Computer Methods of Analysis of Offshore Structures
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Module - 02
Lecture - 15
Computer methods of dynamic analysis

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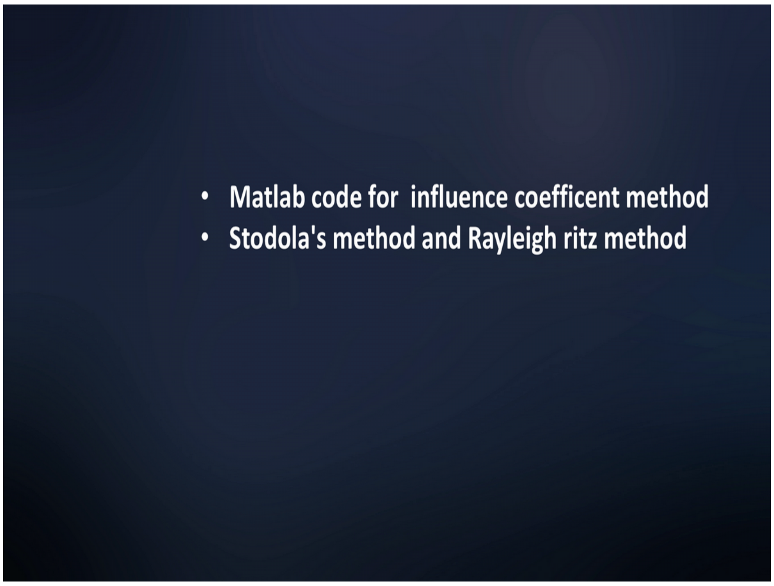

The third program is influence coefficient method program we also did a problem of the same kind in the last lecture in influence coefficient method, but we derive the influence coefficient matrix directly in the last lecture.

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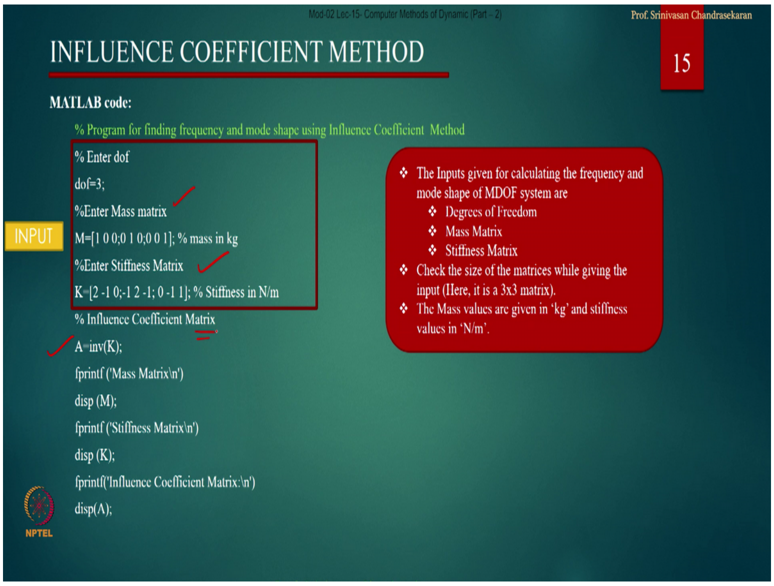

So, the mass matrix and stiffness matrix are again given an input, so it is standard for all the programs. It inverts the mass matrix sorry the stiffness matrix and gets the influence coefficient matrix one can directly also get the influence coefficient matrix which we did in the last lecture. I think you can verify back the solution procedure in the last lecture. For the completion sake let us try to do that in this example.

