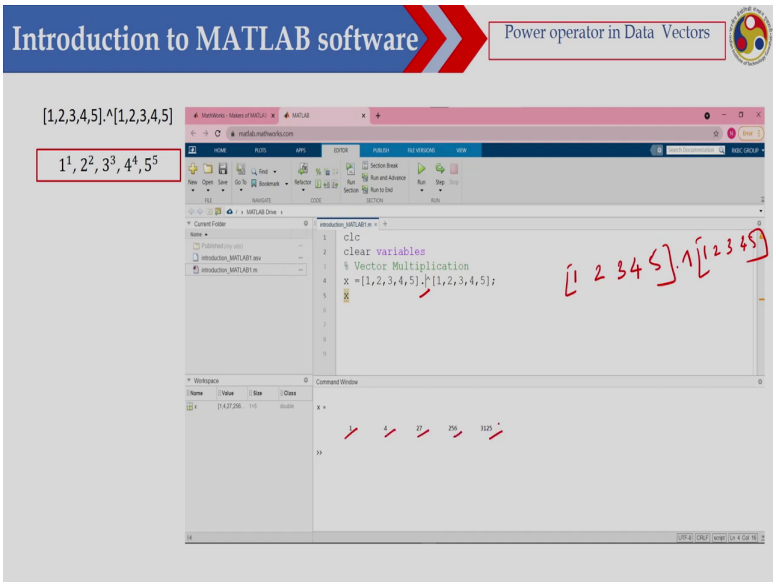

But if I put this dot ok. So, here what I am doing? This is 1 2 3 4 5 ok and then dot cap I am using then this is 1 2 3 4 5 ok. So, then you are getting 1 to the power 1, this is 1, then 4, 27, 256, 3125.

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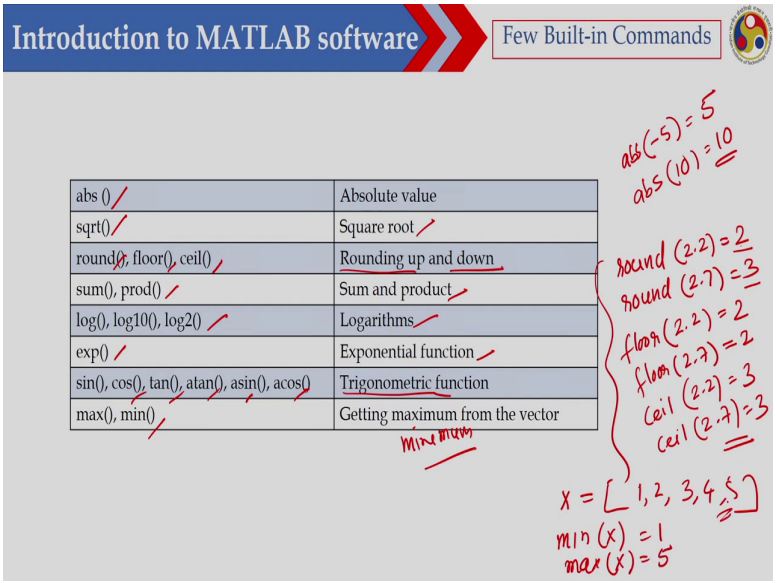

abs ()	Absolute value
sqrt()	Square root
round(), floor(), ceil()	Rounding up and down
sum(), prod()	Sum and product
log(), log10(), log2()	Logarithms
exp()	Exponential function
sin(), cos(), tan(), atan(), asin(), acos()	Trigonometric function
max(), min()	Getting maximum from the vector

Then like R, MATLAB is also having the inbuilt various inbuilt function ok. So, here you just see some of the function that if I would like to calculate absolute value suppose if I write abs minus 5. So, I will get plus 5. So, abs suppose 10. So, I will get 10 ok. So, absolute value you can calculate then sqrt you can write square root then round, floor and this is ceiling ok.

So, round means suppose if I write round 2.2; that means, what you will get? You will get 2, if you write round 2.7. So, what you will get? You will 3 ok; so that means, if it is more than 0.5. So, you will get the higher one or otherwise you will get the lower one ok, but if you are using floor ok. So, floor 2.2, then you will get 2, then if you are using floor 2.7, then you will also you will get 2 and if you are using ceiling here ceil ok and if you are writing 2.2, then you will get 3 and if you are writing 2.7, then also you will get 3 ok.

So, this is rounding up and down. So, this functions are similar to what we have learned in R and similarly I can use sum and product; sum and product, then I can use log I can calculate the logarithmic and exponential function exp I can write, then trigonometric function sin, cos, tan, asin, atan ok acos that you can use and min and max.

So, this is similar to your R ok max and min I can use getting maximum from a vector getting maximum and minimum ok, minimum from a vector. Suppose if I write that X equal to 1, 2, 3, 4, 5 ok. So, if I write min X. So, I will get 1 if I write max X I will get 5 ok this is the 5 is the maximum of this particular vector.

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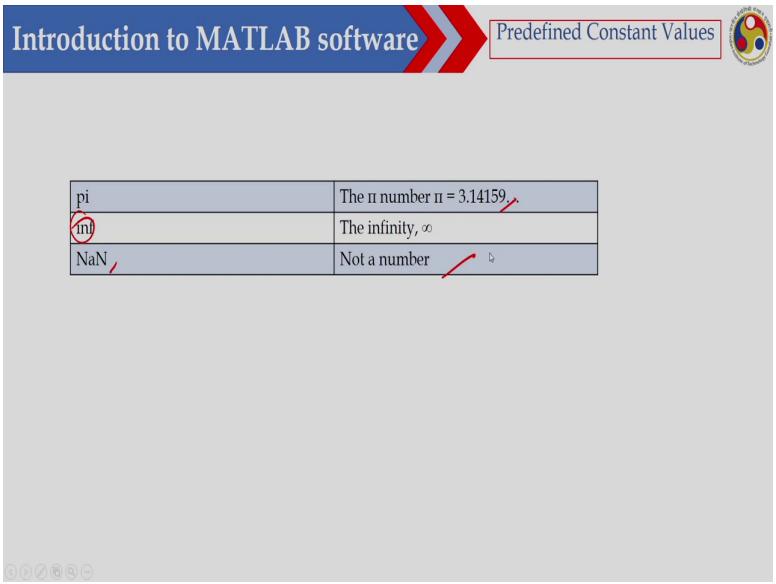

Then if I write pi. So, I will be getting this is pi then infinity. So, its the, its use inf then not a number I can use NaN ok. So, not a number. So, this is predefined constant value then like R.

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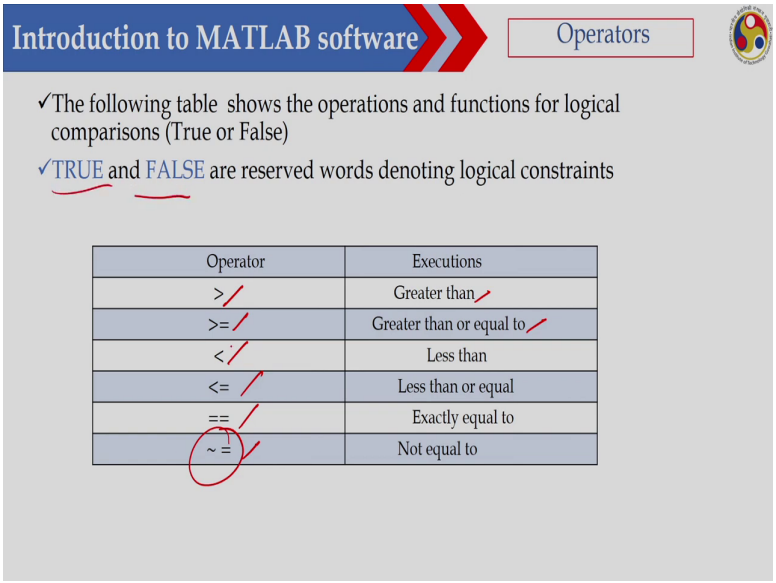

So, I can also use the logical operators for logical comparison suppose this operators are greater than. So, I can use greater than greater than equal then less than less than equal then equal and not equal. So, not equal I will be using this one ok. So, it is basically it will return whether this is true or false basically. So, true or false it will return by this operator.

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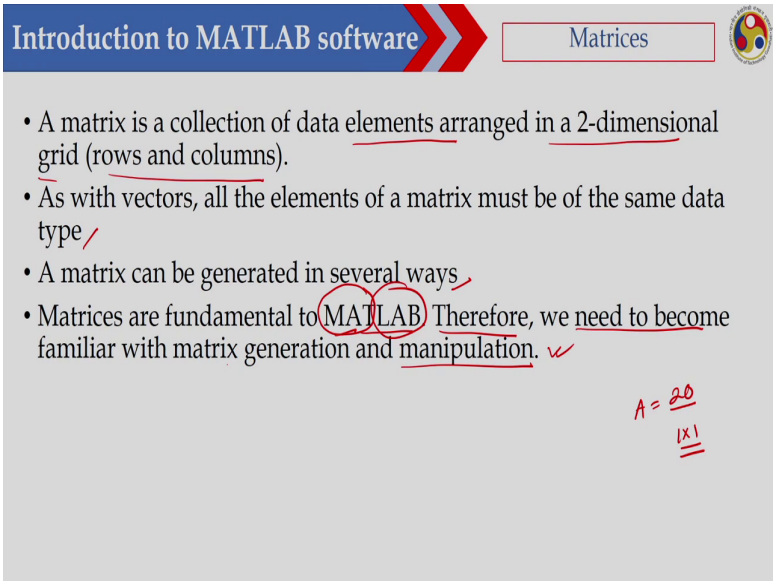

Now, let us see a matrices. A matrix is a collection of data element arranged in 2 dimensional grid row and column. So, in MATLAB everything is defined as a matrix even I can write a scalar which is 20 and actually it is defined as a matrix this is a 1 by 1 array ok. As with the vectors all the elements of a matrix must be of the same data type. So, it must be of same data type and a matrix can be generated by several ways just like R, we can generate the matrix in several way and matrices are fundamental to MATLAB ok.

So, actually it is coming matrix laboratory ok MATLAB is means matrix laboratory and therefore, we need to become familiar with matrix generation and manipulation ok. So, this is we should learn because this in MATLAB all; that means, of data is generally we define as a matrix.

