Numerical Ship and Offshore Hydrodynamics
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Lecture - 60
Closer

Hello welcome to Numerical Ship and Offshore Hydrodynamics. Today is the lecture 60 the last class of this course.

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So, today we actually discuss about the what we have learned through this the journey of last 30 hours class ok. And one by one we pick a topic and we are going to discuss what we learned then, what is the takeoff of this and then what I can provide for all topics ok, after this.

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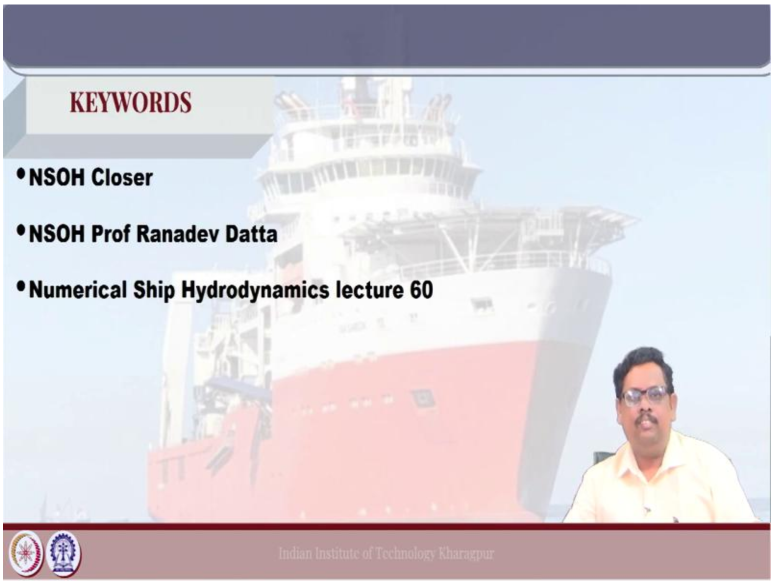

And this is the keyword that you have to use to get this lecture ok.

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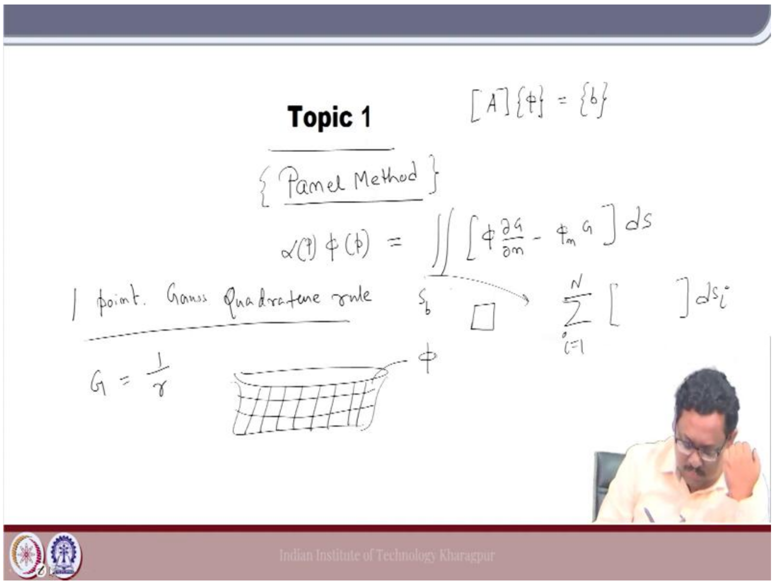

In topic 1, we discuss about the basic structure of the panel method right. Before that we have done bit of sea keeping, we have done bit of hydrodynamics, but the idea is to discuss that what is the panel method or lower order panel method. And if you remember we solve one problem that infinite radiation problem.

And then we integrate this boundary integral equation as $\alpha(P)\phi(P) = \iint_{S_b} \left[\phi \frac{\partial G}{\partial n} - \phi_n G \right] dS$. So, we have you have used this boundary integral equation and we learn how we can split this boundary integral equation in the system of algebraic equation.