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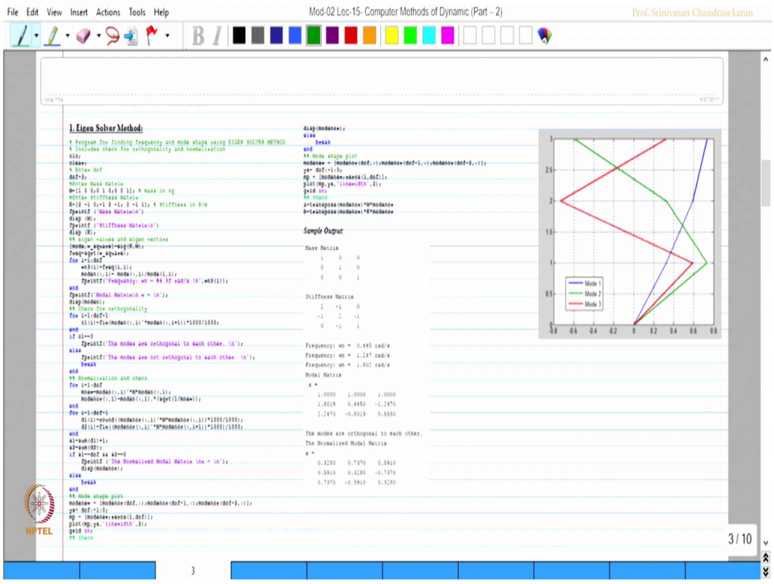

So, this is the coding for the classical Eigen solver which I just now showed you. So, the complete coding it continues from here, the coding continues after this it continues here.

I am sorry for the alignment of the code because it cannot come on the same page. So, please continue the code from here to here after this line this is the next line please continue the code. Sample input is given sample output is also known and you can see here the plot which has been just now discussed.

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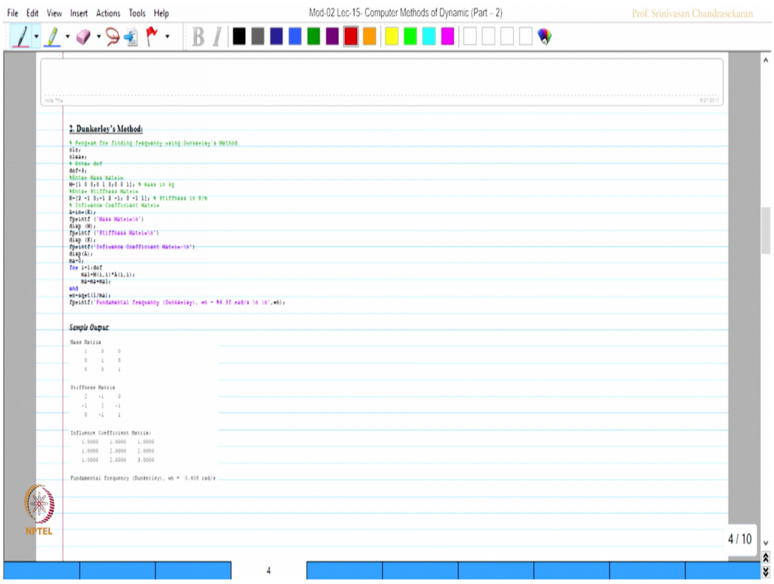

Similarly, the coding for Dunkerley is also shown on the screen now we have already explained different segments of this code and we also have the sample output which is been plotted from the screen.

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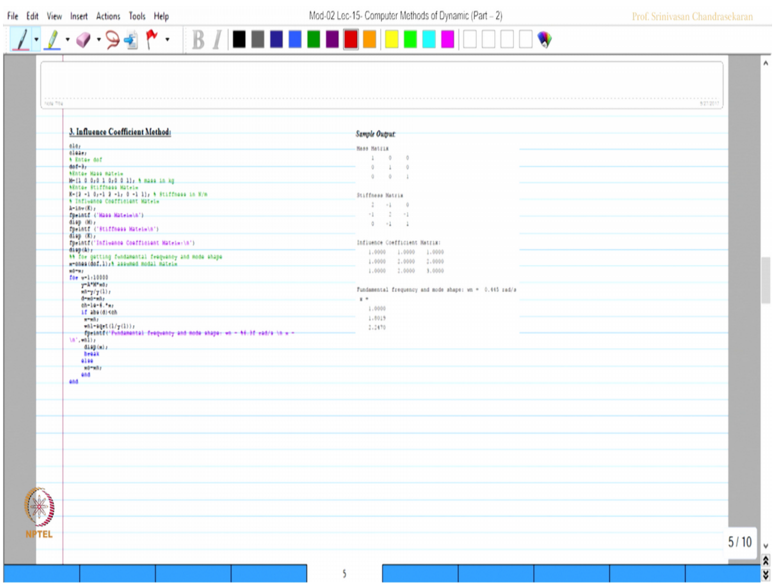