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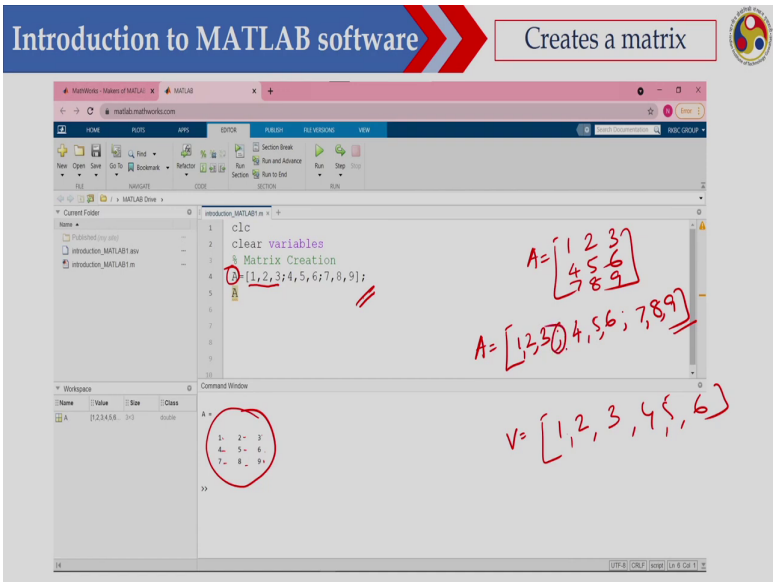

Now, how to generate a matrix in MATLAB? It is very easy ok. So, you can see I would like to define a matrix this is the variable A which is a matrix and this matrix is. So, if I write 1 2 3 4; that means, and then suppose I would like to this is the matrix I would like to define 1 2 3 then 4 5 6 then 7 8 9. So, what I will do? I will write like this, this is 1 2 3 ok then 4 5 6 ok and then 7 8 9 ok.

So, you have to either you have to give comma or you have to give a blank ok. So, you have to give either you have to give comma or you have to give a blank ok. So, now, if I execute this particular line. So, I will get this particular matrix the matrix is 1 2 3, 4 5 6, 7 8 9. So, it is very easy to define a matrix and a vector you can define suppose 1 2 3 4 5 6. So, this is a vector ok. So, either you can. So, this is a vector and once you are defining matrix. So, second line I can define like this ok. So, I can use the semicolon.

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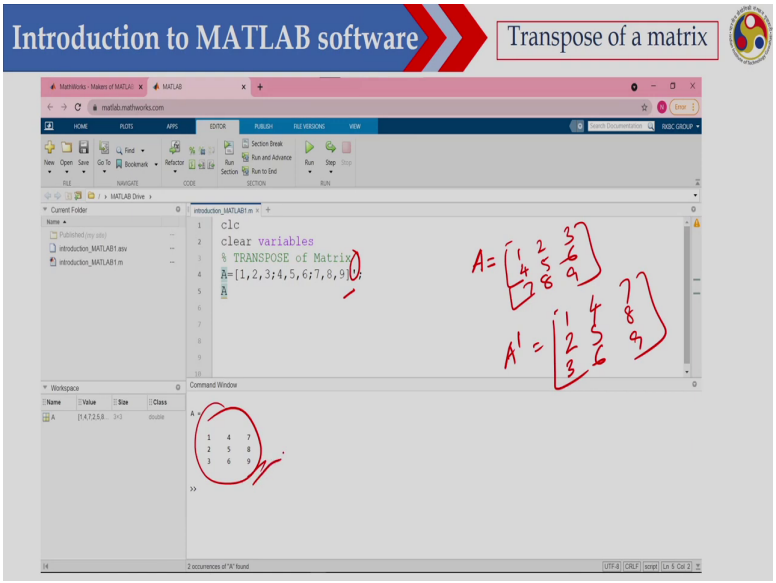

Now, if I want to calculate the transpose of a matrix ok. So, here I have defined A. So, A is this is 1 2 3 then 4 5 6 7 8 9. So, this is a matrix. So, now, I would like to calculate the transpose A transpose which says this is 1 2 3 4 5 6 7 8 9. So, what I will do? I will use this symbol ok transpose symbol. So, I will get this matrix. So, mat A is now transpose of this one and this is 1 2 3 4 5 6 7 8 9.

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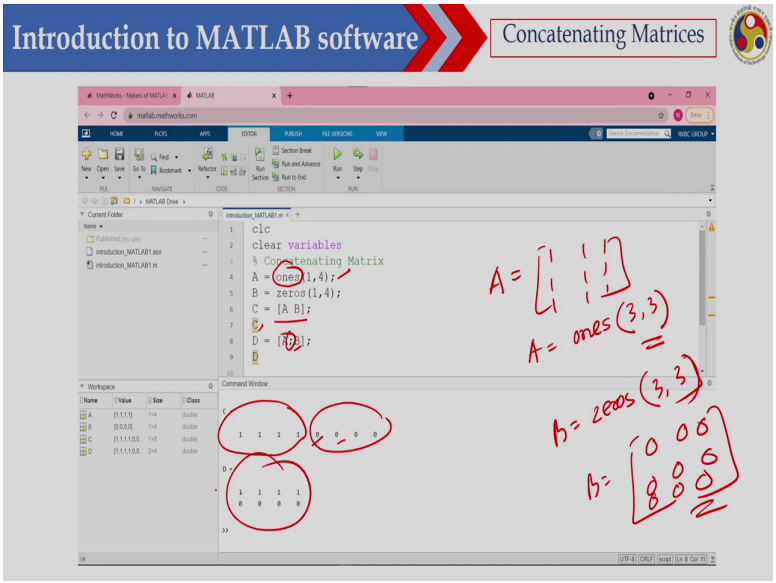

Now if I would like to create a matrix of ones basically ok. So, I can use ones to create suppose I would like to create a matrix this is A 1 1 1 1 1 1 1 1 1 ok. So, what I have to do? So, I can write that A equal to ones this is 3 comma 3 ok. So, then a matrix will be created of 1, this is 1 1 1 all elements will be 1. So, I can use 1 similarly I can write suppose the zeros, I if I want to create a matrix zeros and this is suppose B which is zeros ok this is 3 3.

So, what you will get? The B will be like this 0 0 0 0 0 0 0 0 0 ok. So, this will be your B. So, here I have shown you that A is an array. So, this is I am I have created with ones; that means, all ones ok. So, this is your A and this is your B, B all B is an array and this is 1 by 4 and elements are 0 and then I have added this A and B ok. So, I just I have written A and basically B ok. So, what is happening it has added AB ok.

So, then I have print it using C. So, you can see this one and then now if I want to write on the second line this is A is 1 all 1 1 1 1 1 and B is 0 0 0 0. So, in the second line then I have used this semicolon ok. So, I am getting this particular array.

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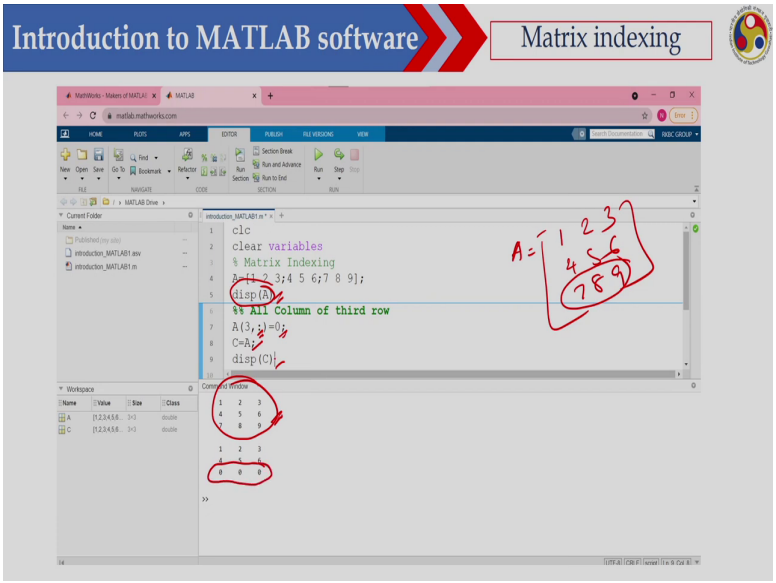

Now I can use the display A. So, to display a matrix suppose in this case what I have done? I have created a matrix and this matrix is 1 2 3 4 5 6 7 8 9 ok. So, this is the matrix I have created and this matrix is I have displayed using this display function disp A. So, it has been displayed here. Now what I have done that the third row ok all elements; that means, this particular third row all elements.

So, what I have done? I put this is equal to 0; that means, this particular row is 0 and then what I have; I have copied it and in C. So, C equal to A and display C and you can see the third row is now 0 ok all zeros.

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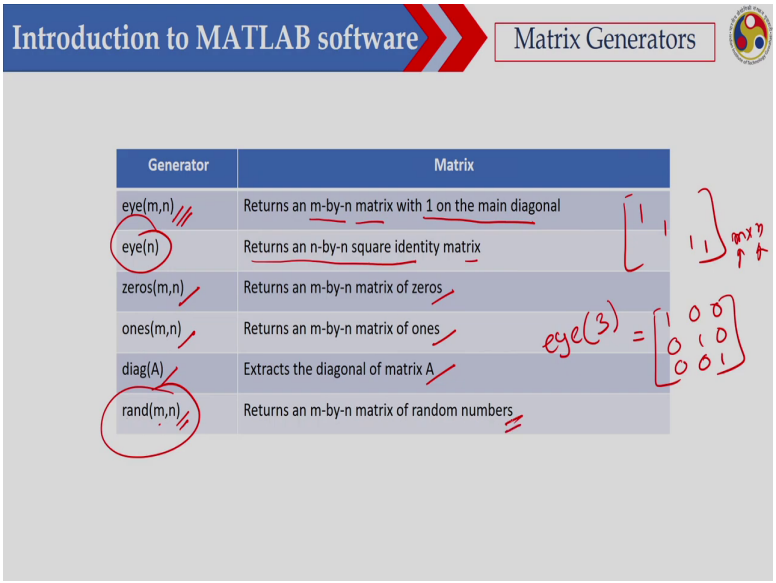

So, there are some other function, I can use eye this is it will return an m by n matrix with 1 in the main diagonal ok. So, what I would like to do? Basically, in the diagonal I would like to make it 1 ok make it 1 and then I can use this particular command eye m into n ok. So, it will create this is m into n. So, this is the row and this is the column and if I write eye n. So, then it will generate a square identity matrix ok. So, it will generate a square suppose if I write e y e and this is 3. So, it will generate 1 0 0 0 1 0 0 0 1 ok this is 3 ok eye 3. So, this will be generated

Now, as I have shown you that I can write zeros ok. So, it will create m by n zero matrix then once I can do that. So, it will create m by n one matrix and I can use diagonal A. So, it will extract the diagonal values and I can also generate random number using this particular function rand m by n. So, it will create a matrix ok and the elements will be generated randomly and the matrix dimension will be m by n. So, let us see that.

