UAV Design-Part II

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Lecture-17
MATLAB Tutorial

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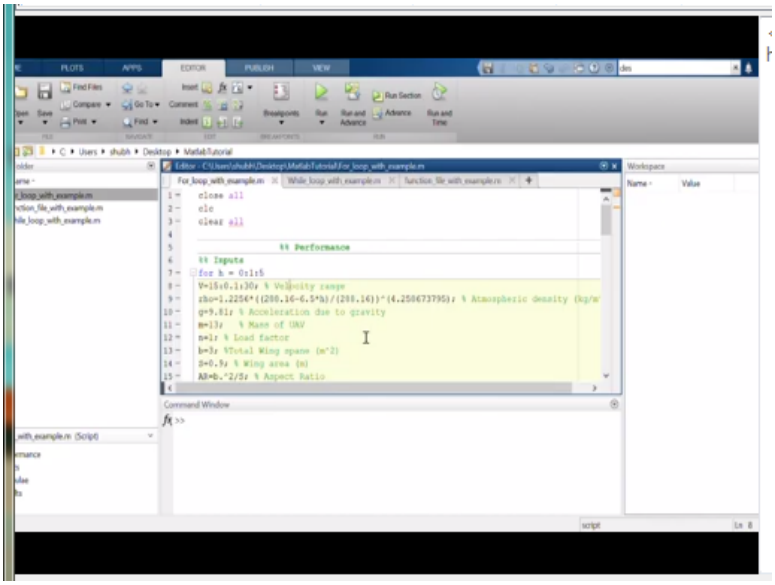

Hello everyone, I am Qazi Salahudden TA of the present course. In this tutorial, we will cover the basics of MATLAB, this tutorial will be very helpful for the beginners. I hope many of the students know about the MATLAB and how to use and how to execute the program? But the basic purpose of this tutorial is for the beginners who do not know the MATLAB and who want to learn the MATLAB.

So, the MATLAB is very important tool for all engineering disciplines as well as science and technology. So, it reduces the effort like suppose that if you take the example of aerospace like aircraft is flying at a steady level flight where is lift equal to weight, you want to calculate the CL for each velocity, so what you can write CL = 2 w d divided by rho V square S right. So, for a different velocity, you will get different CL, if you manually if you do it will take time.

So, if you write there a small program, where your input is w, your input is reference area, your input is velocity, your input is at density, at what altitude you are flying? So, basically air density, so you just insert this input, for each input you will get CL, so fixing everything, if you change the velocity your CL will be change.

So, you just upgrade the value of velocity you will get the updated value of CL. So, from this example you can see that how beautiful MATLAB is? So, this is a very small example, later we will discuss more about this. So, when you open the MATLAB your MATLAB will be look like this, as you are seeing in the screen. So, basically this is called the workspace, if you run the program your all variables as well as answers will appear here and this is the folder file.

If you open the particular folder what MATLAB file you have, you will see here. **(Video starts: 02:57)** Here if you click you can use the different types of files a script file, function files, later we will discuss what will be the script file and what the function file? And here you can open your particular file, here you can go to the location from where you want to open the file? And here you can print your results, here you can save your results, here you can run the code, you can execute your program. So, these are the primary things.

So, I will tell you the first I will explain how the different files exist in MATLAB? And how will you write your program in what file, script file, function file? Subsequently I will tell you, what is the use of for loop, while loop, when we will use for loop and when we use while loop? So, as you can see that this is the example for loop, here you have defined the input. So, you can see that the input it is written in green color.

So, this is basically the comment percentage shows the comment, if you write anything like a, b, c if you put comment it will not will be the part of your program. But for your reference you can see what we have written? ok. So, if you put 1%, see 1% we will be look like this, if you put double percentage your section will break. So, suppose that you want to create input as a different section, so look like this formula, what you are using the formula at different section, figure different section?

So, you can put the double percentage here, so in this you can see, what is our input? Our aim first consider our aim**,** our aim is to calculate the power required drag experience by the aircraft for a different velocity at different altitude as well as what CL by CD our aircraft is flying. So, basically we want power versus velocity, drag versus velocity and CL by CD versus velocity ok. So, you know that drag is nothing but half rho V square S into CD, half rho, rho will be the input, V will be the input, S will be the input and then CD further we can write CD 0 + k CL square.

So, CD 0 will be the input, k will be the input and CL we can compute from 2w divided by rho V square S, so C. I have given the range for velocity 15 to 30 meter per second at the step of 0.1 ok, rho is a function of altitude I am (()) (06:29) fundamentals that are already explained to you, what is the function? how the density varies with 32? So, I have written directly here, G is 9.81 however UAV mass is 13 kg.