Now, why we are doing it we are using that 1-point Gauss quadrature rule right 1-point Gauss quadrature rule. Now, why this is saying this is important because here we assume these panels are sufficiently small number 1 and we are considering that G is very simplified $G = \frac{1}{r}$ right. So, through this exercise, what we learn is how I can split any surface.

How I can split any surface, with a you know series of small panels and also, we learn how we can distribute the ϕ each panel and then how I can write the integral equation into the $\sum_{i=1}^{N} [\ \ ] dS_i$. In this summation form how, we are going to write this.

And then we come to a matrix where we can say it is, the matrix $[A]\{\phi\} = \{b\}$ and I how I solve this ϕ and then how I calculate the added mass in the infinite fluid domain. So, this is the this is what actually we discussion and while doing this we also learn how to compute few you know geometric parameter through paneling right, to do that we have to do so many things right.

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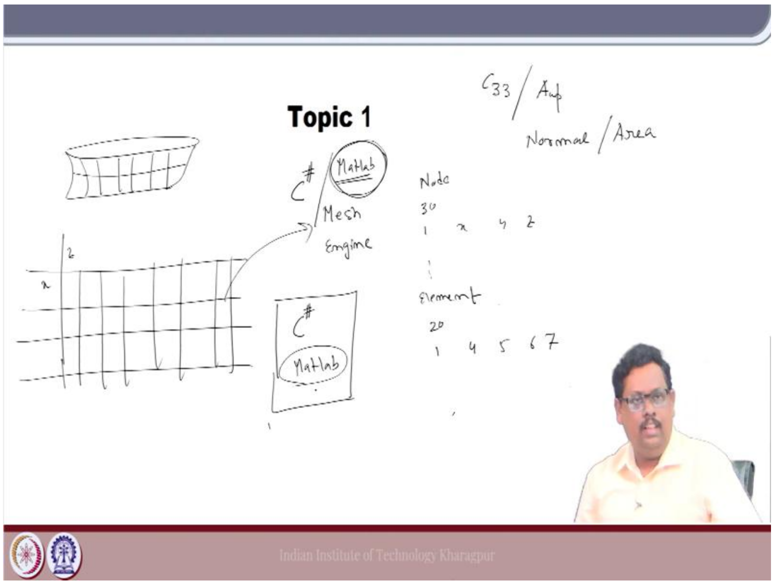

Suppose, I have this surface and then I am doing this paneling. Now through this panel we learn that how I could get so many parameters like for example, how I calculate this parameter C_{33} it means high how I could get this value the A_{wp} so many things how we can get that weighted surface how we can peak the normal right, how we can calculate the area of a panel.

So, those things we discuss and then finally, we write a code right we write a code of course, in using probably $C\#$ which calculates the added mass of a body. We discuss so many things how even how we can do the paneling systematical paneling using like, if you remember that we know that we how we write the paneling right.

How we write the node first and then we write the total node number then one then we put this x y z value and after that we write that element. And in element let us see take element 2 and then with that I write connectivity 4 5 in that way we just right. We know that how systematically, I can write a I can do the meshing right. So, here I so here then after that we write a code in $C\#$. However, in MATLAB we actually come up with the meshing engine right. Here we are coming with the mesh engine right.

So, we so therefore, we have a MATLAB code now in MATLAB code what it is doing. Suppose I have a suppose I have a series of data or so; that means, I have some station versus z and then if I have this offset table. So, if you giving me the offset table from this offset table, I can get the mesh for the to calculate this added mass damping for the body. So, if you give offset table it can convert to the mesh so, that thing actually we done.

So, here what I am giving to my students who is appearing for the exam and all, so I am going to give the C sharp code to you, so for your practice like and then I hope that you are taking the basic thing and you can go forward about it. You further develop the code and then maybe you can use it in for the free service. I have done for the infinite fluid domain; you can you know incorporate the free surface effect and you can write a code for this also.

I can give you this that MATLAB software that MATLAB, you know it is a it is a academic software I just try to get some app so, that I can provide you that app. So, that at least you do not have to worry about the meshing if you have this offset table and in fact, that offset table in fact, you can generate from that same MATLAB code right. So, this is the all about of the topic 1 right.