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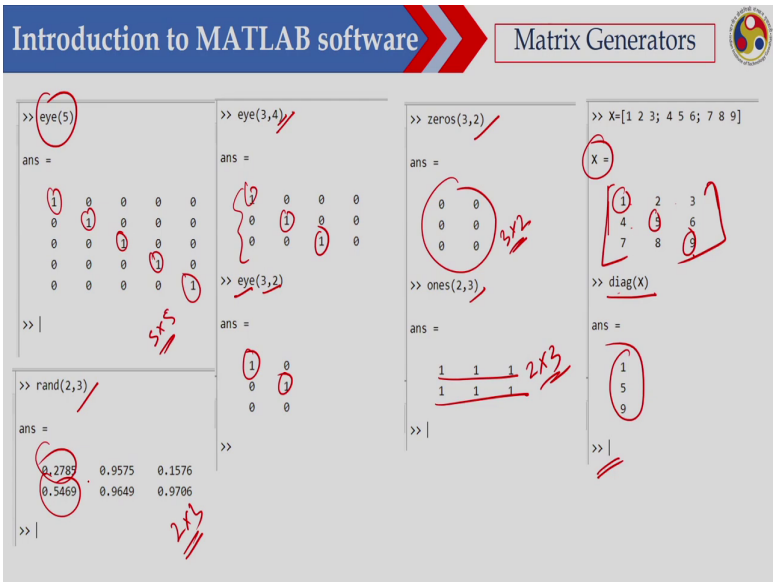

So, here I have shown that eye 5 ok. So, this is a 5 by 5 matrix. So, you can see all diagonals are 1 all diagonals are 1 ok and off diagonals are 0 and if I create if I just write eye this is 3 comma 4 ok 3 by 4. So, it will create 3 rows and 4 columns. So, and all diagonals will be equal to 1 and if it is eye 3 by 2. So, this is diagonals will be 1 off diagonals will be 0 and this is zeros 3 by 2 then all zeros. So, this is a 3 by 2 matrix and similarly if I write ones 2 by 3.

So, this is a 2 by 3 matrix and you can see all you are getting ones and then I have created this particular matrix.

So, X equal to 1 2 3 4 5 6 7 8 9. So, this is the matrix I have created, this is the matrix I have created and I would like to get the diagonal elements; that means, 1 5 and 9. So, I will use that diag X. So, I am getting the diagonal values this is 1 5 and 9 and if I want to create some random values ok and this rand function will create a matrix and the elements has been generated randomly ok between 0 and 1 and you can see. So, I am creating a 2 by 3 matrix randomly ok and this values are between 0 and 1.

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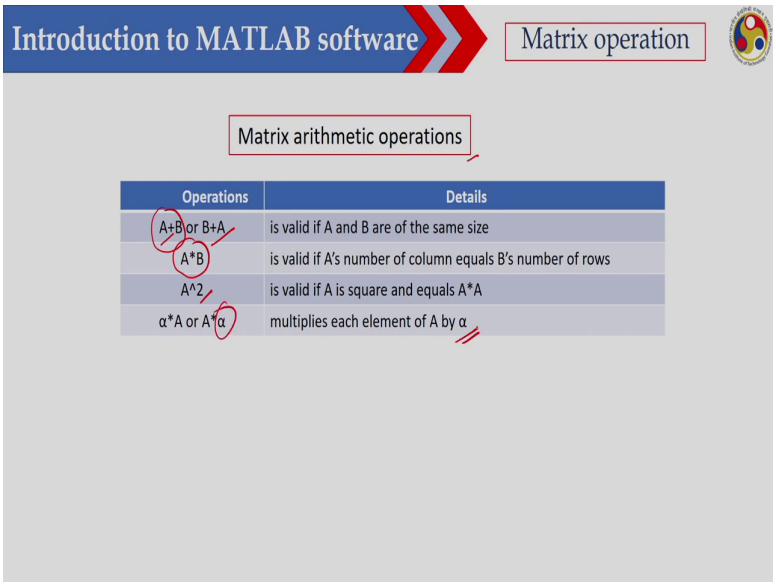

Now, let us see matrix operation arithmetic operation that we have already we have seen in case of n vector. Suppose I would like to add A with B ok and B with A, then if I multiply A

and B then if I want to calculate the square ok and then if I multiply with a scalar ok alpha. So, what will happen?

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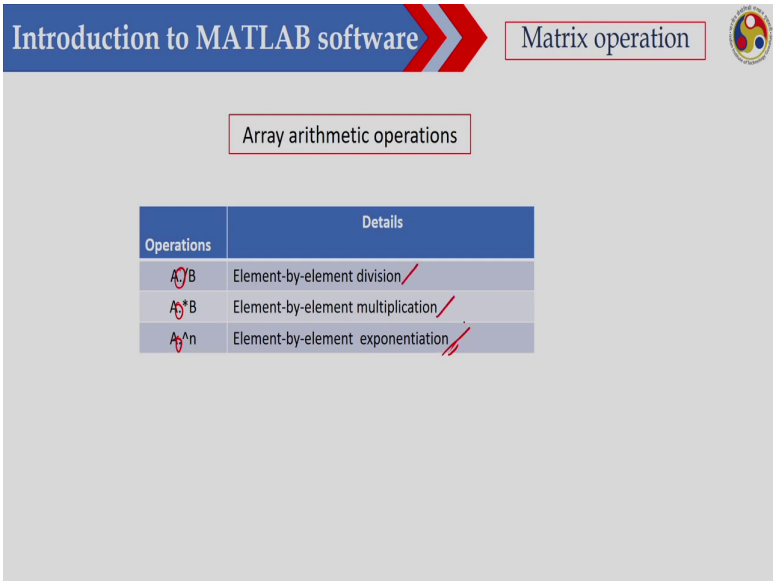

And if I want to do the corresponding that is element by element division. So, if I want to do the element by element operation; that means, then I have to put this particular dot ok. So, this particular dot. So, this will do the element by element operation. So, it is in division, this is multiplication and this is exponentiation.

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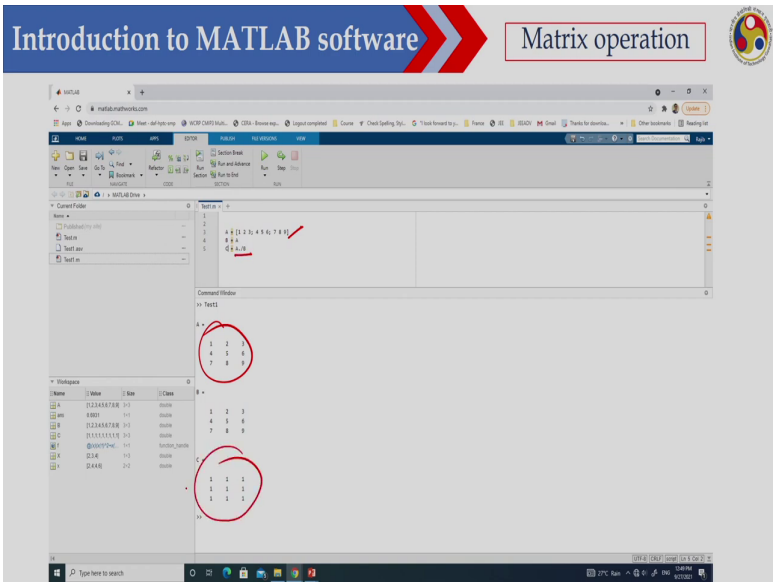

So, I have shown here you just see this is A is a matrix. So, this is the matrix I have created using that line and B equal to A and then I have divided the element by element division that is A dot B. So, I am getting all ones.

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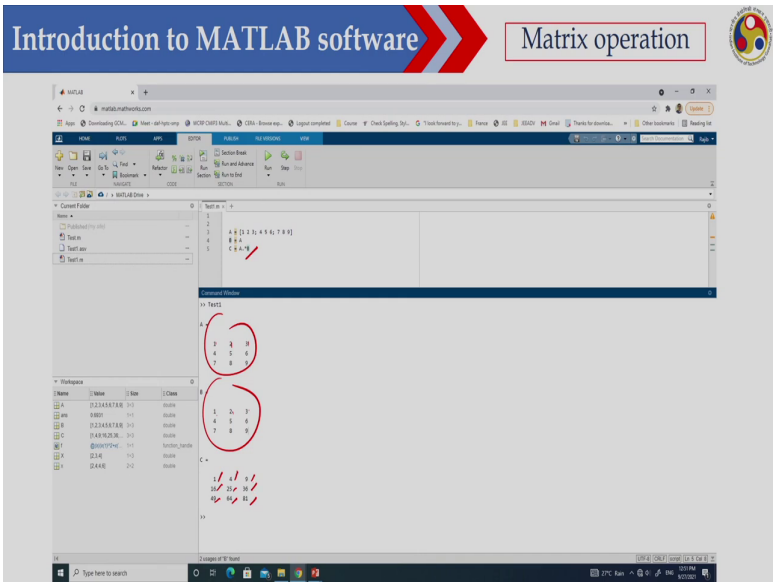

And similarly, if I do element by element multiplication. So, this is A and this is B, this is A and this is B and just see this is 1 into 1. So, I am getting 1, 2 into 2 I am getting 4, 3 into 3 I am getting 9, then similarly 16, 25, 36, 49, 64, 81. So, this is element by element multiplication.

