**Scientific Computing Using Matlab**
Professor. Vivek Aggarwal and Professor. Mani Mehra
Department of Mathematics
Indian Institute of Technology, Delhi
Lecture No. 01
Introduction to Mat-lab

Hello, viewers welcome to this course. So, this is the first lecture of the course of Scientific Computing by using Mat-lab and in this course will study all the numerical methods which are being used to solve for example, to find out the root of a quadratic equation, or a root of a polynomial.

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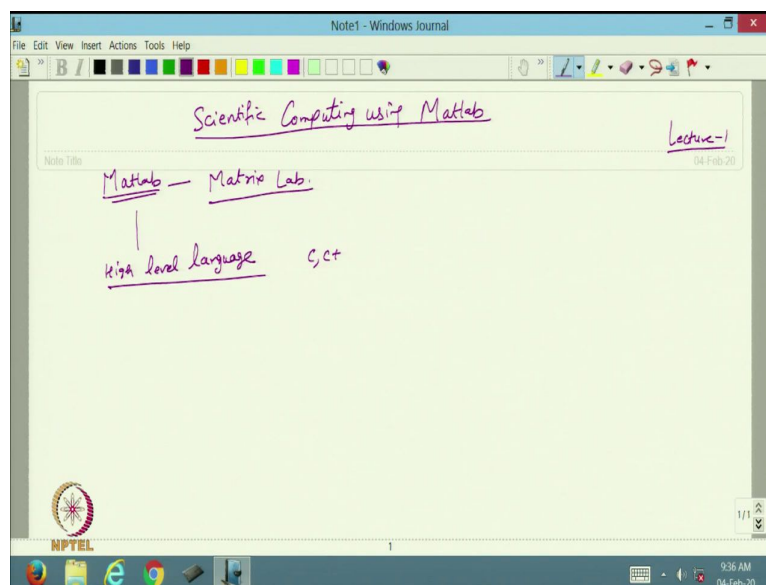
Or to find the Eigenvalue of a matrix or to solve a system of equation $ax=b$ or wherever we are unable to solve the differential equation. So, in that sense we need to find out the numerical solutions for differential equations by various methods. So, this course is a primary course for scientific computing. So, the benefit with this course is that whatever we are going to do in the lecture the same thing will be done by making a program in Mat-lab language. So, this is lecture number 1.

So, in this case, the first few lectures are dedicated toward the Mat-lab, that is how we can do the primaries in the Mat-lab to do calculation and then later on, we can do programming or the codes on the Mat-lab files. So, we start with the first lecture and before that I will tell you that, what is the meaning of the Software Mat-lab? Actually, Mat-lab is a software that is used widely for scientific computing.

So, Mat-lab is basically if, as you see its name is Matrix Laboratory it means, we can do all the programming, all the numerical programming here. So, Mat-lab is basically two types of programming languages, so Mat-lab is a High Level language. So, high level language is like Python or C, C plus-plus where, the you are writing the code not in term of machine language but, you are writing the code in terms of your language, or some specific language because, we all know that the machine language is always in terms of binary numbers 0 and 1 but, we are unable to write the code in the 0, 1.

So, that is the low level language but, like the C programming or Fortran or the Mat-lab or the Python in this we are able to write the code not only the form of 0 and 1 but, we are able to write the code in the specific language, whatever has been defined to write the code and that codes are very easy to debug or very easy to compile so, that is called the high level language. So, I will directly start with the Mat-lab.

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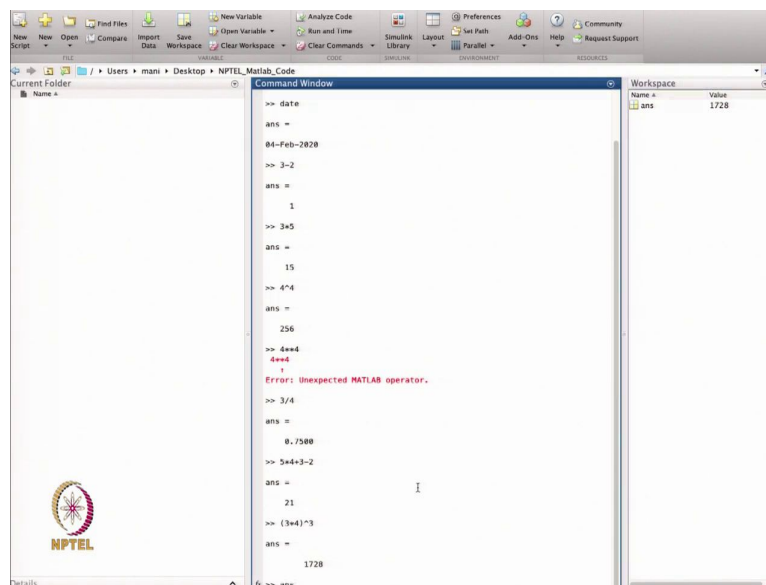
So, let us start with the Mat-lab code. So, this is the Mat-lab I open so, this is the command window in the Mat-lab and this folder if you see there are three different folders here, one is Command Window, another is Current Folder and another is Work Space. So, whatever we are going to write in the command window. So, at present I am going to write all the commands in the command window.