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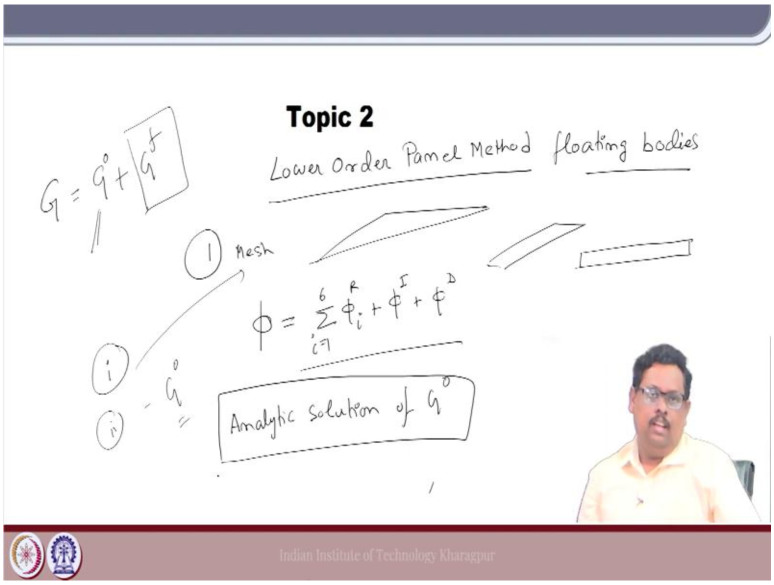

Now, let us see what we learn at topic 2. Now all are interrelated in topic two we are finding out that lower order panel method. Lower order panel method for floating body right; now, here we learn the basics of the lower order panel method right and no. So, and then how we can get the added mass damping force displacement everything using this lower order panel method.

Also, we discussed that what are the you know that key things we need to look for like, how we can do the mesh right, if it is a bad mesh or good mesh that we discussed right; that means, we that means, here we discuss that we should avoid a very bad paneling like this, right any quadratic paneling with low very high aspect ratios or some very elongated panel.

So, we know that we should not do all such panels. Now if you get this such kind of panel then how to handle it that also we discussed right and also, we discussed that how to get the data from any commercial software like how to input the data. So, we have taken one example we are using that WAMIT software and we discussed that in WAMIT if you are using WAMIT then how to give the input right.

And then how to get the I mean how to see the output we do not have the WAMIT to run and show you the things, but at least with this we know that. So, so that if you work somewhere where that WAMIT is available, you do not have any trouble to working on WAMIT.

And also what we discuss the basic principle of the potential theory right, how I get the radiation force? How I get the added mass? How I can how I split the phi into the number of components? Like it says $\phi = \sum_{i=1}^{6} \phi_i^R + \phi^I + \phi^D$. So, so how we split the total component into the summation of different ϕ and each ϕ represent some part of the physics right. For example, R represent the radiation part I represent the instant wave D is the diffraction potential.

So, therefore, the phi should be the total potential and then we understand about the linearity. Also, here we discuss about the greens function G which is $G = G^0 + G^f$. We did not talk much about this because it is fairly complicated and very mathematical to find out, so very we did not touch much on the free surface greens function right.

However, we discuss about the G^0 which is the Rankine panel method and we discussed that how the different technique, that we are following like how to integrate it is in 1 point Gauss quadrature then 2 point Gauss quadrature where to apply the analytic part right and also we discuss the analytic part of the greens function.

So, I expect from this topic to you should know the following number 1, that you should know about the that how about the meshing. So, number 2, about the how to integrate the Rankine part of the greens function then how to extract the data from the WAMIT result and how to give the input to the WAMIT results.

So, all these things and suppose if you have some kind of difficulty like the program is not running, then to judge that why this program is not running then how what parameter it should change which influence that instability that also we discuss in this topic too right.