And we are flying at a steady level firmness, load factor will be 1, our wing span is 3 meter, area is 0.9 as per ratio can be calculated with this by S. And a weight will be mg and our span efficiency factor is 0.9 and our parasite drag coefficient is Cg 0 is 0.04. So, basically these input you have a specify. And we are using for loop because we want to fly from 0 to 5 kilometer. So, we will get the data for 0 kilometer, 1 kilometer, 2 kilometer, 3 kilometer, 4 kilometer and 5 kilometer.

So, h = 0 in a steps of 1 to 5 kilometer ok and these are the intermediate formula we need K can be calculated phi into e into as per ratio CL trim will be 2 w n rho S V square. Then if we know CL CD can be founded CD 0 + k CL square then d will be half rho V square S into CD, p will be half into drag into velocity which is nothing but half rho S CD V q and CL by CD is CL trim and CD 0 + k CL square.

So, now these are my input we have defined and now we have intermediate formula and now we have results. So, we want velocity versus drag, so these are the command plot, velocity versus drag display the name t line with 1, our x label is velocity. So, you have to write like this, this is

a standard procedure and y label is aerodynamic drag and hold on because at 1 kilometer, 2 kilometer, 3 kilometer to 5 kilometer we have to at the same plot, we want the data.

So, we have to hold on and I will tell you these are the very basic tool for coloring the figure, line style, if you want to make any grade these are the standard command. Now if you run this program you will get the plots. So, first plot we will see aerodynamic drag versus velocity, so it will look like this. So, this is nothing but the legend if you click legend it will appear here. So, as you can see that the blue line represent the 0 kilometer and your aircraft is flying at a sea level condition, your drag variation with flight velocity will be like this.

And when you are flying at 5 kilometer, your drag will be like this sky blue line. There is a so many options here as you can see there are data tips, you can click here and you just put here, you just drag, you will see you can get the different you can check at what velocity suppose that at 25 velocity, what is our drag? So, you can check by using this tool. Also like if you want to copy your figure, you can go to edit and you can copy your figure and you can directly paste into your report like if you are making the report in MS word.

And if you do not want to do it, you can go to file, you can go to save as, you will get a different option first is MATLAB file. If you save this, anytime if you open, you can edit it or you can save in the EPS form, enhance form, JPEG form there is a lot of options available. But good quality image if you want to save then always save in EPS form or this TIFF image form it will look good. So, this is nothing but the aerodynamic drag versus velocity.

And another diagram you can see the aerodynamic power versus velocity. So, if you go to the aerodynamic power versus velocity, you will get like this, if you just insert the region we will get the variation of the aerodynamic power versus velocity. So, from this diagram you can get the information that at what design speed your aerodynamic power is, at what aerodynamic power is required in order to fly at the this design, suppose that you are flying at a 5 kilometer ok and your design speed is 25.

So, you can check at 25 speed where aerodynamic power requirement is 276.51 watt ok. And our third interest is to see the response of aerodynamic efficiency. You will see these are very important parameters like aerodynamic efficiency at 25 and 5 kilometer your aerodynamic efficiencies is almost 11.4 something, ok. And at a sea level your aerodynamic efficiency is go down to 8.11 ok. And this flat line is independent of flat speed like this flat line because as you know CL = 1 under root CD 0 by k and CD = 2 CD 0, 4 minimum power condition for maximum base condition.

For minimum power conditions CL = under root 3 CD 0 by k and CD = 4 CD 0, so CD 0 and k is independent of flight. So, you will get the constant L by D ratio, one important things of this is like when you flying a very high lift to drag ratio tamping will decrease pilot will feel very difficult to fly, take very large amount of time to time the aircraft. So, basically I am telling you the basic purpose of this to show the graphs and how to edit the graphs and all.

But see once you design the aircrafts you will see the important of these graph like aerodynamic power drag L by D some more graphs will come when you will design ok. So, these are the graph first is aerodynamic drag, second is power and third this L by D ratio ok. So, as you can see this graph represented from 0, 1, 2, 3 to 5 kilometer, ok. If you want to fly if you want to see the data only for 0 kilometer, in a for loop you can put only instead of 5 you just put 0, to from 0 to 0 you are going, ok.

So, basically you are flying at a sea level 0 kilometer ok, you just done this program and you just see the L by D, how the L by D is varies and also how the aerodynamic drag is varies and how the aerodynamic power is varies? so ok. So, now if you go to legend, if you click this you will see h = 0 kilometer. So, now there is a lot of option also available, if you go this arrow and if you just clicks here, ok, you just click this line what you are seeing?