Now the influence coefficient method coding is available, but I am interested to estimate the influence coefficient matrix without inverting the stiffness matrix. This code actually inverts the stiffness matrix it inverts the stiffness matrix to find the influence coefficient matrix, but I can directly find the influence coefficient by the first principles which I am going to do now.

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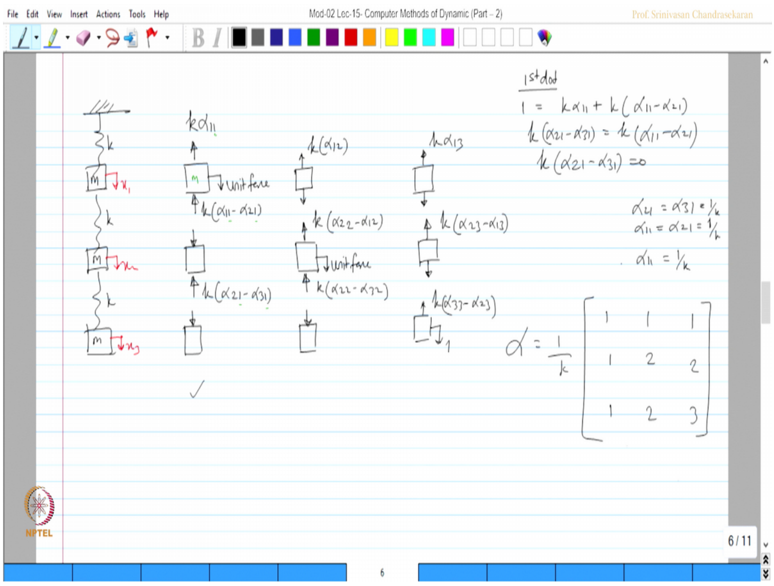

So, this is the problem let us write down the problem this is m and these are all k. The degrees of freedom are this is x 1, this is x 2 and this is x 3. So, influence coefficient is nothing, but the flexibility. So, flexibility is give unit force and find the responses. So, I say k alpha 11 where alpha is the influence coefficients in the given matrix and this is going to be k alpha 11 minus 21. Similarly, for the next the arrow is reversed and this spring is going to compress which will be k alpha 21 minus 31 and again this arrow will be reversed. So, one can notice very well here.

The second subscript in all will be one indicating we are given unit force in the first degree and we are getting the first column of the flexibility matrix. Let us do for the second case to give unit force here so obviously, this spring will try to pull it back. So, k times of alpha 22 minus 12 and there was reversed and this is going to be k times of alpha 12 and this spring will try to compress therefore this is going to be k times of alpha 22 minus 32 and this spring is reversed.

Similarly, for the third degree unit force, so this is opposing k of alpha 33 minus 23 which will be reversed with this spring this will try to pull the mass back which will be k times of alpha 23 minus 13 which will be reverse here and this will try to pull this back again which is k times of alpha 13. So, once this is d11 can write the equations and try to solve and get the influence coefficient matrix for example, let us do for the first two degree. So, I am referring to this figure. So, I am writing it as 1 is equal to k alpha 11 plus k alpha 11 minus 21 I can also write k alpha 21 k alpha 21 minus 31 is equal to k alpha 11 minus 21, k alpha 21 minus 31 is 0, so this implies that k cannot be 0 therefore, alpha 21 minus 31 is 0 which implies alpha 21, alpha 21 is actually equal to alpha 31.

