MATLAB Programming for Numerical Computation

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Module No. #01
Lecture No. #1.1
Introduction to MATLAB programming – Basics of MATLAB

Hello and welcome to module 1 of introduction to MATLAB Programming course. In this module we are primarily going to go over basics of MATLAB and introduction to MATLAB programming, how the MATLAB is laid out and so on ok. So, this is the first lecture in this module.

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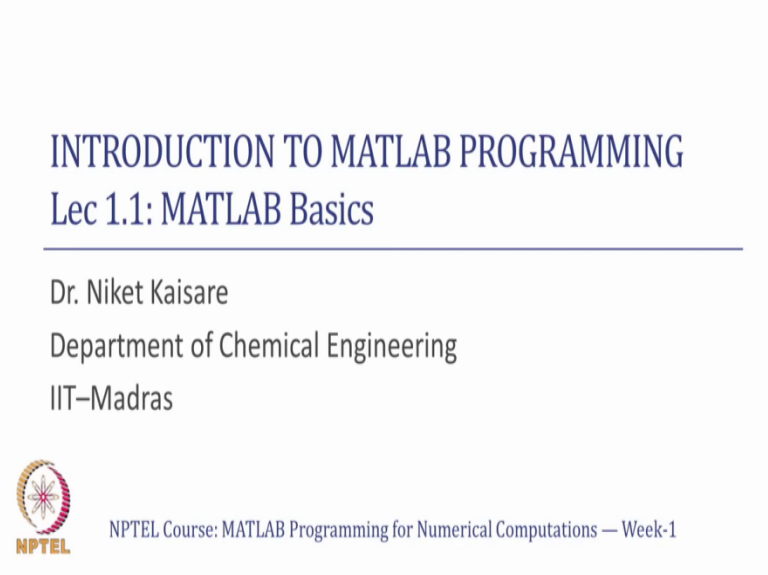

We will cover this module in approximately 5 lectures. The first lecture is on MATLAB Basics

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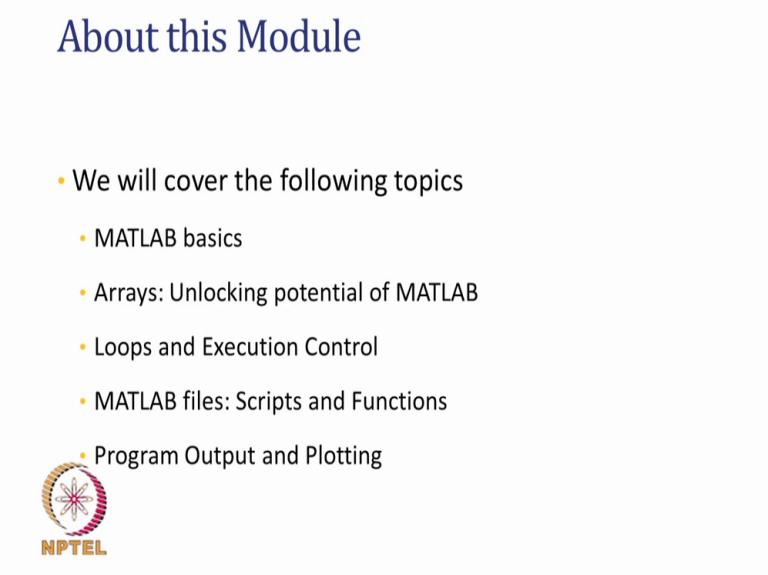

Now this module overall is going to cover after MATLAB Basics, we are going to cover arrays. So that is the main aspect of working in MATLAB, basically arrays and matrices. So that is the second lecture in this particular module that we are going to cover. There after we are going to look at loops and how to use loops, for loops and while loops in order to do various computations.

That will be followed by talking about MATLAB files, MATLAB scripts and functions and how to use MATLAB files which will require a lot in the rest of the course and finally will talk about plotting and outputs in using MATLAB ok.

