Computational Electromagentics and Applications
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Exercise No 22
Algebraic Topological Method (ATM-III)

So now we are going to look into the conical capacitor problem which we saw in the earlier module of the finite element method we are going to choose the same problem using algebraic prologic method and we will follow the same pattern what have done for the calculate capacitor.

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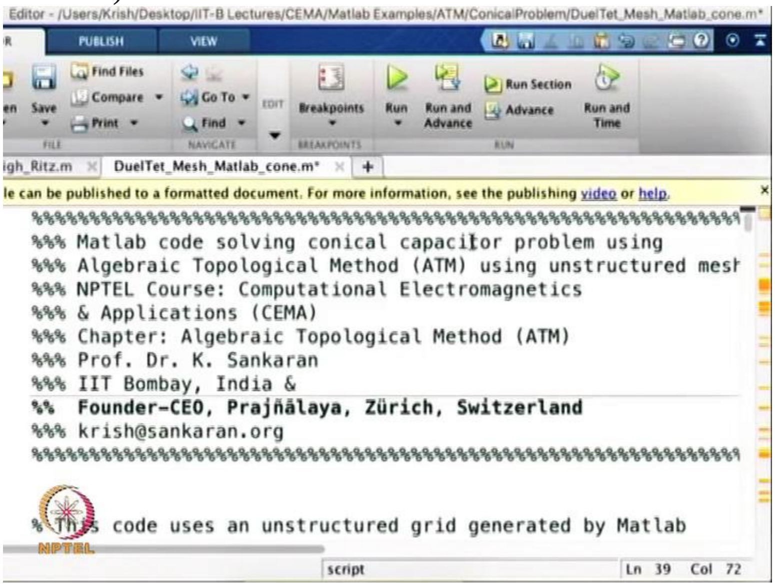

So without much do let us go into the code itself so the code is going to solve the conical capacitor.

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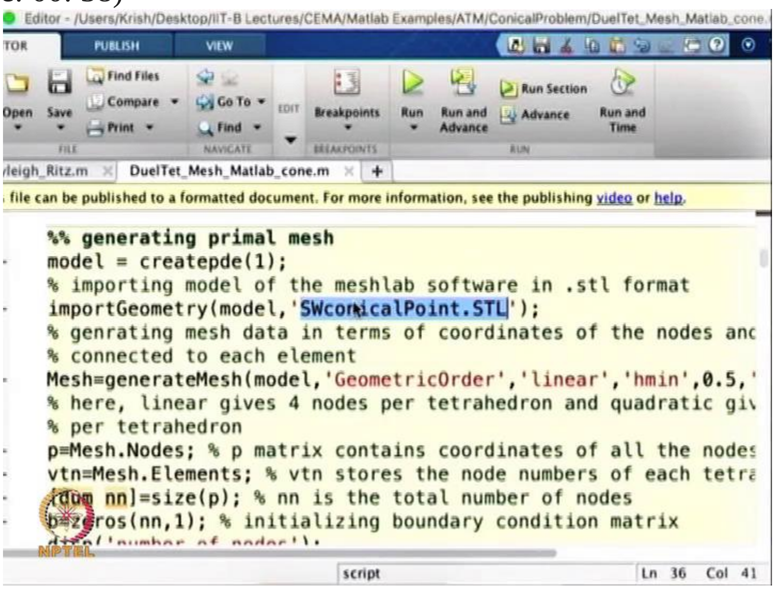

So now we are going to use this problem so let's set the value for maximum and minimum exercises as 0.5 and we have a problem geometry that is coming directly from commercial solver we can also use simple simple solver to create a model geometry.

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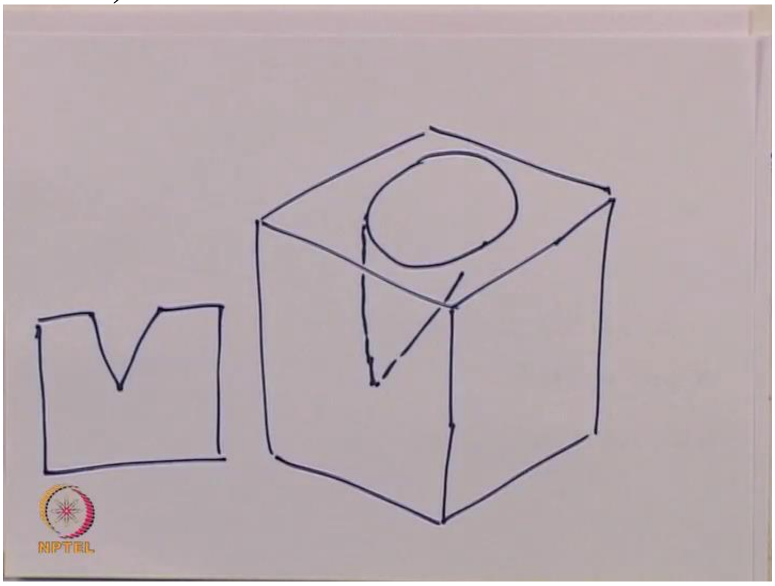