You are seeing cut, copy, delete, color, if you want to change the color, go whatever you want? You can color it came black if you like red color you can go to red. If you do not like this solid line you can go to the line style you can make a dash, ok. So, you can see here so many option is available like line style, dash, dot, dash dot check how dash dot is look likes, ok fine, ok. See you

can increase the line with hours currently it is a 1 hour, if you increase to 2 will be like little thicky ok it will be thick.

Now you have also option like, suppose that you have so many graphs, how will you differentiate? one thing is by color but if I want to print it into the black and white then color will not be matter, you have to differentiate by something else like. We can differentiate by using marker ok, we can go to the plus ok, you just increase which is very marker size you reduce, ok, you will get plus ok or you can go to the hexagon, diamond, circle, so many options is available like, ok.

So, here you can see now it is like circle, ok. So, if find you just decrease the line width and make go to marker and put the marker size 2 and marker whatever you want? So, currently it is circle just put a star you will get star, ok. So, in this way you can modify your figure and also some option is available, like if you go to the edit and figure property. So, if you go to the figure property, from that figure property you can edit this axis limit, you can edit the font also, you can edit the font of the legend also.

If you go to this tool you will see lot of option is available and I request you to if you face any problem if you are not understanding anything then please post the question in the forum. I am promising you I will give the answer because when you at the time of learning you will face lot of problem, like when you run execute the program definitely you will get the error. And this is a beauty when you will get the error just correct it day by day you will become the expert in MATLAB.

You just play with the MATLAB, you will learn, like suppose that you have written this program and you have if you miss this, see if you using for loop ok and see notice that I am putting dot ok just remove this dot put backspace you will get error, why error? Because element by element we have to multiply, so basically dot represent the element by element. So, basically at 0 kilometer you want data, at 1 kilometer also, 2 kilometer also.

So, element by element you have to multiply, so dot represent that see you are missing 1 dot and you are getting the error. So, likewise you will get so many problems but please correct it. If you want to try to correct it, please go to the Google and search how to fix the problem? If you are not getting same problem take the screenshot in a MATLAB post it in the forum I am promising with that I will give the answer for show.

So, this is about the for loop, now we will go to see the while loop and what is the difference between for loop and while loop? So, for loop is nothing but you are not putting any condition like this type of condition like less than or greater than. So, if this condition is not required then we will use for loop, like you want to fly the aircraft at 0 kilometer 1, 2, 3, 4, 5 there is a no condition like less than greater than, so will use for loop.

But suppose that the problem is such that there is a condition a specified like less than greater than or for loop or while loop at the same problem we can use for loop as well as while loop is depends upon your choice also. So, let us see the while loop, so suppose that you n is number 1, 2, 3, 4, 5 we have taken 5 you want to estimate the factorial of n, ok. So, factorial of n you want to 2 factorial will be the positive number, so it will start from greater than 1 right.

So, we are putting condition n greater than n - 1 ok and as you know that factorial is what? See what is the logic of mathematics is there? Same logic we will write here ok. So, suppose that when you calculate the factorial of any number let us say 5 what you will do? 4 into 5 into 4 into 3 into 2 into 1, right. So, you are taking 1 number as a 5 then you are subtracting 1 getting 4 multiplying by 5 then again subtracting 1 from 4 you are getting 3 again subtracting 3 y - 1 ok.

Then you are getting 2 and 2 - 1 and you are multiplying 5, 4, 3, 2, 1 you will get the factorial. So, that is why we have (()) (21:40) that our next number will be N = N - 1 and factorial will be the multiply of 5 into N like 5 into 4 if it is 2 number there. So, far if suppose that N is 5 N number of factorial will be 5 into 4, 4 which is coming from here N - 1 ok, till that condition it will apply when N greater than 1.

So, at N = 1 it will stop ok, so now we have N = 5 if we run our program, so it will appear factorial N = 120 what is the factorial of 3? It is 6 you know let us see whether we are getting or not, see we are getting factorial N = 6. So, you are specifying the numbers 3 and you are putting the condition N greater than 1. So, this while loop ends when N will be 1, like it will compute N - 1 2, 2 - 1 1, so 3, 2, 1 will be the answer, so 3 into 2 into 1 will be the 6, 6 is the answer, so this is the use of a while loop.

So, now as far as this problem is concerned it is very simple, now we will see the use of function file. So, before going to the function file, I want to tell you what is the script file. So, what you have written this program, this is in a script file your all the program executed in a single file. But suppose that your program is very large like starting from 1 to like 78 line program is there very simple program.

But suppose that your program is 2000, 3000, 6000 line, can you put all the program in a single file? It will be very difficult because if you divide the section wise then it will be very easy to see the things for looking into the program you can easily change whatever you want in the same program. So, in this situation the function file helps, like if you use the function file, if you suppose that you have the 6000 line program.