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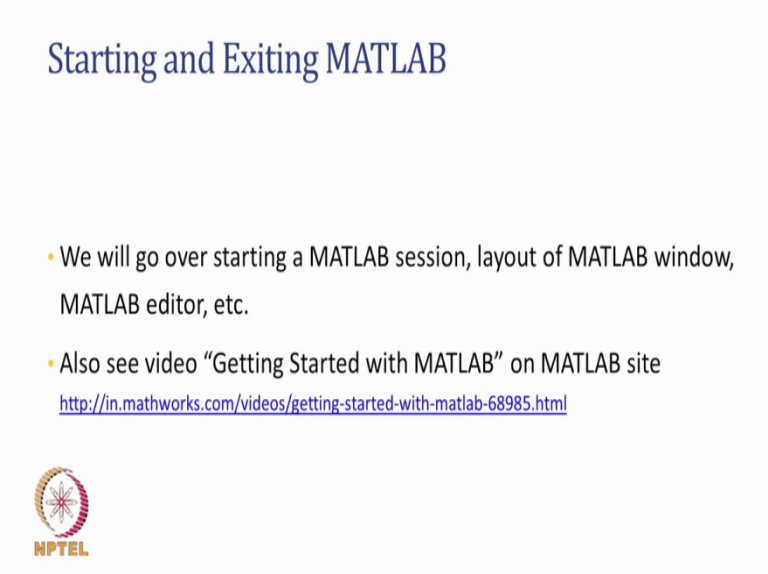

Alright so we will go over how to start a MATLAB session, the layout of the MATLAB window, MATLAB editor and so on and so forth. All of these is also available on MATLAB's website. The link for which is given right over here. So you can also, in addition to this video lecture I encourage you to also go to MATLAB website and look at the video "Getting started with MATLAB". And that is what we are going to cover in this particular lecture. So let us go and open the MATLAB.

(Video Starts: 01:56)
So, I have just created a short cut over here for MATLAB in your case you may have to open it using programming files ok. So, this is how my MATLAB window looks like when I open MATLAB. Your MATLAB window may look slightly different and however the main components of the window will still remain the same. So, this window has several components. The first is the most important one is what is known as the command window.

So, that is, so lots of times people just display command window and nothing else that is also fine. I like to display my current folder as well as the workspace, workspace is nothing but the variables that you currently have in the system, defined in system ok. You can move all these things around by just clicking and dragging and as you can see, you can drag it at various location. So, if you drag it and put it on the current folder itself.

You will basically have the 2 current folders and workspace as 2 tabs, ok. And again you can drag this workspace back over here and you can place it next to the command window then we can have current folder workspace command window and so on. Again as I said I like to place the workspace variables and my current folder next to each other or below each other to the left hand side and that is what we will do, again you can resize all these windows as you find fit ok.

So, let us, now, this is the overall layout of any MATLAB window that you might have. What will do, go and do is will start a MATLAB editor as well in order to do that you give a command edit space followed by the file name, so you will call this my first file and I press enter and we will be able to open my first file and this a blank file in MATLAB editor. This is where you can

put in all your commands all your functions and expressions assignments so on and you can use MATLAB.

So that is what I just wanted to give an introduction to MATLAB now let us look at the various MATLAB files that I have already created in my folder. So currently in my folder I have 3 MATLAB files ball animation, ball trajectory and ball trajectory fun that is ball trajectory function. If I go to MATLAB window, I cannot see all these 3 files and that is because am in a different directory ok.

So, I can change my directory using the cd command change directory command or I can go and because I have used to this particular, been to this particular directory, before I can look at that in my history. So I will just select from the history and now I am able to see all these files ok. So let me just go and open ball trajectory file by double click on it and this is how my file looks like I will go over the various basics of this particular file in the PowerPoint again ok.

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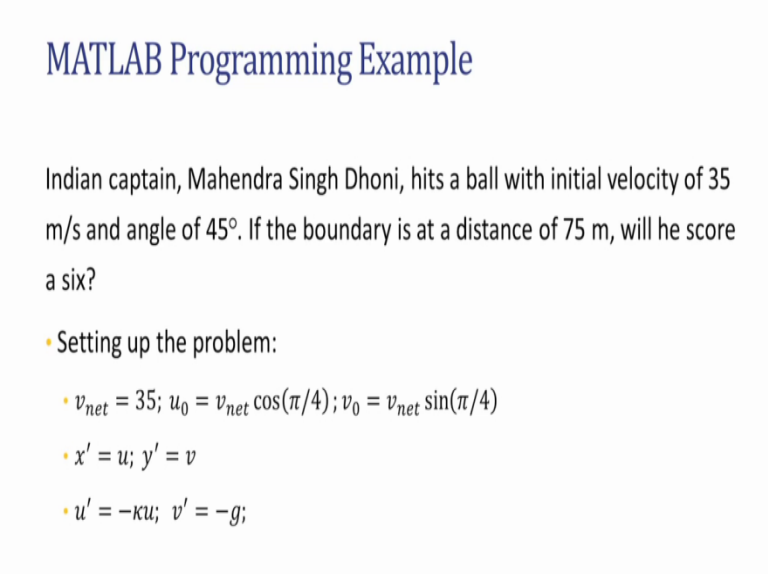

Ok this particular file uses the following example. This is an example of the famous cricketer, current captain of Indian team Mahendra Singh Dhoni trying to hit a ball for a six, Dhoni hits ball with an initial velocity of 35 meters per second at an angle of 45 degrees. And the question that we are asking ourselves, I have, which will solve in MATLAB is whether the ball is able to

cross the boundary rope that is 75 meters from where Dhoni is standing in order for this to be registered as a 6.