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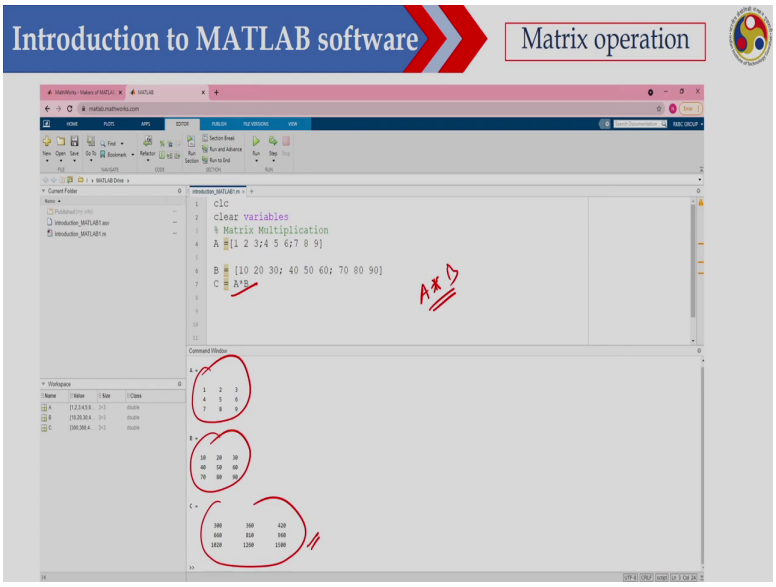

Now, if I do if I write that A star B then what will happen? So, this will give you the matrix multiplication. So, I have created 2 matrix this is A matrix and this is B and then this is C is your matrix that is A cross B ok. So, I am getting this ok. So, its a matrix multiplication between A and B.

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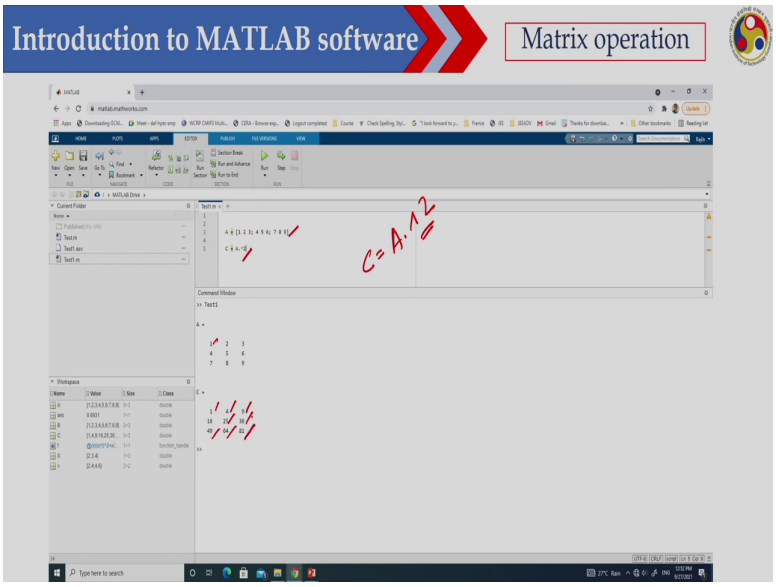

Then if I want to square the corresponding element of this particular matrix. So, I have to put dot. So, in this case I am writing C A dot cap 2; that means, I have square all the corresponding elements. So, it is 1 square this is 1, 2 square 4, 3 square 9, this is 16, this is 16, 25, 36, 49, 64, 81.

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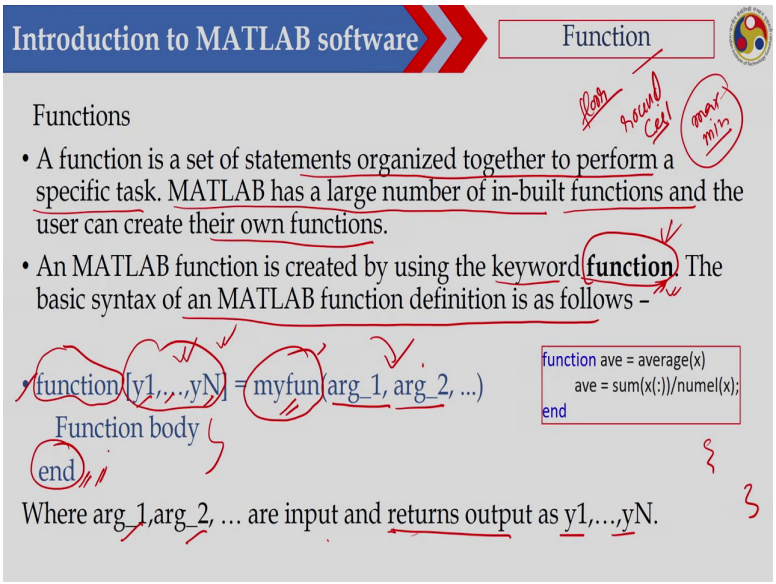

Now we can also define the function in matrix. So, already we have learned how you can define a function in R. So, let us see how you can define a function in MATLAB ok a function in MATLAB. So, a function is a set of statements organized together to perform specific tasks MATLAB has a large number of inbuilt functions. So, you have seen there are functions.

Suppose I have seen the max function, then min function ok. So, these are some of the function already we have and there are lot of several inbuilt function in MATLAB you have seen that round ok. So, this is also a function, then floor ok floor is also a function then ceil ceiling is also a function. So, there are several inbuilt function in MATLAB and the user can create their own functions ok. So, you can also create your own function and once you have created this function and you can use this function just like an inbuilt function ok.

A MATLAB function is created by using keyword function. So, the keyword here is function and the keyword is same as what you have learned in case of R the same similar key the same keyword the function keyword you can use the basic syntax of MATLAB function define as follows ok. So, you have to use this particular keyword function and y1 y2 yN. So, this is the value of the variables which is coming out of the function ok.

So, these variables are coming out of the function and then you can define a name or you can give a name suppose this is my function you can give any name of your means as for your requirement. So, you can give a name and then these are the arguments what is coming to the function. So, what is happening these arguments are coming into the function, then you are doing some calculation here and these variables ok we will go out of this function ok.

So, I will get this particular variable after executing this particular function and then here we are not using in case of R we have used the second bracket, but here we are not using. So, we are writing this is the beginning of the function and this is the end of the function. So, end of the function we are writing end ok. So, e n d end. So, where argument 1 argument 2 are the input and what this function will return? The function will return y1, y2, yN.

So, this is your simple its not difficult ok just like your R, the syntax is little bit different. So, its not similar to R, but keyword is same. So, in R also we are using the function keyword to create a function and here also we are using we are using the function keyword to create a function and syntax is different. So, here the function is created using the function keyword and then the function will end with end ok. So, we have to write e n d.

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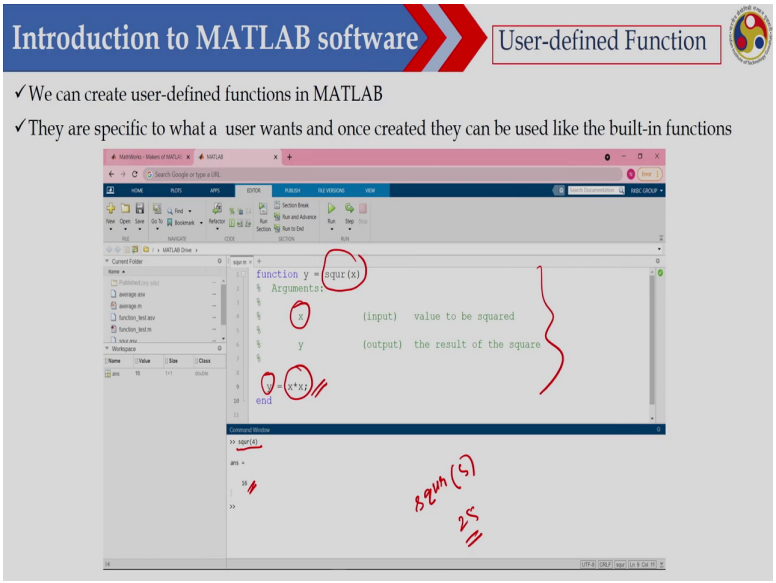

Now, let us see a function. So, the function is square ok the function is square and what we have to what we are doing here? So, this is the vector I am taking. So, as x is the vector and this is x and I would like to calculate square of this particular x and. So, I have written this is x into x ok and I have stored here and this y will be coming out of this function. So, now, I have defined this particular function and now I would like to calculate the square of 4.

So, simply what I will do? I will write square 4 ok square 4 then I am getting 16, similarly if I write squr 5. So, you will be getting 25 something like that. So, this function will return the value of y ok this function will return the value of y.

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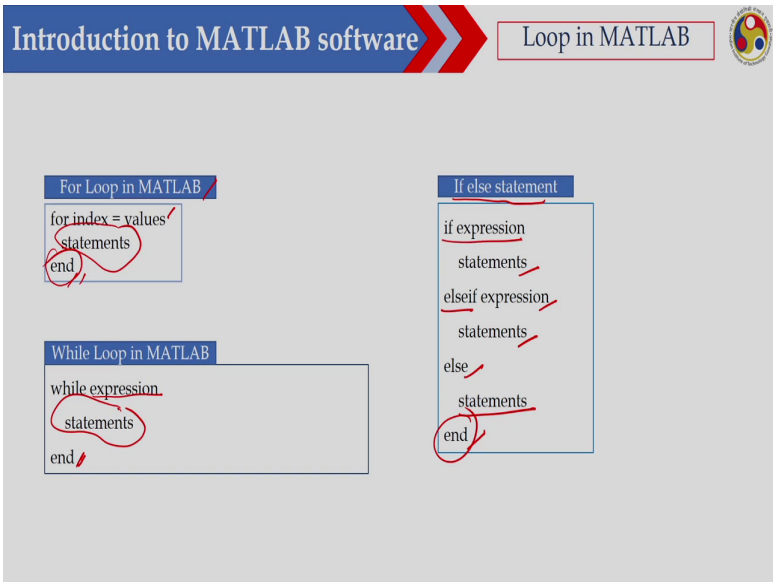

Now, there are several your ways to implement the loop and conditional statement in MATLAB. So, let us see. So, I would like to discuss here the for loop ok. So, for loop the syntax is for index equal to values then this statement will be created and then this loop will end by this end. So, you have to write end.