So, here only I mean that thing that from the coding aspect one thing actually I did not give, but definitely you can do by your own that how to do the analytic solution right. So, this analytic solution of G^0 this is some coding thing that actually you can get from this topic too.

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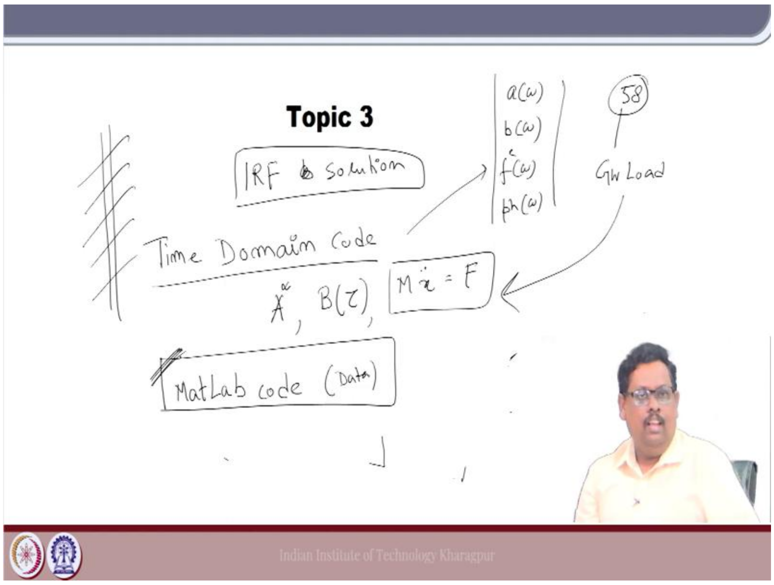

Now if I look at the topic 3 which is the IRF based solution this is the IRF solution. So, here what we learn is suppose I have the frequency domain data for added mass if I have the frequency data for damping if I have the frequency data for exciting force and I also have the frequency domain data for the phase.

Now, if I have this data then how I can write the equivalent time domain code right. So, here actually the first time we are writing a time domain code, but now it is not fully independent, this is depending on the frequency domain data. Suppose you have the WAMIT with you and then if you have if you add this data then how to convert the frequency domain code to the time domain code right.

Now, here we discuss very thoroughly about the you know each aspect of this IRF based solution, we discussed that how to get that value an infinity right also I we discuss how to get this the B tau that thing and how I can solve the equation of motion M x double dot equal to F in the time domain. So, these three are the main key part of this whole thing.

And also we discuss that why it is important to have the time domain code why the frequency domain code is not sufficient right. So, in fact, at that moment we have not yet we did not you know use do the direct application because we are not ready at that point, but if you remember in then when this when we discussed about the I think it is lecture 58, that time we are using that we are modeling the green water load right and that actually I apply in the IRF based solution.

So at the end actually I showed you that where is the use of everything where is the practical use of the IRF based solution sometimes that I avoid to discuss very detailed mathematical analysis I try to go in a surface level. I put more emphasis on the coding part right. So now, at least after the topic 3 everybody should have impulse response-based code with you, now what actually I am thinking of offering you a MATLAB code of the same thing in fact, for the rigid body not the flexible body.

So, I just I will provide you the MATLAB code and with some you know some data that I have with me. So, that you can run this code and then you can incorporate the green water load on that and then you can see that how it is working and then how actually the code is written. So, this is so once you appear the exam and all after that definitely this is the thing that actually I am going to give to my students ok.