So, we want to find out whether the ball lands before 75 meters or after the 75 meter line and we are going to solve this particular problem using the simple equations that we know of and those equations are shown over here. Distance dx / dt depends on the horizontal velocity, dy by dt depends on the vertical velocity. The acceleration in the horizontal direction is the one by the air drag and that in the vertical direction is the one by the gravitational force ok. So these are the equations that we have ok.

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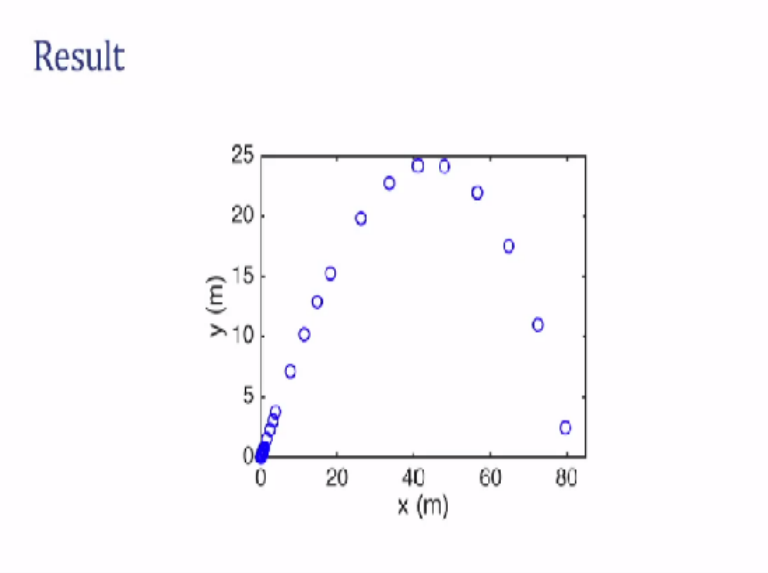

And when we put this in MATLAB and we plot we are going to get a plot of this nature this is how ball trajectory looks like at the end of every second or at the end of every .1 seconds, I am sorry and the ball lands approximately 80 meters from where Dhoni is standing. So, indeed this ends up being a six.

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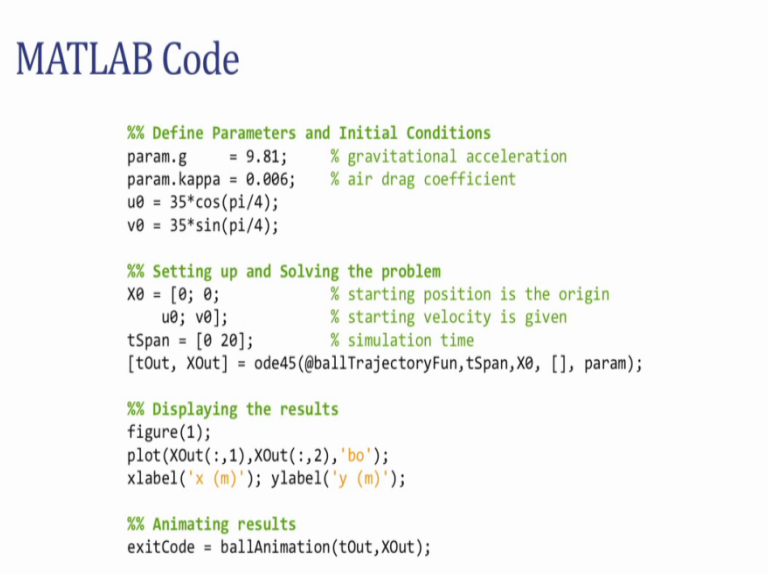

And the MATLAB code that a quickly shown you earlier. We will go over that in a minute. And I will show.

(Video Starts 07:26). How this MATLAB code runs. In order to run this MATLAB code, what we need to do is type the file name ball trajectory over here and press enter. And this is going to run and what have done is also done as small animation of how the ball moves and lands at approximately 81 meters ok.