So, you complete this as a smart calculator. We are going to do so, in this case just I want to start with Matlab. So, I want to see what version of this Mat-lab, so this is the version 8 point 6 point 0 and it is R 2050 B and I want to check the date, so we are going to start this course
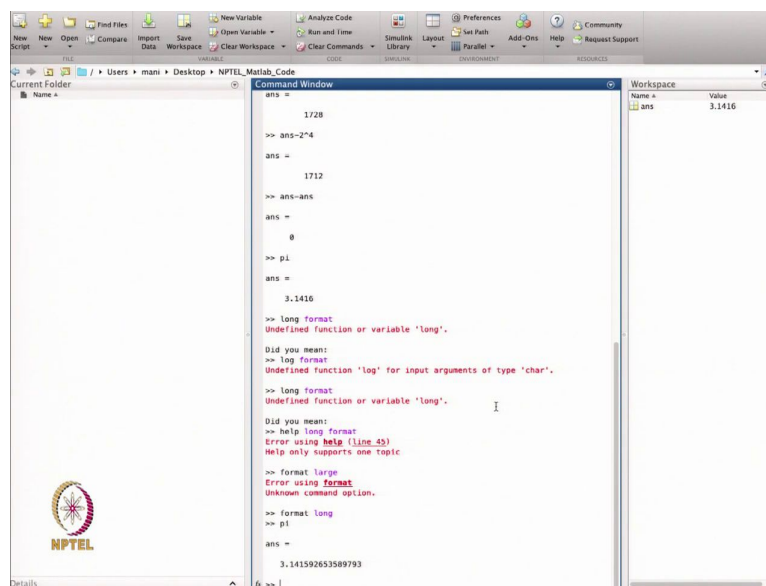
on the fourth of February 2020. So, now I want to start with this Mat-lab code, now I wanted to do some little programming or little calculations.

So, let us I want to write 3 - 2 so, it is 1 I want to write 3 x 5 = 15 so, this star means multiplication and this is negative sign and I want to calculate $4^4 = 256$ but, in sometimes we always write 4 ** 4 so, this is undefined, this is not in Mat-lab whenever, I want to take the power so, we have to use this symbol not double star like, we used to do in some other languages.

Now, suppose I want to divide the number 3/4 so, that is the answer. So, in this is the benefit 3/4 we are doing and the result is coming in the real numbers point 7500 so, that is the benefit here, there is no predefined that which type of variable we are defining earlier, like in a C programming if you do, you have to define the number whether integer or real number but, here it is automatically takes that 3 / 4 is the real number.

Then, I can start with 5x 4 + 3 - 2, so I can do this one or I can take 3 square 4 brackets and then race to power 3, so that is the answer. So, in this case it will be 12^3. So, this type of calculations we can do then, the variable in this coming whatever the variable using or answer getting that we can see in the workspace so, in workspace given the answer so, answer is 1728 so, this answer I can use.