Substituting this back in the second equation the left hand side will become 0 which says that alpha 11 is also equal to alpha 21, substituting that back in the first equation you will see that alpha 11 becomes 1 by k which are now true for all the cases. So, alpha 11 therefore, alpha 21 is also 1 by k and alpha 31 is also 1 by k. So, that is the first column.

One can similarly do for the second column and third column which we did in the last class last lecture please see that. So, the alpha matrix can be simply said as 1 by k of 1 1 1 that is what we got the first column 1 2 2, and 1 2 and 3. So, let us see what did we get from the computer program.

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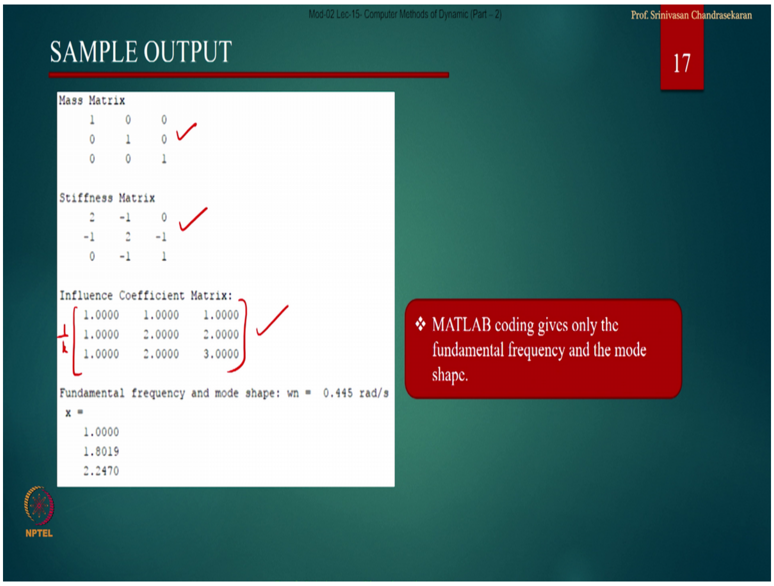

So, one can see here for giving a mass matrix and stiffness matrix I get the influence coefficient matrix as 1 by k multiplier is anyway out. So, 1 by k is anyway here. So, first column is as same as what we got second column and third column. So, the matrix exactly is same as we obtained from the program.

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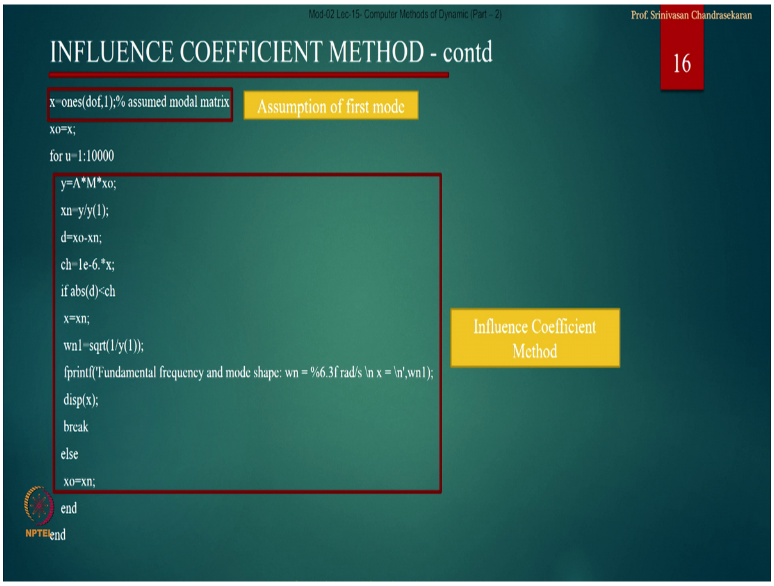

So, once we know this then this coding estimates the fundamental frequency and mode shape and the fundamental frequency now is 0.445 and the mode shape is first mode shape is this value which closely compares and agrees with the previous methods.

The next is a Stodola's method which we also solved a problem in the last lecture.