Once we have run this file, this is what we are able to see in the workspace. All the workspace variables we are now able to see over here. And what we see over here is that the function has existed and we have come back to the command prompt ok. (Video Ends 08:12)

Let us go back to what the MATLAB code looks like. And this is how the MATLAB code looks like the green, green things that you see over here are basically comments that we have entered in MATLAB and am going to go over the various parts of the MATLAB.

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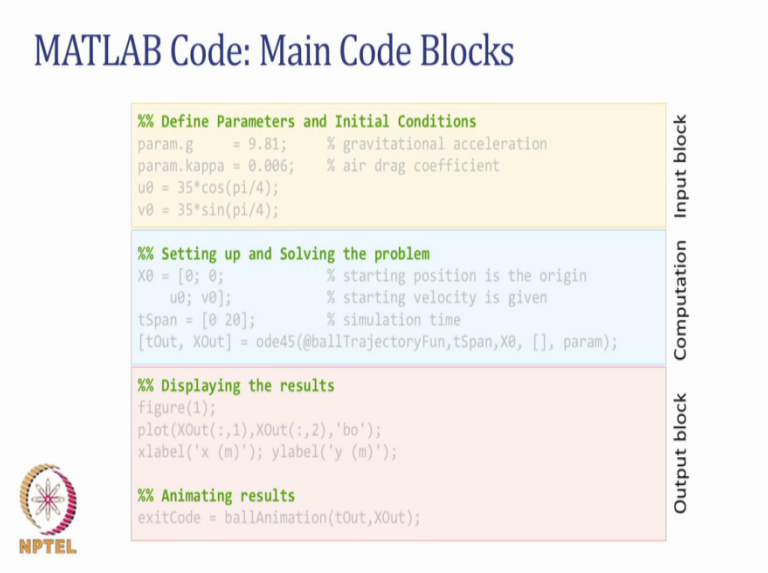

The over, overall structure of this code looks something like this. We first have this input block where we are defining parameters and initial conditions. We have the computation block where we are setting up the ordinary differential equations and solving them. And finally we have the output block where we are displaying the results and where we are showing the animation.

The animation is not going to be covered in this particular course we are going to cover rest of this stuff in this course we will go over the things in the input block computation block and output block the name parts of it

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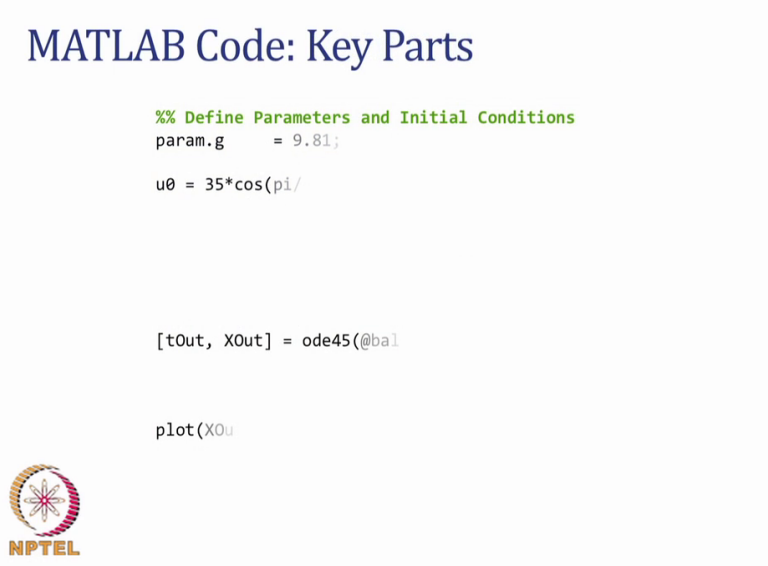

So, what are the main parts been highlighted over here?

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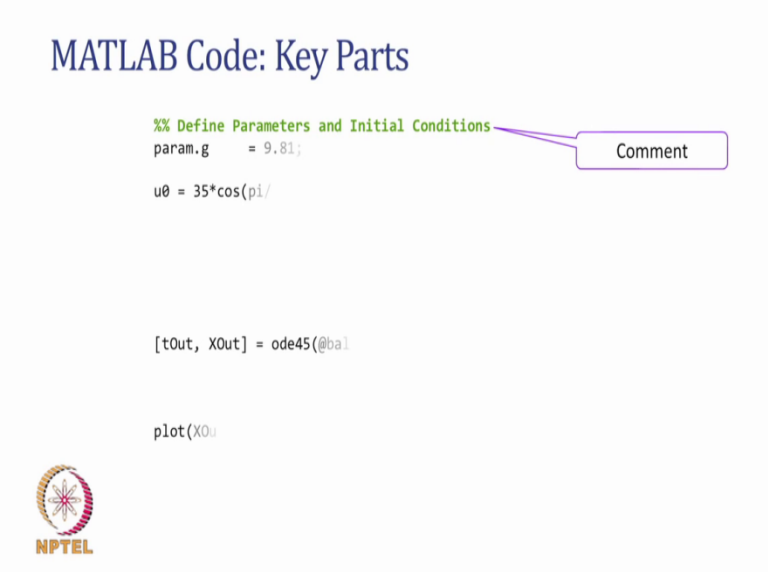