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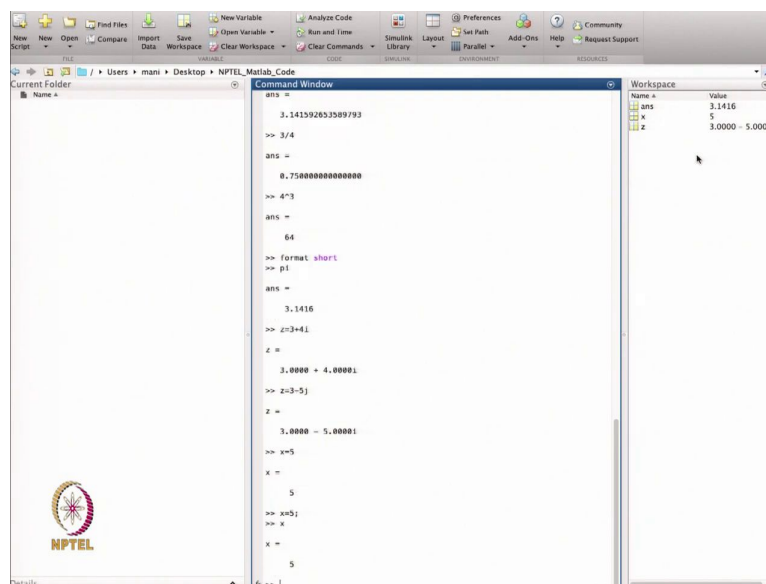
So, answer -2^4 so, this is 1712 so, this is the new answer now even, I can take the answer - answer that is the 0. So, whatever the recent answer is coming that will be taken into the variable answer and that answer we can use for the future calculation. So, if you see the program just I want to write inbuilt function so, suppose let I given the pi, pi is 3.1416 but, suppose I want to see it in a long format so, I will write long format I can find the pi so, this pi will be 3.14 and if you see this is taking the number in the 16 digits so, this will give you the format long so, I will write format long.

So, whatever the calculation I want to do, I want to do 3/ 4 so, that is the answer I want to see 4^3 so, 64 is integer but, in the floating point number or the real number the answer will come in the in the 16 digit long floating point number so, I can go the same way so I can write format short so, this is format short and this will give me the number in just first 6 digit number so, that is the way we can do.
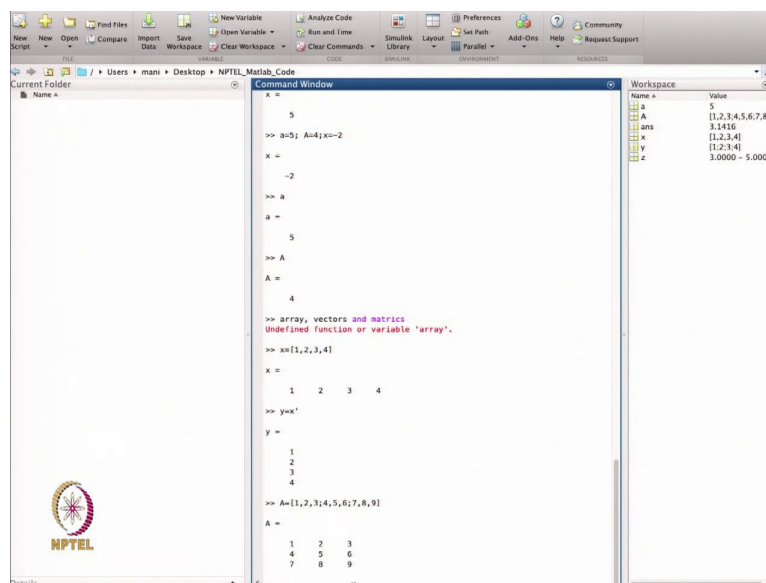
Now, I can define the even complex number here so, you can write z =3 +4i so, there will be the complex number or maybe I can define z = 3- 5j so, if I write j here also so, in this case Mat-lab will also give me the number 3-5i so, that is the complex number or this is also a way we can define the complex number.

So, this is just the number we can define then, I can define the assignments that how we can assign a number to a variable so, suppose I take x = 5 so, there is a number I am getting one I am getting x is equal to 5 semicolon so, in that case I write the semicolon after the command the result will not display on the command window but, it will be save in the workspace and if, I want to see that workspace so, the x will appear.
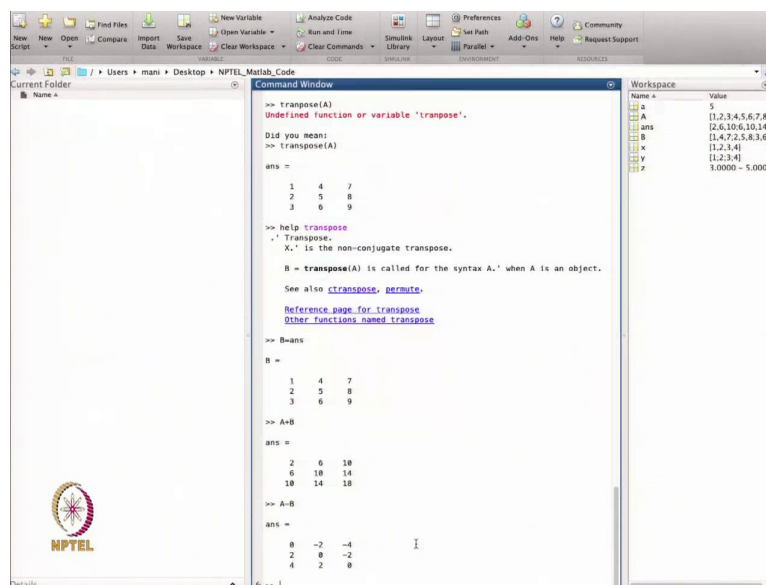
So, generally we do put the semicolon just to not show the results on the command window. So, suppose I want to define a = 5 ; capital A = 4 ; and x = - 3 so, it will show only the result