Our problem is going to have this geometry so the top plate and the bottom plate are going to be in this manner but there is going to be a conical thing at the centre off the top plate and it's going to have tapering and it's going to be a cone so you can imagine it's a cone and a circular thing and it is having a dimension and if you see this in the 2D what you will see is something like this this is a problem that we simulated in the case of finite element method but the three dimensional case will be having a kind of a cone at the centre so you can see the problem figure as follows.

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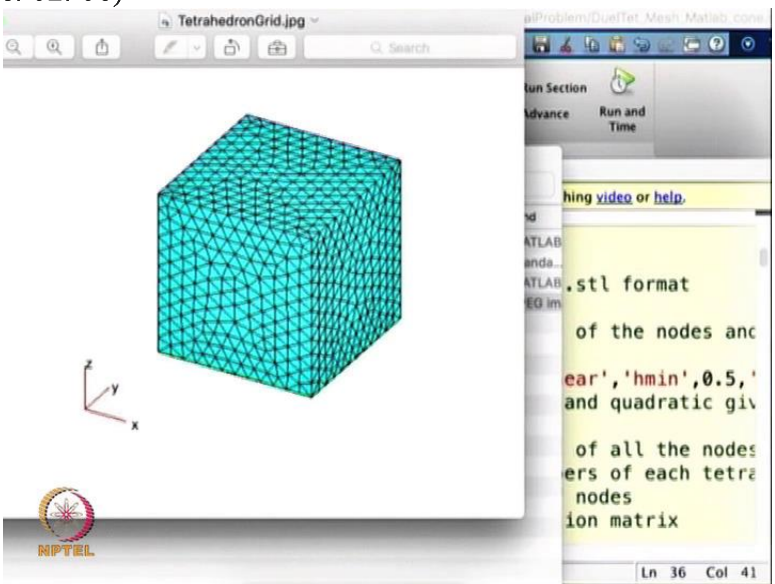

So this is the dimension of the problem we are interested in.

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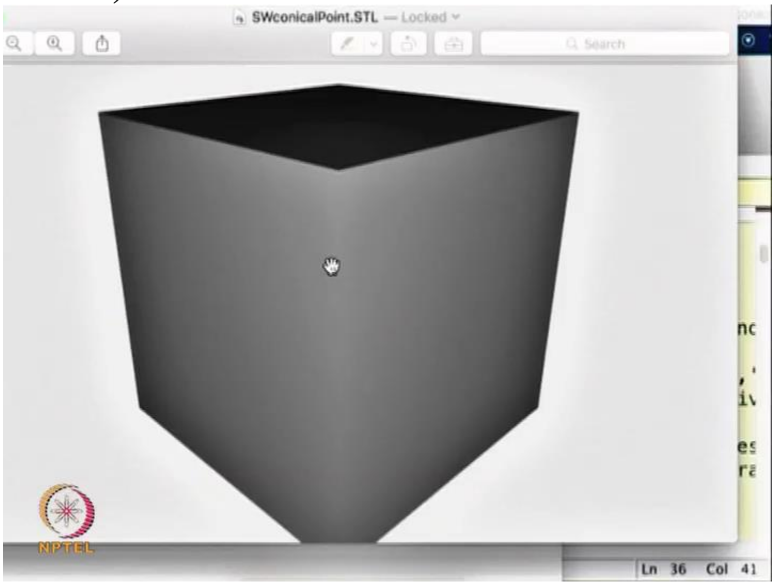

And when we run it so this is going to be a problem dimension and there is going to be a cone on the top which is going to come like this.