The first one is a comment. A comment starts with a percentage sign and it is colored green in MATLAB editor window. So, the comment that starts with 2 percentage signs are basically they mark start and end of a section in MATLAB. This is nothing but sectioning just to identify for humans MATLAB ignores this particular command it is just for us to identified the code or structure the code in a better way.

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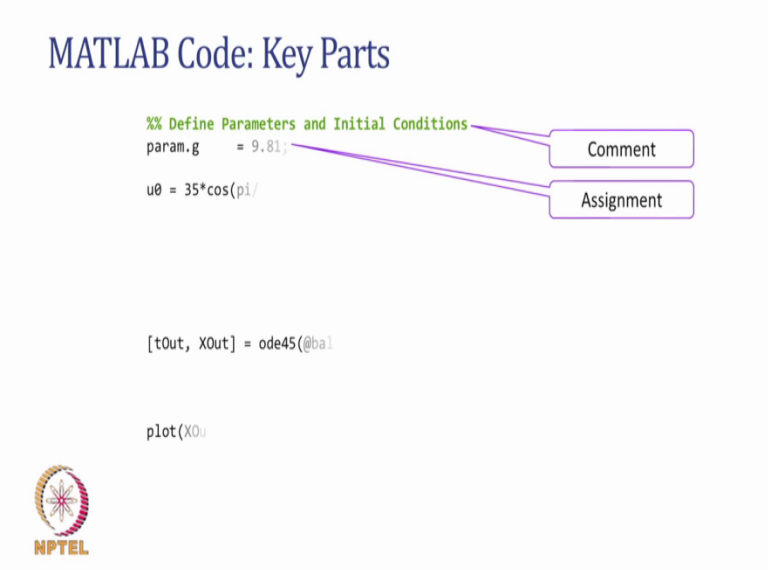

The next thing is that we see over here is an assignment. Assignment is basically you have a variable and constant is been assigned to the variable instead of a constant we can assign any expression to the variable also.

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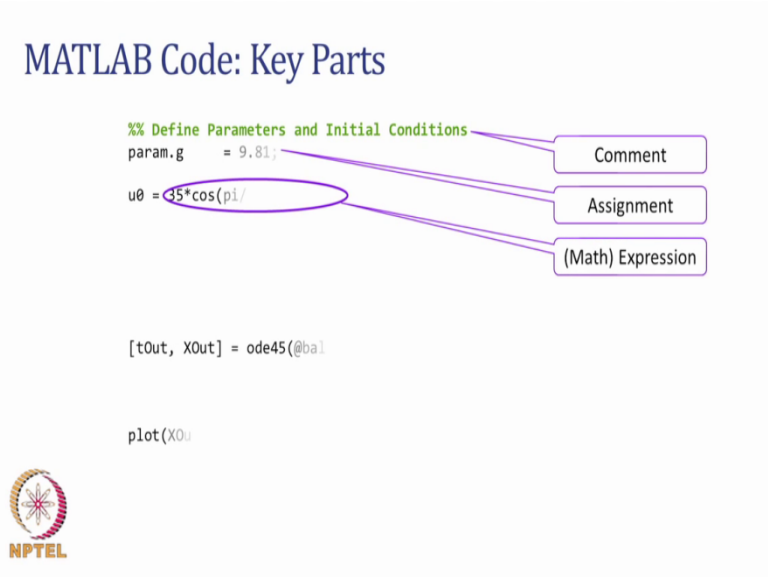

This is a mathematical expression 35*cos (pi/4). That is the mathematical expression over here. We will go over what variable declarations and mathematical expressions are in this particular module in lecture 1.2.