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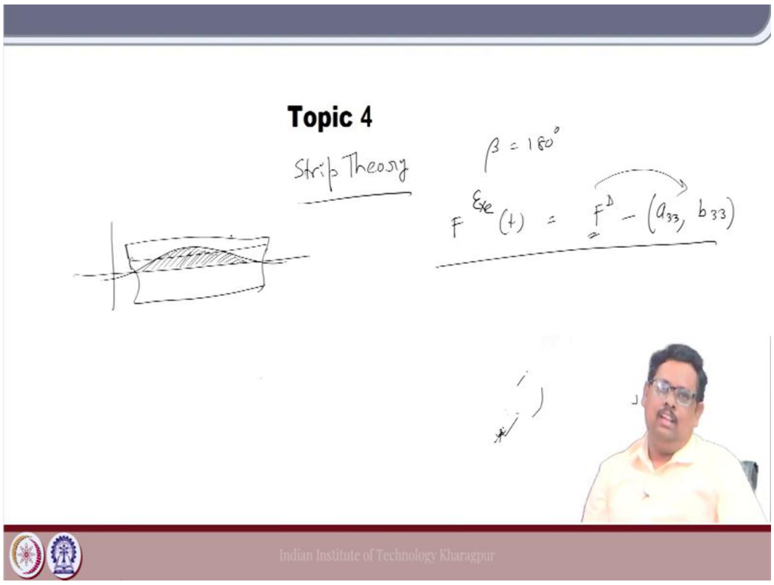

So, then we have the topic 4. Now this topic 4 is the most difficult part you know the topic 4 and topic 5 like we have the strip theory, in the strip theory we will learn that how we can convert a two-dimensional problem into the three-dimensional problem right.

And then we learned that how to use some chart like least curve to get the added mass, to get the damping and then once we know the added mass and damping in the zero speed, then how we can incorporate those data to estimate the response for the forward speed right.

So, those things thoroughly we discussed some coding aspect also we discussed and if I remember correctly, I asked you to write a strip theory code, assuming that this added mass data I mean assuming following things, this wave hitting angle that $\beta = 180^0$. So, that you can approximate the exciting force I mean $F^{exc}(t)$ you can approximate, because you can approximate that diffraction force F^D right. I mean this diffraction force you can write in terms of added mass a_{33} and the damping b_{33} right.

So, I know that we discussed this part and I asked you I just I gave you one homework where I ask you to develop a strip theory code assuming the simplistic head waves and as well as the exciting force, the diffraction in writing in terms of added mass and damping and this added mass and damping you can get from the Lewis curve right. Also, if you remember we discuss about how simplify way we can write the exciting force also.

If you remember that extra buoyancy force, we discussed that suppose this is the ship and then if you super impose the wave and then because of this wave let me just do that little bit here. So, then this extra buoyancy force can be acting as exciting force. So, that also we discuss and extra and then moment because of this extra buoyancy force that also we can take as exciting moment right.

And then you get this added mass and damping from the Lewis curve and then find out what is the strip I mean just write a strip theory code, so that also we discuss right. So, now, if you able to write a code. So, now, in this topic four you should send me that you are coding ok. So, so that I know that at least you know how can I write this strip theory code simplifying those aspect.

So, now it is your turn to give me a software or some code in MATLAB or whatever the I mean it may be Python C sharp that you are comfortable with send me.

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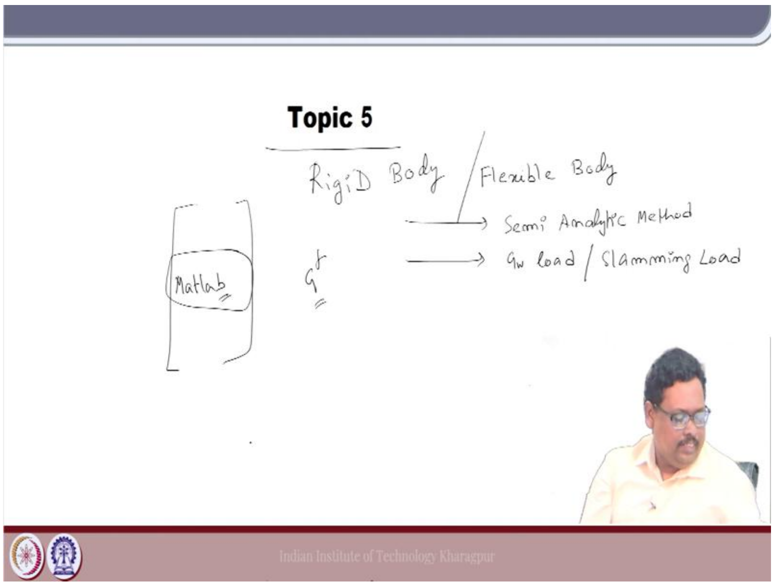

Now in topic 5 as I just said it is the time domain panel method right. So, now, in this time domain panel method we I do it for the rigid body and also, we discuss how this extend to the flexible body right. Not only that here also we discuss some semi analytic method, also here we discuss how to incorporate in some very easy way at least the green water load or the slamming load.