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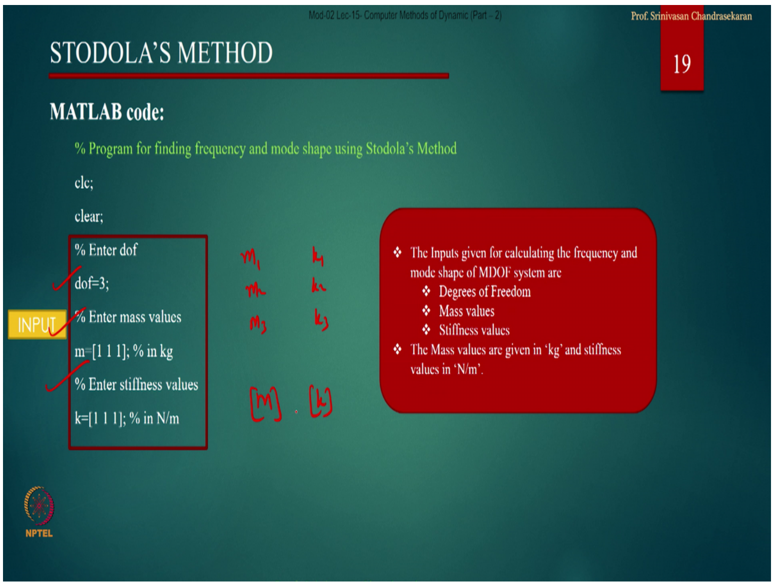

We maintain the same degree of freedom, mass value and stiffness values as entered in this case, but please note here the entire mass matrix and stiffness matrices need not be given, you want to give only the value of m 1, m 2 and m 3; then k 1, k 2 and k 3. We do not have to give the mass matrix and k matrix.

Please note in the earlier case we are supposed to give the mass matrix completely and the k matrix completely row wise. But in this coding it does not require you to give the mass matrix and k matrix you are to only give the mass values and k values with a space bar in each row.

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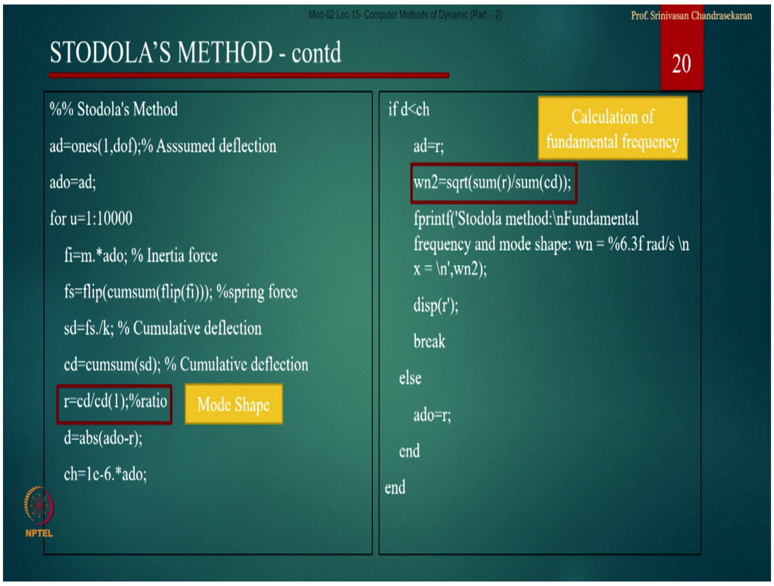

This is the mass value this is a k value once you do this the code actually identifies and computes accumulated deflection finds the mode shape plus iteration and then from the iterated value it picks up omega n square the fundamental frequency and then also picks up the mode shape. Let us see the sample output what we got from this code it is 0.445 and this is my vector. You can see this value closely agrees with what we have in influence coefficient method.