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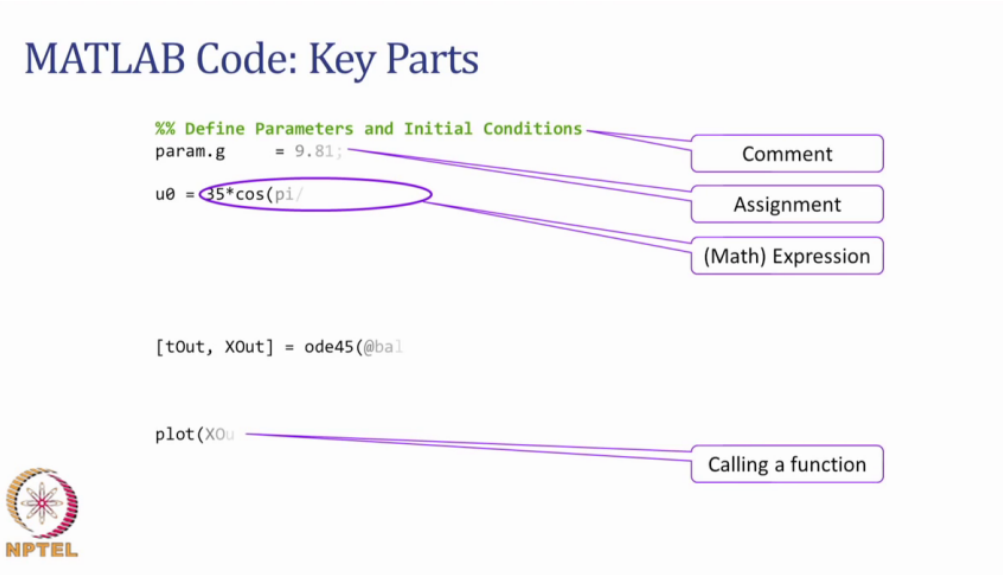

Over here, what we see is a function. This function is a plot function and we are calling this function with certain set of arguments. Again I am not going to go over this in this particular

lecture, we will go over that later on in this module. In this particular example we have called function and we are not worried about the outputs of that functions. So, we are just calling this function as is, if you want to capture the outputs of this function, we are going to call the function and capture the output as shown over here.

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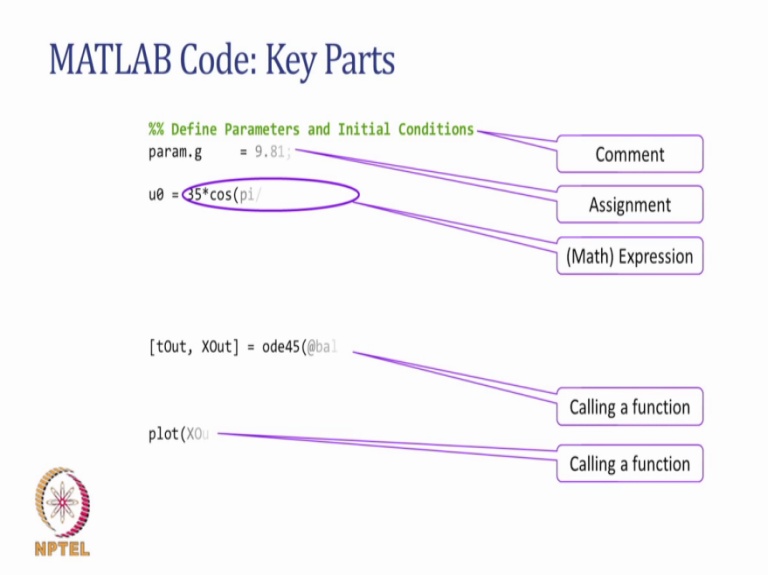

Again these are things that we will go over the MATLAB basics and introduction to MATLAB in this particular module in the subsequent lectures.

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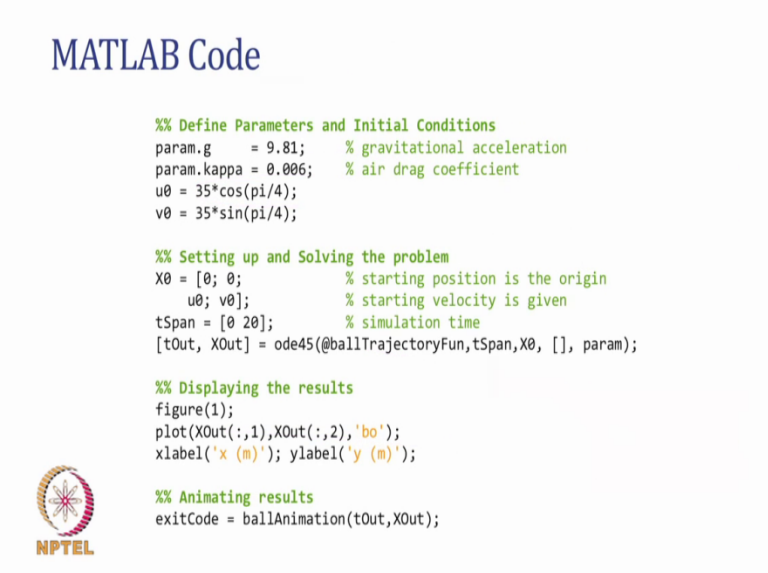

Ok. So, this again was the overall MATLAB code we are going to cover various things that are involve in coding of this MATLAB in this particular course.