So, in topic 5 I combined everything in this topic 5, I mean it could be breakup into topic 5, 6, 7 I mean easily can, but let it be because it is everything comes under the primary code is the time domain panel method code. Now, in time domain panel method code like we discuss the basic principle. Now when we discuss this already it is known that about the paneling about the integration of the greens function.

However, some complex part of this code we discussed that how we can integrate the convolution term which is the I would say the most difficult thing in this entire code ok. Also, we discussed that some sort of non-linearity right. Till now we discuss everything under the linear regime, only in topic 5 we discuss about the non-linearity how we can incorporate the non-linear forces right.

And also, as I promised definitely, I am going to give you that that evaluation of the greens function. Now we discuss about the code how to write that code. But the, but we did not discuss about the greens function which is the most critical part. So, so today I can tell you that this the greens function that evaluation of the greens function that the free surface greens function of course G^f. Evaluation of the free surface greens function that MATLAB code I am going to give you ok.

But you know why I am giving going why I am giving you the idea is, that you should be able to develop the remaining code at least for the rigid body case, because each aspect actually discussed throughout this journey. We discuss how to panel it, we discuss how to get this hydrostatic coefficient, we discuss you know how to write the algebraic equation from the integral equation, how to split the thing everything actually it is very thoroughly discussed throughout this course.

So, I hope that with getting this greens function evaluation of the green’s integration of the greens function thing you can able to write this code ok.

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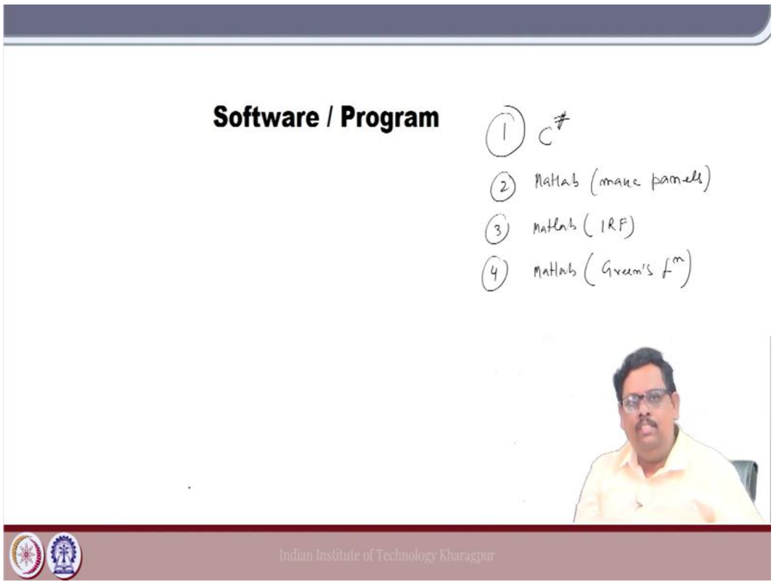

So now, let me summarizing that what the software or the program I am offering you, the first thing that now I already listed out for the 1st thing. Yes, the $C\#$ code for this infinite fluid domain right and also with this I will I am going to give you that MATLAB software which makes the paneling, to make paneling, to make panels. Then I will just give the MATLAB code for your IRF based solution right and then I am just going to give you a MATLAB code for the greens functions right.

So, in a way you are going to get some software that would be useful for you if you are working in industry or you are your research student try to make your career in the domain of fluid structure interaction. So, if you are keen on these things then definitely that what actually I am offering will be helpful for you for your future. So, with this note I would like to say thank you and all the best, ok.

Thank you very much.