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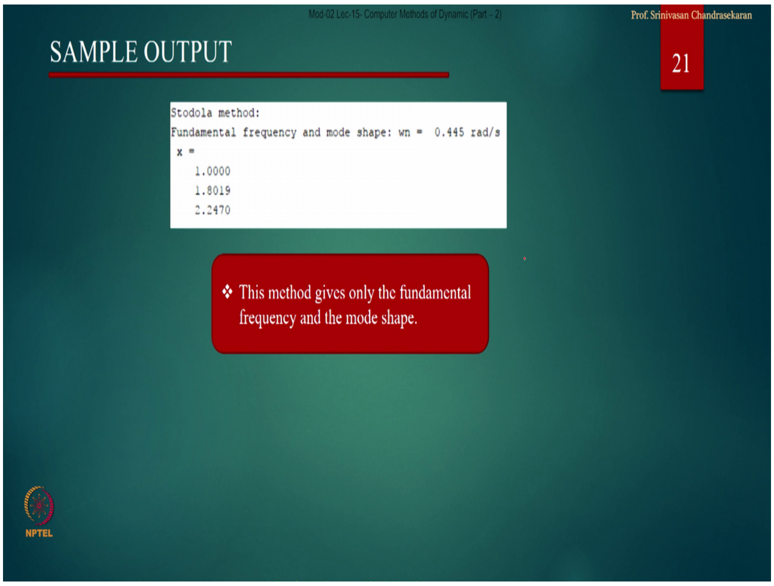

We have 0.445 and the vector is 1, 1.8, 2.25 you can see here, this is again 0.445, 1, 1.8, 2.25. So, the values are exactly matching and surprisingly you will also notice we add exactly obtained the same values close to this by hand calculation in the last lecture. So, you can compare them. So, the computer program what we explained to you is exactly in the same line as the computer methods what we discussed by hand in the last lecture.

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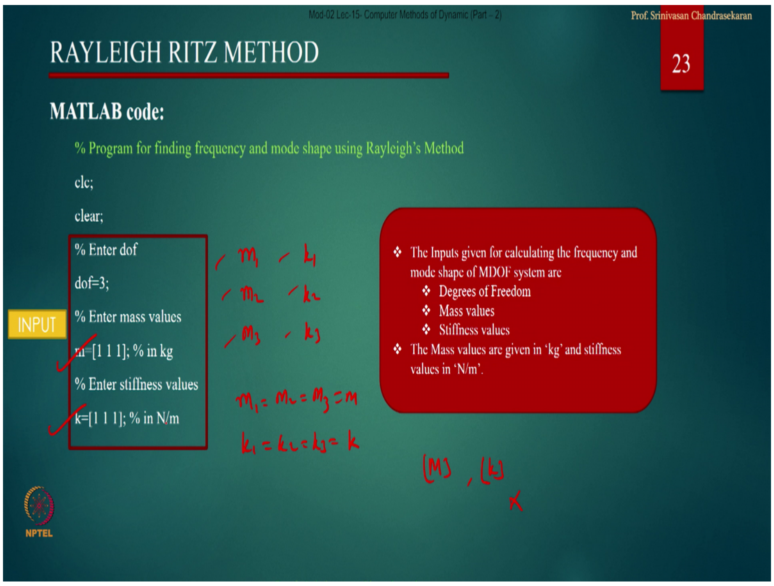

The last one is the Rayleigh Ritz method which we also explained in the last lecture we solved a problem using Rayleigh method. Similarly please note friends in this method also we have to give the value of m 1, m 2 and m 3 similarly k 1, k 2 and k 3. In this problem all ms that is m 1, m 2 and m 3 are actually equal to m, so they are taken as unity. Similarly k 1, k 2 and k 3 in this problem are taken as k and we have entered 1 1 1. You do not have to give the mass matrix and k matrix as an input for this problem, you have to give only the values of independent stiffness and mass the row wise as you see the screen here.

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Once you do this it assumes an initial mode shape here because we are looking for a fundamental frequency all are taken as positive.