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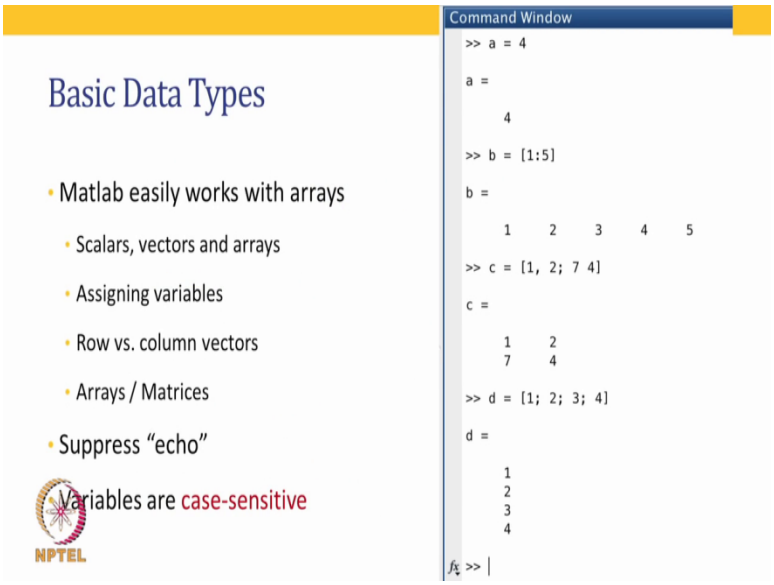

Ok so, now let us go over what the basic data types of MATLAB are. Now the 2 main data types in MATLAB are going to be scalars and matrices or arrays or vectors. So, when we talk about scalars, scalars are nothing but a single valued variable where as arrays or matrices are going to be of size m by n where m is the number of rows and n is the number of columns.
So, we will go over some of these basic things in this particular lecture and in the subsequent lectures in this module.

Ok. The most powerful thing about MATLAB is that it works with matrices and that is what mat in MATLAB stands for MATLAB. Again we are going to look at how to assign variables, how to assign scalars, how to assign vectors, how to assign arrays and matrices and that is shown over here. a is the scalar, b is what is known as row vector, c is the matrix over here. And d is what is known as the column vector. So, let us go and type these things in MATLAB and see how that works.

(Video Starts 12:17) So, let us say an equal to square bracket 1, 2, 5. If we type this, close this square bracket and press enter. We will now have a vector a. This vector a has 1 row and 3 columns over here and that is shown as a row vector as seen here ok. If we type b =1; 2; 5, we are now instead going to get a column vector. So, that has 3 rows and 1 single column as shown over here.

So, the commas are going to separate various elements in a particular row where are semicolon is going to separate various rows. So, that way we can build a matrix as shown over here 1, 2 that means thus this is the first row 3, 5 that is the second row, minus 1, 0 that becomes the third row so we have 3 rows and 2 columns in this particular matrix.

And this is what we can see over here. So and now let us say we wanted to define a scalar. So let us say q = 5 that becomes a scalar ok. As you can see over here, every time I type a command the results of the command get displayed in MATLAB window. I will just clear this MATLAB window, so if we do not want to display, then we can basically type sorry, we can basically type this a.

And we can end it with a semicolon. So if line is ended with a semicolon, the echo is been suppressed. As you can see the a, the variable gets assigned to the matrix a, however we do not see the result on the screen. If you want to see the result on the screen, we can just type a press enter and we will be able to see result. Another thing we can do is go to this workspace, click on, double click on a and we will be able to see the contents of this particular variable a ok.