where I have not put the semicolon but, value of a = 5 and value of capital A = 5 so, from here you can see the Mat-lab gives you the variable small a and capital A so, it is case sensitive in the sense we can take this variables small a and capital A in differently.

Now, we can define so, after this assignment we can define the Arrays, that is how we can find arrays or vectors and matrices so, this is what we can define. So, let us define suppose, I want to define a array x = 1, 2, 3, 4 so, this is my array or a row vector now, suppose I want to define y that is equal to x transpose so, this is the column vector I am defining or suppose, I want to define matrix a =[1, 2, 3; 4, 5, 6; 7, 8, 9] and I go down so, this is the matrix I am defining so, 1, 2, 3 in the first row 4, 5, 6 the second and this is the third row.

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Now, I can take the transpose of the matrix, transpose of A so, this is not define it will show you that do you mean by this so, yes and that is the transpose we have defined so, in a Mat-lab the best thing is there where you have some doubts you can tap the help button, help transpose so, it will give you the help, what is the meaning of a transpose so, it shows you that help transpose the transpose x is a non-conjugate transpose.

So, if I want to write the transpose it will give you B = transpose of A is called the vector of the syntax of A so here wherever there is a doubt in syntax we can verify from here. Now, suppose I want to take another matrix, so I have taken the transpose so, I define B = answer, B this one. Now, I can take sum A + B so, A and B means I am adding the transpose of the matrix to the matrix A and we know that this is a symmetric matrix. So, it is a symmetric matrix we are getting.

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Now, I can define A - B so, A minus B then it is a skew symmetry we know that I can define the skew symmetry matrix with the help of A transpose or maybe I want to find a matrix some E matrix that is we can define with the help of [1, 0, 0; 0, 1, 0; 0, 0, 1] so, this is the identity matrix I am getting.

Now, if you see from here that this is the variable so, I just want to see which of the variable I am using you can write the command who so, who will tell you the variable A, B, E, a, answer, x, y, z and this all these variables are coming here because, if I want use any variable later on because, we can see from here that these are the variable we are using and that variable we can use to make the further modification.
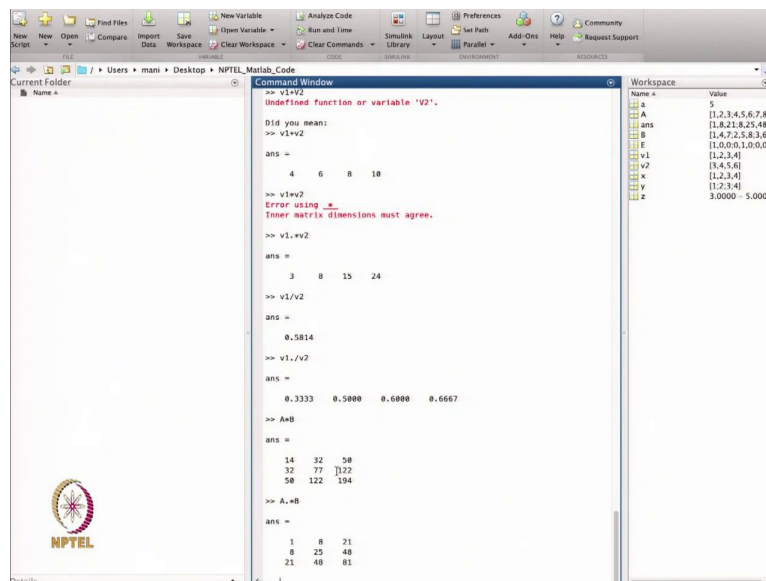
Now, suppose I want to do matrix I have taken so, I want to find the determinant so, I will write determinant for the matrix A so, that is the det(A) the matrix determinant is this one so, it is how much 0. So, in this case you can check the matrix we use a singular matrix because, in Mat-lab calculations it gives you the 16 digits accuracy so, Mat-lab works on the double precision, it means it gives the 16 digits accuracy.