So, you can divide into 500 different sections in a function files. So, the beauty of the function file is you can call the function file anywhere in the MATLAB in the same folder, it will take the data from the function file, we will see, ok, so these are beauty of function file. So, for how to write the function file like? So, function file is start with function and suppose that whatever you want to take, average you know.

So, this will be the like after the function output will be appear like average is the output, what type of average? You want to take the average of a number, we will see a average like average of 1 + 1 and 2 1 into 2 average will be 1 + 2, 3 number is 1 and 3 2 3, so 3 by 2 will be 1.5, ok, we will see. So, function file a start with function, then output, then equal, then name of the function file see you have to be very careful here, what is your the file name should be the same as written here, ok.

And now you will write the computation formula average is nothing but sum of X column basically you are have more than one data. So, that is why you are putting this symbol here and just count the number like suppose that X is 1, 2 what is the average? 1 + 2 total number is 2, 1 + 2 by 2 is 3 by 2, 1.5 ok. Suppose that you want to compute these things like average, so what you will do? You will run this file, what you are getting? You are missing something right, error in a function file.

So, you just write the function file error and give the command in the command window. So, like what command I have to give? Let us say I am putting X = 1, 2 and I want to compute the average of it, ok, you just copy the same thing and just enter ok you have put the semicolon here, to move the semicolon in turn you will get 1.5 ok. Suppose that you want to compute the average of this 1, 3, so by manually what will be the answer 1 + 2 + 3 ok, so total 6 by 3, 2 will be the answer, right. Let us see we are getting to 2 or not, 2 will be the average.

So, this is the beauty of the function file. So, till now we have covered the for loop, while loop different type of files script file, function file and what are the basics? Like basic command things, how to edit the MATLAB plot and all? So, this all about the basics and here in command window also you can do some like if you want to add something, like suppose that you do not have any calculator you want to add 23 + 99 ok.

So, you can like 23 and you can write plus and 99 you will get the answer 122. So, basically as a calculator you can use this and suppose that you want to write the matrix A equal to this 1, 2, 3 then put 1 column 3, 4, 5, 6 ok then 7, 8, 9 you just close the bracket, ok. So, what you will get matrix A, first row is 1, 2, 3, second row is 4, 5, 6, third row is 7, 8, 9. So basically, you can notice that when you are writing matrix A 1, space, space 3, ok, listen again.

You are writing 1 space 2, space 3 this is nothing but 1th row, if you are putting semicolon, now you are going to second row 4, space you are writing 5 then space 6 then again putting semicolon. Now after the semicolon, the third row will come, 7 space 8 space 9, so your matrix

is A. Now you want to take the inverse ok, so you have just type small inv you just take the n, so ok you will get this answer inverse, ok.

Now you want to add the matrix, similarly you can add the matrix, similar way you can multiply the matrix. Similar way you can subtract the matrix ok, similar way if you want only column matrix then you just write B = 1, 2, 1 column 2 semicolon 3 ok 1 semicolon 2 semicolon 3 ok. This will go to the column matrix and if you write the only row matrix then 1 space 2 space 3 matrix, this way this is the matrix multiplication.

And if you want to find the determinant just go to dit simple command t your determinant will be like this. So, these are the way like you can calculate it, suppose that you want to find that e square exp this is nothing but the e then 2 you will get e square is 7.3. So, as we are using like a calculator you can instead of using calculator if you calculate you can use here itself. Now as you observe that your workspace these are the variable stored, we can put an also lot of things is there in that command window.

And if you want to it is all the things then what command you can do? You can just clear all you just press enter. So, you will see that key all the variable which has mini stored in the workspace has been eliminated not present there, erased. And now when you will plus CL C you will notice that all the operations performed in the command window like in erased. But there are so many MATLAB commands are there for simple arithmetic operation, ok arithmetical operation.

So, that command I will attach in this week I just separate sheet I will attach the some basic command for MATLAB, like how to compute the inverse? How to compute the exponential? How to write the identity matrix? Something there are so many things like, so it will help you. And if I will find some extra material related to MATLAB that will also I will attached in this week ok and thank you so much for listening this tutorial.

And once again I am saying that please post a question in the forum like if you are not getting anything like suppose that if you are getting any error, so you just post in. Because see MATLAB you should know the MATLAB this is very important when you go for higher study,

see this is a first requirement like whether you know MATLAB or not, and your answer should be yes.

Because everybody in this era should know that MATLAB, who are doing their research especially. So, thank you so much and if you have any question please post on the forum. I am sure that when you install the MATLAB you will get the error. Try to fix the error yourself and if you are not getting you just take the screenshot and post it in the forum. I am promising you I will give the answer, thank you so much **(Video Ends: 34:02)**.