And you can again close this particular window, so that we can get back our command window as before ok. So, this is how to work with your MATLAB window. (Video Ends 14:49)

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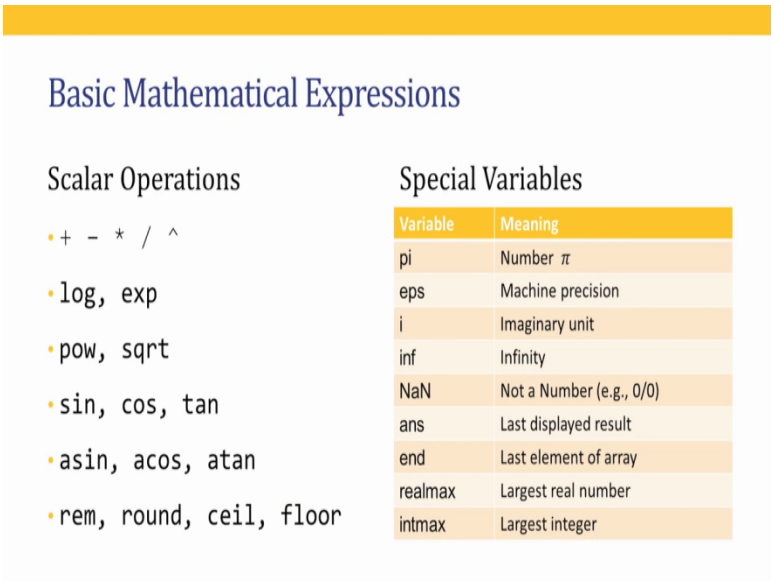

Let us go over the basic mathematical expressions. So, we want to look at mathematical expressions that work with scalars as well as mathematical expressions that are going to work with vectors and matrices. So, first we will go over the various scalar operations.

So, let us look at the scalar operations over here. The standard scalar operations +, -,*, / and ^ that is caret. In addition to that, logarithm and exponent are the one shown in the second line, power, square root, sin, cos, tan, asin, acos, atan, remainder, round, ceiling, floor these are the various scalar operations and we have special variables that are shown to the right hand side. So, let us look at how these variable operations works.

(Video Starts: 15:43) So, let us say we have so, 3 + 4 and that is 7. So, MATLAB has computed value 7 and is sight, it has assign that value to a special variable called ans. So, if an expression is calculated and you do not assign it to any variable, MATLAB automatically assigns it to a special variable called ans ok.

Let us now look at the matrix that we had a. So, if we were to multiply a with a scalar, let us say 2 multiplied by a, what is going to happen is that each individual element of a will get multiplied with by that particular scalar we have over here. And this is going to be the result 2, 4 and 10 as we expect the result to be.

We had shown certain other commands that was so exp that is exponential. So, if we give exp of a, this is what we will get as you can see. This is an exponent has acted upon each and individual element of a. So, we get exp or e ^ 1, e ^ 2 and e ^ 5 that because a was 1, 2, 5 and we get back a row vector as seen in the result over here ok.

If we were to do exp of b, note that b was a column vector, so if you were to do exp of b, we will get a column vector as a result of this. So we have this. The result is going to be a column vector with 3 rows and 1 single column and because we had not assigned it to any variable. The special variable ans gets assigned that particular variable ok.

So, talking about special variables there are certain other special variables. For example, the value of pi, if you type pi and press enter, we will get the value of pi. Likewise, there are special other variables also that we have in this particular power point slide. (Video Ends 17:51)

So, eps is the machine precision I is the imaginary unit that is square root of minus 1, inf is an infinity nan is not a number, ans, we have already seen before and the other couple of. There is one more thing that you need to know.

(Video Starts 18:15) So, let us say if I assign the value pi = 4, if I do that what is going to happen is, from this point onwards the standard value of pi is going to be overridden by my expression. So, next time when I calculate say pi/ 4, I am not going to get pi/ 4 but I am going to get 4/ 4 that is 1.

That is because I have overridden the value of pi by assigning the value over here. If you want to cancel this all, I have to do is clear that variable by using the command clear space pi and I am now able to recover the value of the standard value of the pi again that is 3. 1416 ok. Now if I want to clear all the variables in the workspace, I have to give the command clear or I have to give the command clear all.

That means everything in the workspace is going to be cleared. When I give this command; everything in the workspace gets cleared as you can see over here. And I can give the command

clc to clean the screen and my command prompt comes back to the top with completely clean screen as you can see over here ok. (Video Ends 19:28)

(Refer Slide Time 19:29) So, let us go back to the basic mathematical expressions. We have seen mathematical expressions for scalars and with that we will come to the end of this particular lecture ok. As I said earlier, one of the most powerful features of MATLAB is that it is going to be able work with matrices and arrays and that is what we are going to cover in the next lecture in this module that is lecture 1.2 ok. Thank you and see you in the lecture 1.2.