So, this is the beginning of this particular loop and this is the end of this particular loop similarly you can also use while loop ok. So, this is I am writing while expression and then these are the statements to be executed and this is the end of the loop and similarly you can also use if else statements to execute some conditionals your statement.

So, if expression. So, you will write expression, then statement, then else if you write expression then statement then else you can write statement. So, then end. So, end is basically end of this particular conditional statement.

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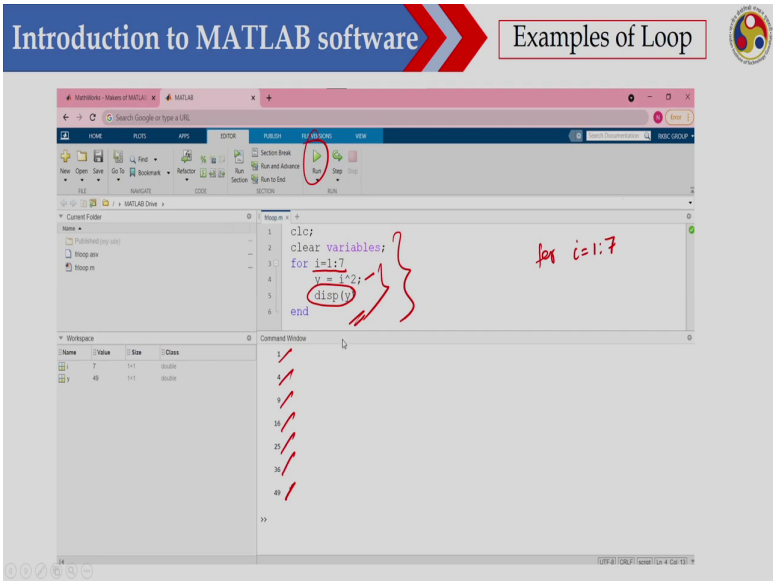

So, here let us see that I how to use the for loop this is very easy. So, what I would like to do here that for i equal to 1 to 7; that means, for i equal to 1 to 7; that means, i equal to 1 to 7; that means, for i equal to 1 2 3 4 5 6 7 then you calculate the y and y is equal to i square and then display y. So, if you are executing this code using this run button. So, you are getting that 1 squared and 2 square 3 square 4 square 5 square 6 square and 7 square.

So, this is 1 to 7 ok. So, this is if this is your for loop then I can also execute this one using while loop here. So, ok while loop.

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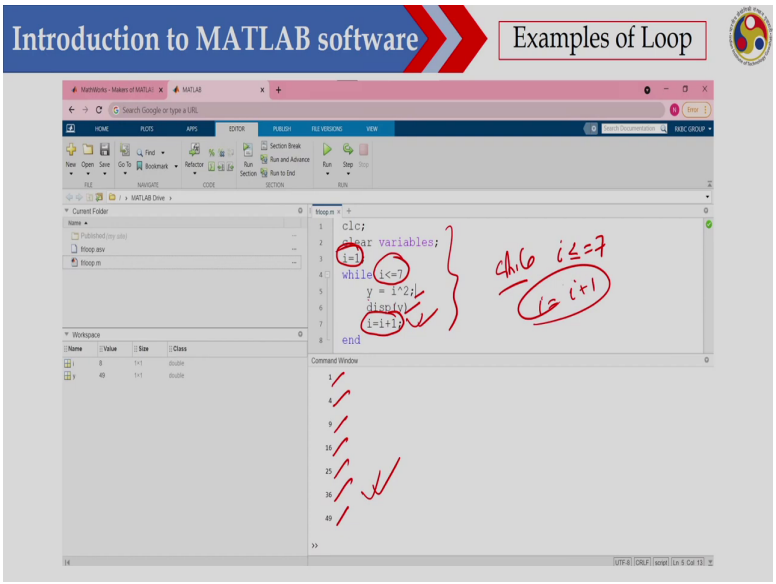

So, while i is less than equal to 7 ok. So, i is less than equal to 7 while ok. So, while this is less than equal to 7; that means, it will start from 1. So, i equal to 1 I have defined then 1 2 3 4 5 6 7 ok. So, and then this y equal to I square then display the value of y and in this case I have to put a counter here.

So, in the next time I will be equal to i equal to i plus 1 ok. So, I have to write this one and once you are executing this is 1 square 2 square then 3 square 4 square 5 square 6 square and 7 square. So, you are getting this particular output.

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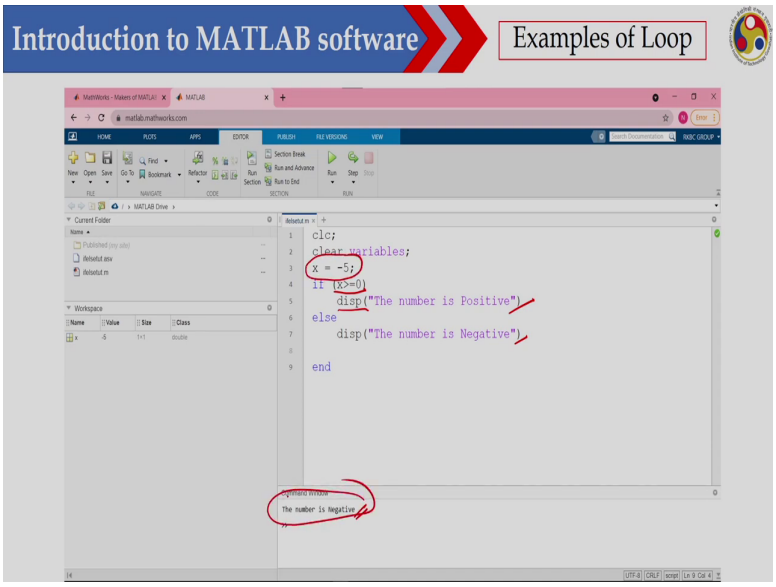

So, let us see how you can write the conditional statement using if. So, if x is greater than equal to 0 then display the number is Positive if x is less than 0. So, in that case it will be Negative. So, what I will do here that if x is greater than 0, then display the number is Positive else the number is Negative. So, therefore, now I have I put x equal to minus 5. So, therefore, this number is Negative. So, this has been displayed.

Now, let us see how we can write an expression suppose I would like to like to write an equation the way we have written in case of R. So, let us see how we can write an equation. So, this is just similar to what the way this is just similar to the way you have written in R ok the similar way I can write an expression. So, let us see that ok.

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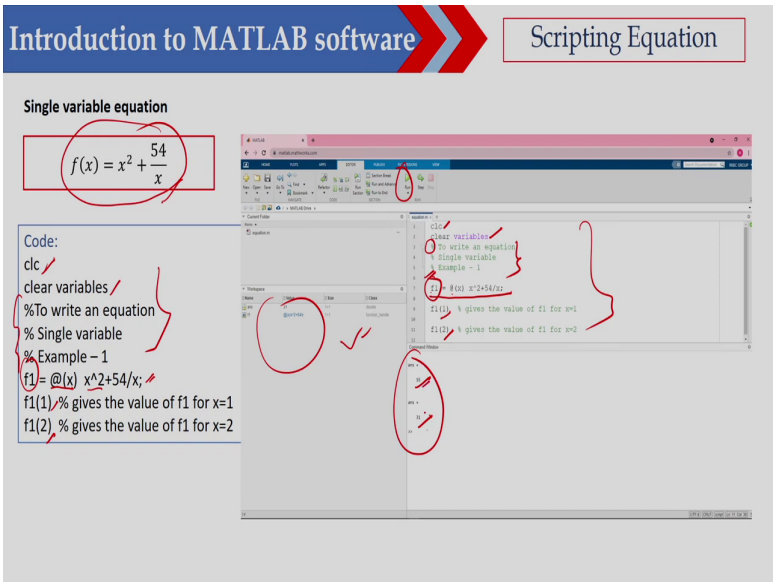

Now, suppose I would like to write this single variable equation that is f x equal to x square plus 54 by x the code is anyway. So, these are something we these are some common line ok. So, and here so this is clear the environment and clear the variables here ok and then these 3 lines are command lines and then I have written f equal to. So, this is I have written at the rate and within bracket I have written x. So, x is a variable here and this is x square plus 54 by x ok.

So, in this case x is a scalar. Now if I would like to calculate what is the value of this f 1 for x equal to 1 and x equal to 2. So, I can write that f 1 1. So, for the value of f 1 for x equal to 1 and value of f 1 for x equal to 2 now let us see this code. So, this will be executed. So, it will clear the command window and this will clear the workspace ok. So, this will clear and after that this 3 line will not be executed because it has start with the percentage sign.

So, therefore, it will not be executed. So, this is for comment only, then I have written this is the fun this is the expression that f of x. So, this is f 1 and at the rate within bracket x this x square plus 54 by x and then I calculate the value of this f 1 for x equal to 1 and this is for x equal to 2. So, once you are executing this particular code. So, using this run button. So, you will get 55 and 31; that means, the function value for x equal to 1 is 55 and function value for x equal to 2 is 31.

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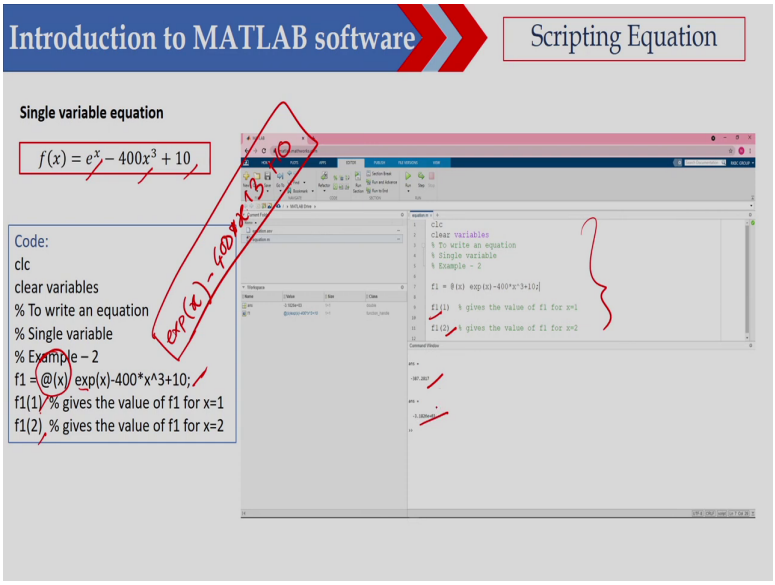

Now, let us see a different function. So, this is f of x equal to e to the power x minus 400 x cube plus 10 ok. So, here I have written this expression. So, now, this is e to the power x means e x p this is x ok minus 400 star this is x cube ok plus 10 plus 10. So, this is similar to what we have learnt in case of R ok. So, this is similar and then only thing is that this syntax is different ok. So, in R we have written using some different syntax.