So, 0 is equal to something to 10^{-16} so, this number is consider as 0 now, I can find, this matrix addition, I can multiply the matrix. So, suppose because I know that the two vectors I can add no problem but, how we can add two vector that should be a component wise addition so, suppose I take a one vector so, I define v1 new vector I am defining or maybe I can define the vector v1 = x.

So, this is one of the vector and I defined v2 another vector I take so, that I define as x + 2 so, this another vector I am getting where I am putting this x and adding to this component so, 3, 4 this one. Now, I want to define v1+ v2 so, it is undefined because, here I am using the small v and here capital V but, my earlier variable was v1 and both in the small letter so, it will show you the did you mean by this yes so, it will give you the sum 1 + 3, 2 + 4 6 and this

one.

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So, it is component wise addition we can do but, what about if I want to do v1x v2 so, in this case it will ask you that these are the two vectors v1 and v2 and which type of multiplication you need so, to deal with this one I will write v1 .* v2 so, it will tell you that this is the two vectors I am multiplying by putting this dot before the star and this multiplication will be the component wise multiplication so, it is 3 x 4, v1 is 1 and v2 is 3 so, it is 3, 4 into 2 8, 15 and 24.

So, it will give you the multiplication of the two vectors or maybe you can see as the dot product of the vectors or maybe suppose I want to divide v1 / v2 so, what is the v1 / v2 so, this is the wrong answer and suppose, I want to divide this one by v2 so that it the real answer so, the component wise division so, what it is doing it is 1 / 4, 2 / 3, 2 / 4, or 3 /5 point 6,and 4 by 6 point 67 so, here also I am putting the dot before the division symbol so, if I put this one that means I am going to deal with the vector division.

Now, suppose matrix A and B so, that gives me the multiplication of the matrix or I can define A .* B so, what is that so, it is the A star B and this A dot star B that give you the so, here I am saying that multiplication is done in the form of vectors and here I am doing the multiplication of two matrices.
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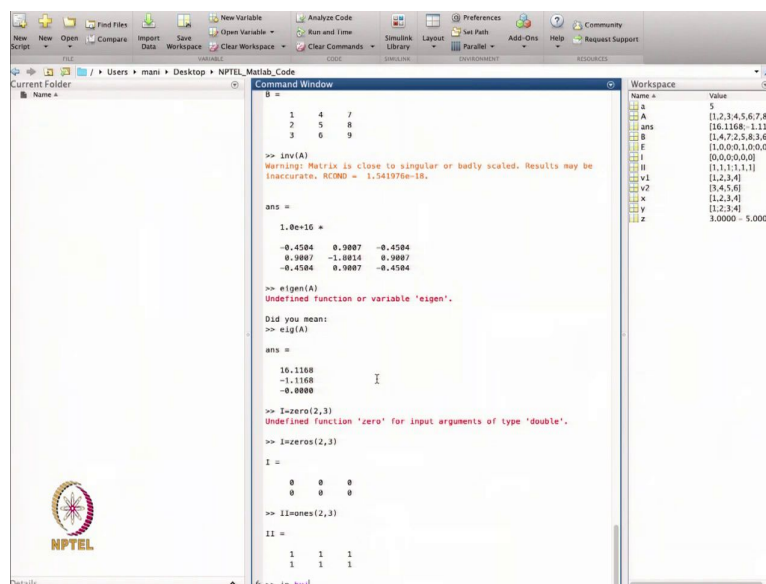
So, suppose so let us see that this is my A and this is my B so, I multiply this matrix by this so, 1, 2, 3 it will multiply by this one so, this will 1 plus 4 plus 9 so, 14 so, that 14 is the answer but, this is wrong, it gives you the one only 1, 8, 25 so, how it is give me one it is giving this 1 multiply by 1 here it is give me 8 2 into 4 8, 3 into 7 it is 21 so, in this case if, I put dot symbol it gives you the component wise multiplication of two matrix but, if I want to multiply the matrix then it is the correct answer.