Then it calculates the mode shape then it calculates the fundamental frequency let us see the output. So, you get 0.445 and this is the vector, so eigen vector of the first mode shape which is exactly same as we obtained by the previous methods and this value also matches with what we have worked out by hand in the last lecture. This is the coding for Stodola method, which is shown on the screen now there is a sample output and this is the coding for Rayleigh Ritz method which is shown on the screen now and that is the sample output.

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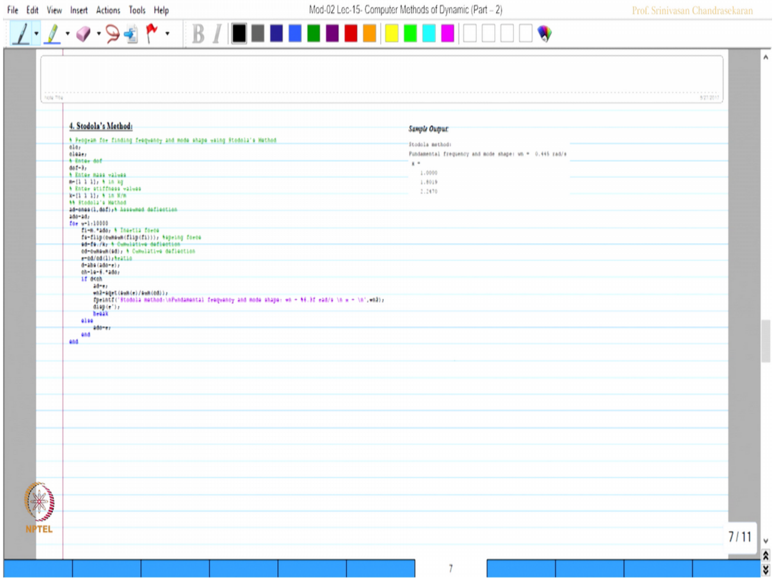

We have compared the results and they were all in good agreement.

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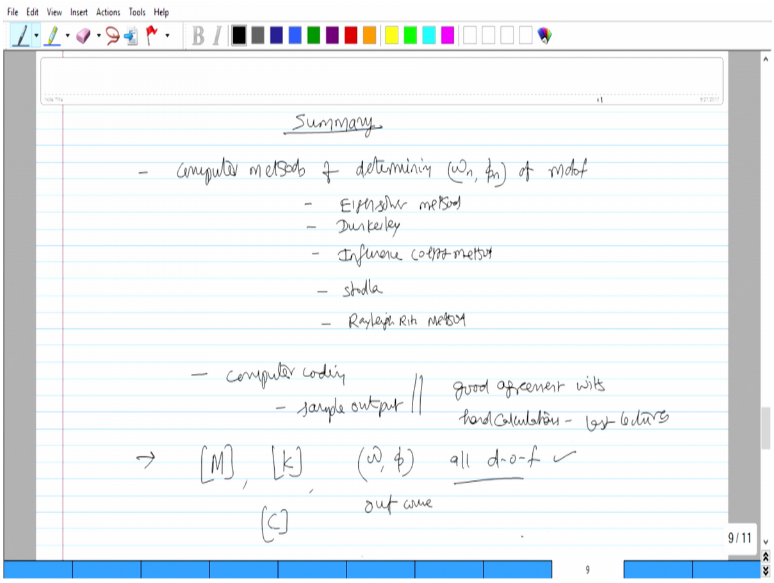

So, let us make the summary. So, the summary says we learned computer methods of determining natural frequency and mode shape of multi degree freedom system models. In dynamic systems the methods learnt where classical Eigen solver method, Dunkerley method, Influence coefficient method, Stodola method and Rayleigh method. We picked our sample problems, we also gave you the computer coding, we showed you the sample outputs and they were found to be in good agreement with hand calculations what we showed in last lectures.

I think friends now if I am able to obtain the mass matrix for offshore structural system and stiffness matrix for offshore structural system I should be able to obtain omega and phi for the dynamic system in all degrees of freedom. That is the outcome of this particular set of programs what we did for dynamic systems. In the next lecture we will start discussing about the damping matrix which is also one of the important issue as far as offshore structures are concerned.

Thank you very much.