So, here it is different then I calculated what is the value of this particular function for x equal to 1 and x equal to 2. So, if I write this particular function if I execute this 1 then I am getting the function value for x equal to 1 is this that is minus 387.2 right 17 and for 2 this value minus 3.1826 e to the power 3.

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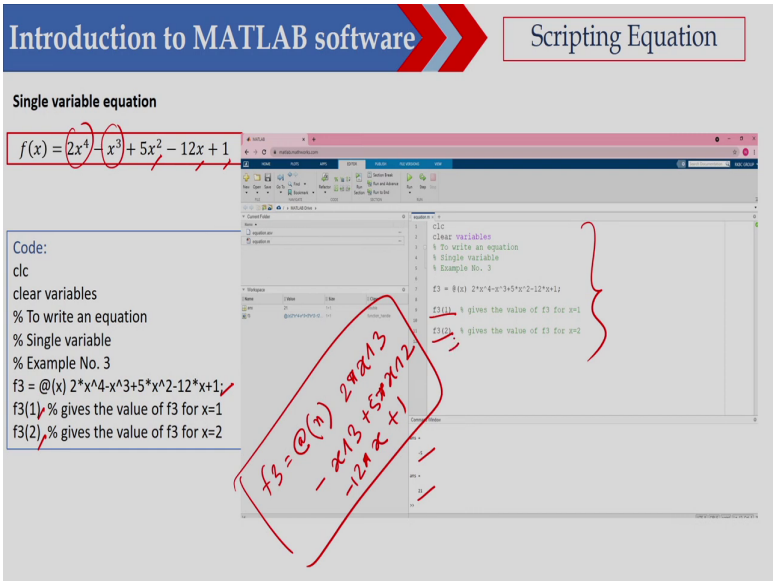

Now this is a another function. So, this is an another function. So, that is 2 x to the power 4 x minus x cube plus 5 x square minus 12 x plus 1 ok. So, here I have written this particular function; that means, that f 3 ok. So, which is equal to at the rate this is x and then this is 2 star x to the power 4 minus x to the power 3 plus 5 star x to the power 2 minus 12 star x plus 1 ok.

So, this is and then I calculated the value of this particular function for x equal to 1 and x equal to 2 and I have written this code here and if you are executing that 1 then f 3 for x equal

to 1 is minus 5 and f 3 for x equal to 2 is 21. So, this is very simple. So, you can write an expression or you can write in your function and you can calculate the value of this particular function for different value of the variables.

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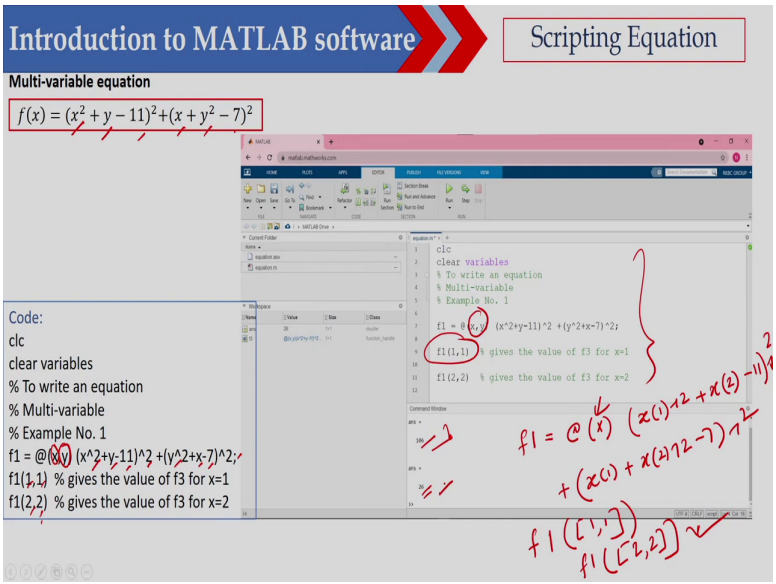

So, this is a two variable function the function is x square plus y minus 11 square 11 whole square. So, that is x square plus y minus 11 whole square then x plus y square minus 7 whole square. So, its a two variable function. So, what I can do here? So, I can write this is x and y ok and then this x square plus y minus 11 whole square then y square plus x minus 7 whole square and then you calculate the value of this particular function for 1 1 and 2 2.

So, if I execute this particular function. So, you are getting that f 1 for x equal to 1 y equal to 1. So, it is 106 and for 2 2 it is 26. I can also write this particular function I can also write it

something like that then if I write this is f 1 which is equal to at the rate I can define this I here I have defined as a scalar, but let us define as a vector ok.

And then you should get it that this is x 1 ok, this is square plus x 2 minus 11 ok square plus this is x 1 plus x 2 ok square minus 7 and then square ok. So, I can define x as a vector also. So, in that case I have to write that f 1 and this is a vector now this is 1 1 ok and f 1 for 2 2. So, I have to write 2 2 ok. So, if you execute this one. So, you should get the same value 106 and 26.

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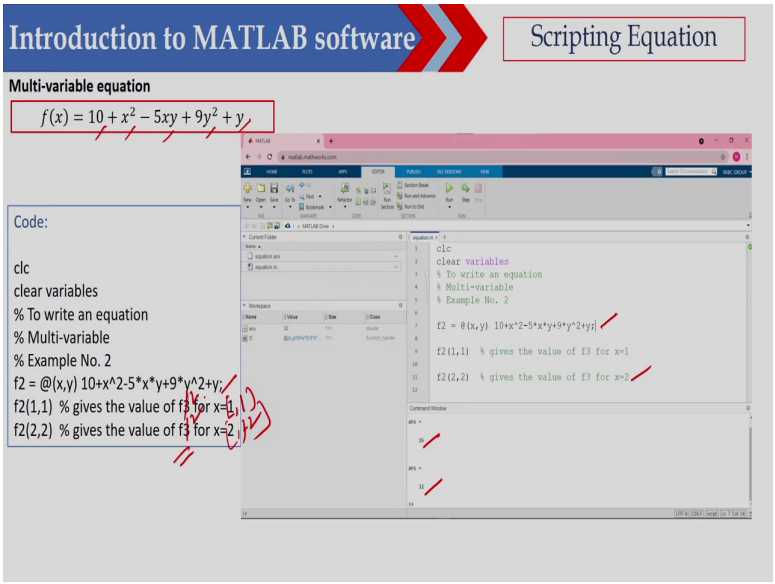

Now, this is another function that function is 10 plus x square minus 5 xy plus 9y square plus y. So, I have written the function here and this is for x equal to 1 1 and this is 2 2 ok. So, this is 2 2 and if you are executing this one. So, you should get the value of 16 and 32 ok. So, this

is x equal to this is a vector and this is also a vector 2 2 ok. So, you should get the value of this particular. So, this is 2 and this is 2.

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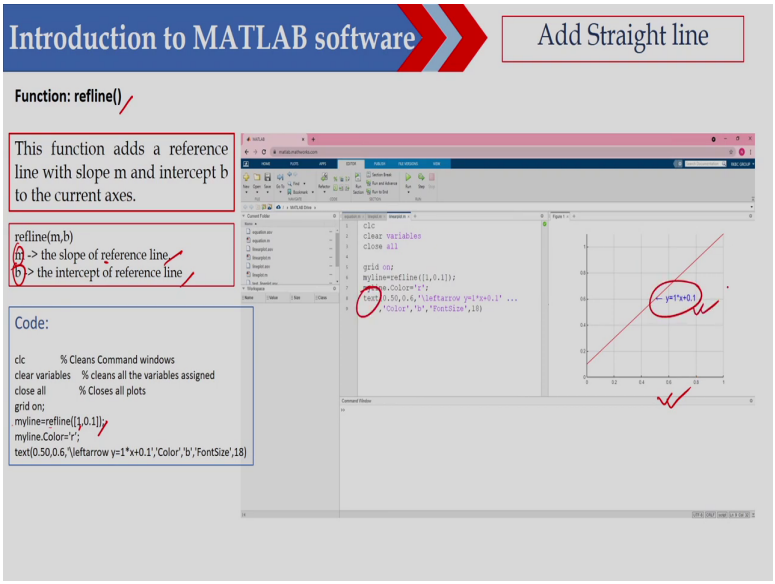

Now, in case of R. So, we have used the a b line a b line to draw a line, but in case of MATLAB. So, you can draw a line using refline ok r e f l i n e. So, here you have to pass this particular argument that is m and b where m is the slope of the particular line and b is the intercept ok. So, I can use that one. So, here I have written my line and my line is refline, refline which is the slope is 1 and intersection is 0.01 ok. So, you can execute this one. So, you are getting this particular line and you can so, using this text. So, you can also print the equation here.