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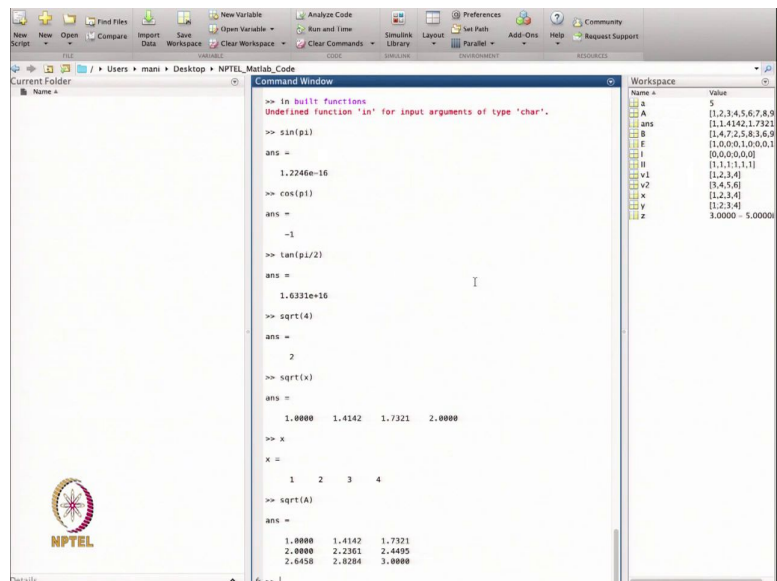

Now, suppose I want to find the inverse so, suppose I want to find the inverse of the matrix so, let us take the inverse of the matrix so, this is the inverse of the matrix or suppose, I want to find the Eigenvalues, Eigenvalue of the matrix so, it gives you this do you mean by this yes, and that given you the Eigen value because, the matrix A was almost singular matrix so, that is why you can see the Eigenvalues coming 0 here so, in this case we can find the Eigenvalue.

Now, suppose I want to find another matrix that is i made up of zeros sometime we need to define the vector so, let us take this matrix so, undefined the value 0 so, zeros I could write so, I got the new matrix made up of two rows and three columns and all are zeros suppose, I want to define another matrix double i, that is equal to 1s.

So, this is the matrix I have define with all the elements that is 1 by this way we can define the 0 matrices or unit matrix in which all the elements are units or identity matrix we can define so, in this way we can define the matrices now, this is the little bit calculation we can do now, we can use the inbuilt functions.

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So, inbuilt functions is what suppose, I want to find sin of pi so, it will give you the answer 0 in this case sin is the inbuilt function or I want to define cos of pi so, this is the minus 1 or I want to define $\tan(\pi/2)$ so, it will give me the value 0 so, this way this is the inbuilt functions or we can find $\sqrt{4}$ it give the value 2 and this is the function or this the variables that is saved in my workspace so, I can use now, suppose I want to find out the square root of the vector x so, that is the vector because x was the vector so, I have written $\sqrt{x}$.

So, it will give the square root of each component and that is this one or I can find out the $\sqrt{A}$ so, that gives you the square root of each component or each element of the matrix A so, that is the way we can define the square root.

Or suppose, I want to do x^2 so, x^2 is not defined because, x is a vector so, I will write x^2 so, it will give component wise square of each element or maybe I can define A^2 so, that is the matrix we are defining so, basically this is A x A because, if I write A x A that is equal to same matrix.

So, in the matrix form there is no need to put dot but, whenever dealing with the component wise addition or component wise multiplication, division then we have to put the dot there. So, this one is we have define now, suppose I want to define the variable like suppose I want to define name, so name character I want to define and suppose I want to write so, that is the variable I have define its variable is not a real number it is the character it is giving you the name character and that character has the value that is vivek kumar.

So, it is a string basically you can check that this is the string or a character variable which with the value b this or suppose I want to find what is the name of v or I want to see what is the variable v because, the vector form at first value v second i, third v, e, k so, I want to find what is the character at the fifth position so, that is k so we can write down maybe I can check with the sixth one so, that is just the space I am putting here so, that is the answer or suppose I want to check with the seventh so, this is the k.

So, this is the little bit today we have done that how we can start with the Mat-lab and in the next lecture we go further and we deal with other type of functions, how to plot the functions, how to make the graphs, and other calculation we can do so, that will do in the next lecture. Thanks very much.