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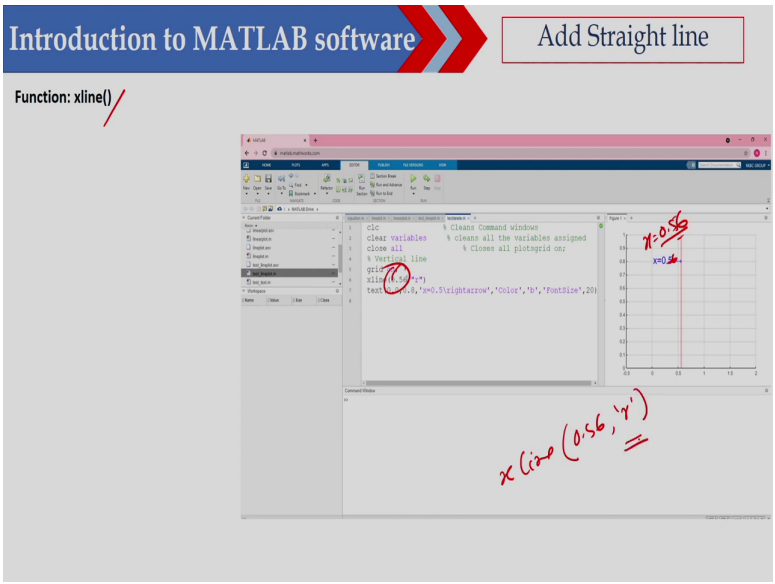

Now, if I want to draw a line which is parallel to y axis. So, I can define x line ok. So, this is x equal to 5 x equal to 0.5. So, I have drawn this particular line sorry x equal to 0.56 I have used. So, at x equal to 0.56. So, I have used this is 5 6 ok. So, x equal to 0.56. So, I have drawn this line which is parallel to y axis. So, then I will use x line ok. So, x line and then this is 0.56 and color I have used red color ok. So, this is x line you can use.

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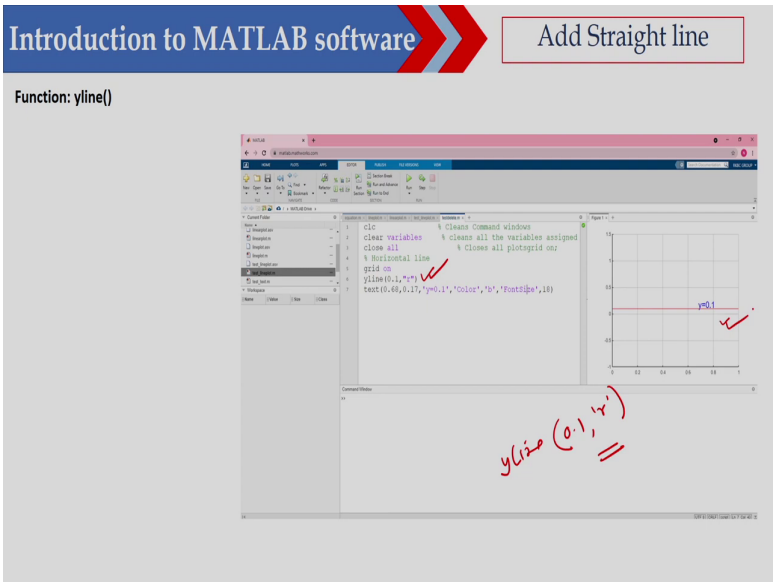

So, similarly if you want to draw a line which is parallel to y axis. So, what you will use? You will use y line ok. So, y line and I have drawn a line at y equal to 1, 0.1 and this is also red color ok. So, you can use this particular function to draw a line parallel to x axis.

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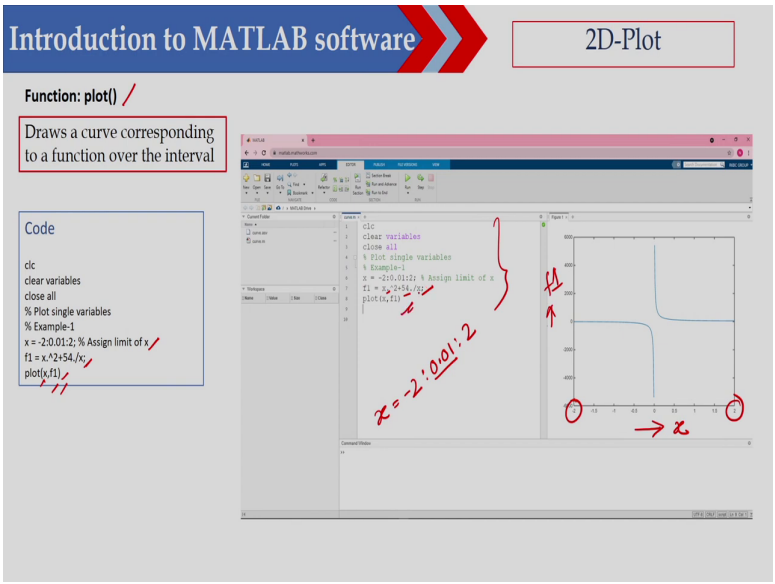

Then if you want to plot a particular function. So, you can use the plot function. So, here I have defined the value of x and then I would like to plot this particular equation ok. So, this particular equation I would like to plot and this is your plot x and f 1; that means, in x axis this is x and in y axis this is f 1. So, I have used the variable I have used the value of x and f 1 and dimension of x and f 1 has to be equal otherwise it will not plot.

So, this is the m file. So, you just see I have created the value; that means, x equal to. So, its starting from minus 2 and then intervals are 0.01 and it is going up to 2; that means, minus 2 to plus 2 and the interval is 0.01 and then I calculate the value of y axis that is f 1 which is equal to x. So, I now, I am using I calculate the value at corresponding elements. So, therefore, I have used dot and this is x square plus 54 dot divided by x and then I have used this plot function.

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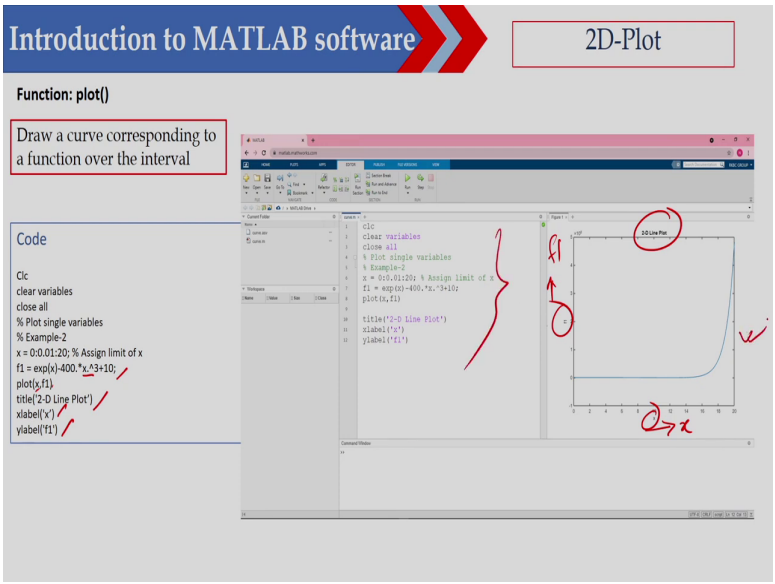

Now here this is a different equation ok the second equation that is e x p x minus 400 x cube plus 10 and I have plotted. So, this is x and y. So, this is x axis is x and y axis is f 1 and then you can put the title. So, title is 2 d line plot. So, and x label y label you can put ok. So, I will write x label x so; that means, I will get x and y label f 1 so I am getting f 1 ok. So, if you execute this one. So, you will get this particular plot.

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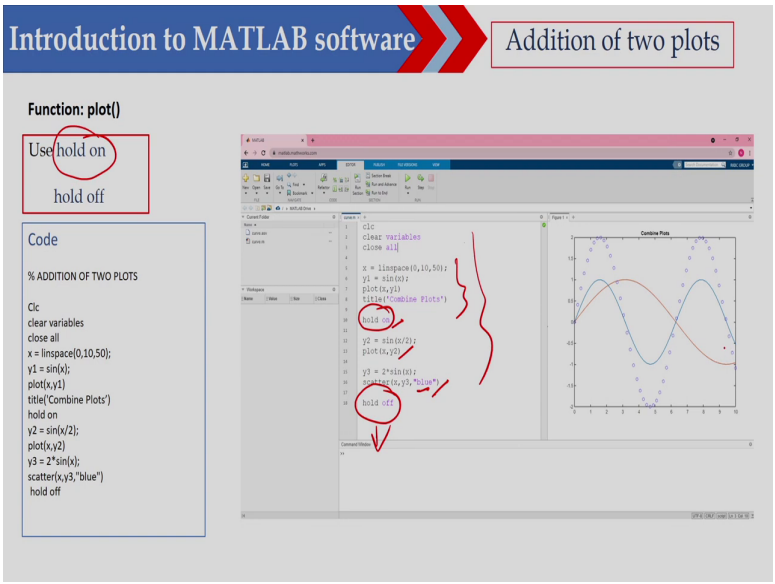

Now in MATLAB. So, if you want to plot suppose I would like to plot all this graph in a single plot ok. So, in that case what I will use? I will use this hold on command ok. So, if you are using this hold on command so; that means, what will happen? On the same plot all this function will be plot ok.

So, suppose I would like to plot this particular function. So, if I execute this 1 ok. So, this will plot the particular function and then I have to write hold on; that means, on the same plot I would like to plot the other function. So, this is another plot and this is the scatter ok. So, this is the scatter and this is also I have used the blue color ok. So, now, if you are using hold on then in a single plot all these function will be blocked then after that you make it hold off ok. So, if you are executing some other line. So, then it will not be this graph will not be plot here.

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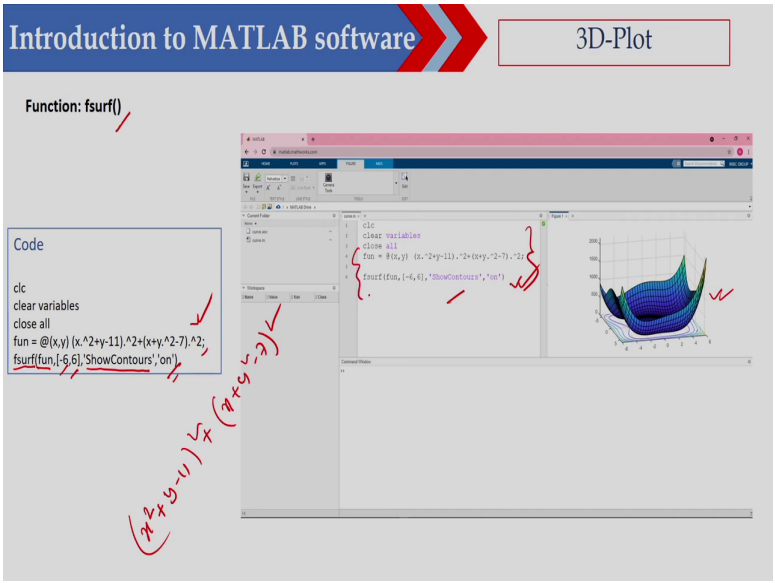

Then if I want to plot or if I want to get a surface. So, I can use fsurf function ok. So, here this is the function the function is x square plus y minus 11 whole square plus x plus y square minus 7 whole square. So, this is the function and then I have used s surf and this is the function and this is the lower bound and upper bound and I have also written ShowContour so that means, contours will be shown at the bottom ok.

So, you can see the contour lines are here and you can get this surface plot. So, this is quite easy and you just see quality of the plot is also very good ok. So, you can just simply only 2 lines. So, I have written 2 lines to plot this particular function.

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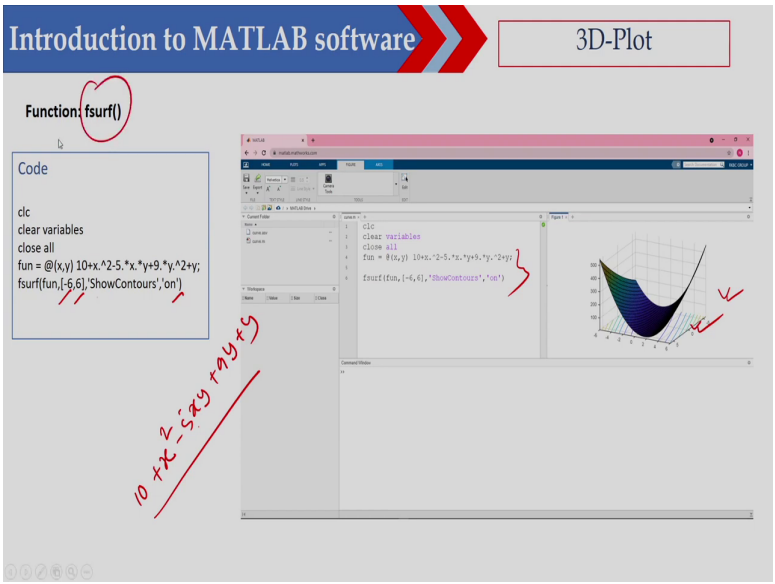

So, this is another function ok the function is 10 plus x square minus 5 x y plus 9 y plus y. So, this is the function ok. 10 plus x square minus 5 x y plus 9 y plus y and this is also between lower bound is minus 6 upper bound is 6 and ShowContour on. So, you can see the contours are here and if you are executing these two lines. So, you will get the 3D plot of this particular function. So, I have used here s surf function.

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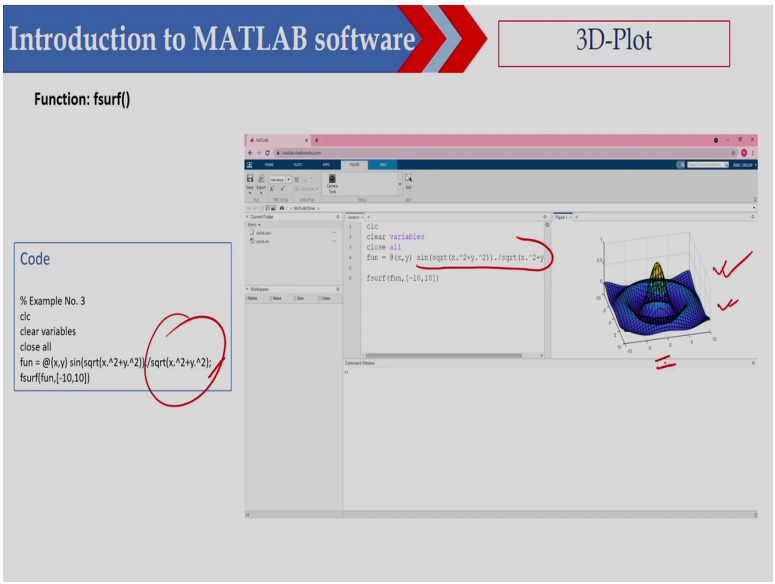

Then this is another plot. So, you can see this is the plot and this is the function equation ok. So, this is the equation this is x square plus y square ok. So, this is the equation and once you are executing this particular 3 D plot you will get using s surf.

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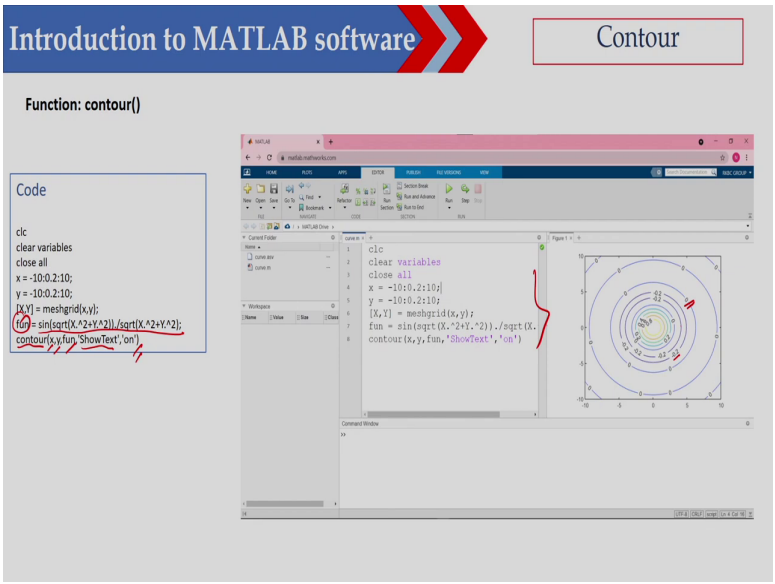

Then similarly I can also plot the contours and the function is contour here. So, I have to pass what is the value of x, what is the value of y and what is the value of z here. So, in the fun. So, I have calculate the value of z and then ShowText on ok; ShowText on means the contour your the marking will be given. So, this is yeah this is minus 0.2. So, this marking will be given here ok ShowText on. So, this is a few lines code to get this particular contour.

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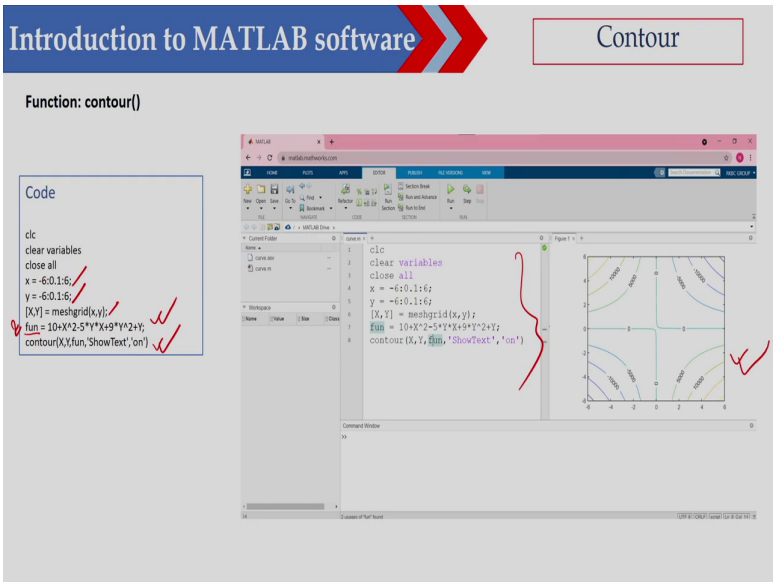

So, this is for another function. So, I have calculated here. So, x is between minus 6 to plus 6, y is between minus 6 to plus 6 and then I have created the grid using mesh grid function ok. So, X Y you have created and after that you calculate the function value this is nothing, but the z value at each grid point I have created and then I use the contour function to get this particular contour ok. So, this is quite easy and easily you can plot the contours.

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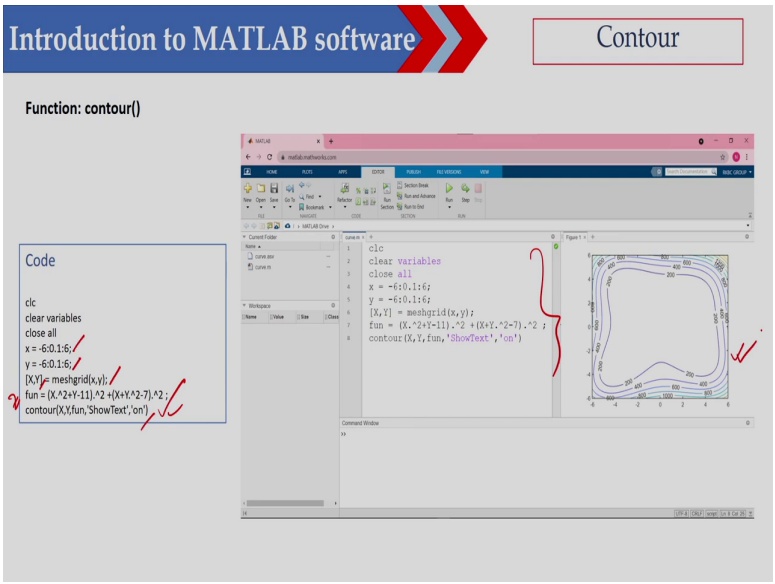

And this is for this particular function that is X square plus Y minus 11 whole square, then X plus Y square minus 7 whole square and here also. So, I created the x value between minus 6 and plus 6 and this is also y is also minus 6 and plus 6, then I have created the mesh grid ok and which has been stored in X Y and then I calculate the value of the function this is nothing, but the z value and then you plot this contour and if you are executing this particular m code. So, you are getting this particular contour. So, thank you very much. So, I have introduced here what is MATLAB.

So, how you can write or how you can define a variable here, then how to create a vector how to create a matrix and how to do the elementary operation suppose you want to add 2 vector then you want to add 2 matrix and you want to multiply 2 vectors ok so, that operation I have

shown here and I have also shown how you can write a function suppose I would like to write a function and that function I will write.

So, that I have shown here and finally, I have shown you how you can plot a particular function. Suppose I would I can plot a 2D plot a 3D plot suppose using surf s surf ok you can plot a 3D function and you can also use the contour to get the contour lines ok. So, that also you can do. So, you can use contour, you can use surf ok s surf and you can also plot a 2D plot ok using the plot function.

Thank you very much.