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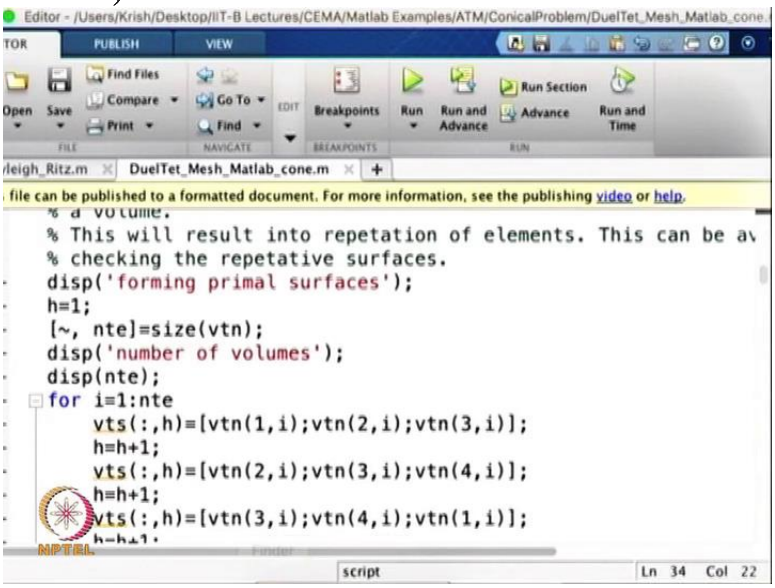

So let’s run the cone and see how the problem is being replicated we are going to do the same thing what we have done in The parallel plate capacitor initially we are going to go and do the various aspects of the Primal and dual grid.

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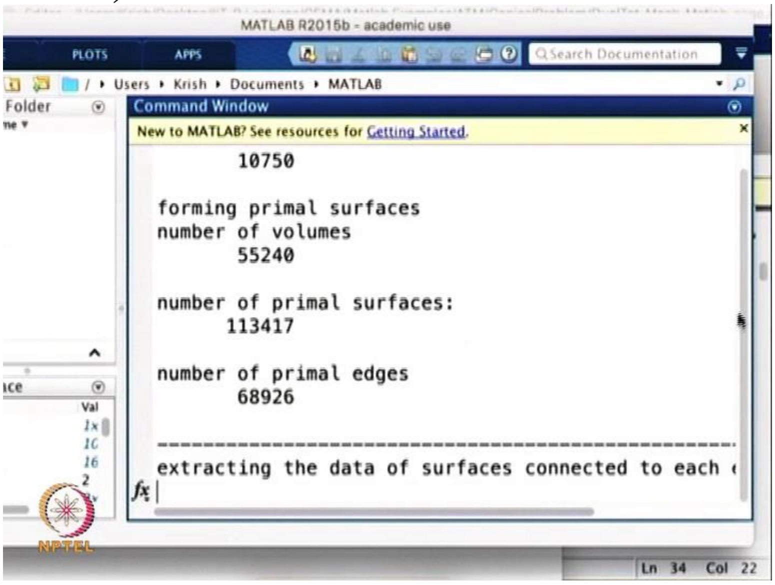

You see that the starting the 10750 like the way we did before and the Primal surfaces and Primal edges are as follows we are extracting the data of surfaces connected to each of the edges and we are going to compute the value of A1 and A3 matrices for the Primal and the dual grid follows.

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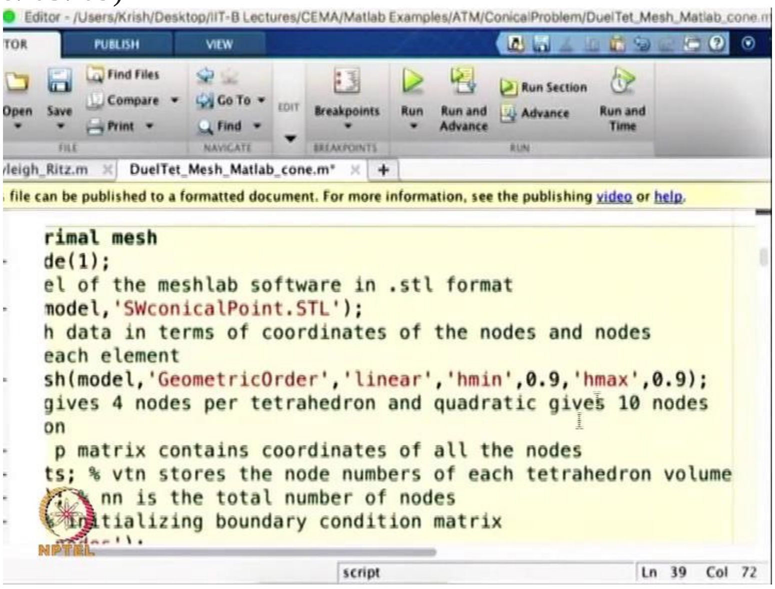

We will see the final graph for the potential in a second so we are going to have a minimum length as 0.9 in order to make the core run a little faster because then you will have a little number of elements in the case so we'll set it to 0.9 to show the proof of concept but you can go for m i n u s discredit action at a later stage if you want to run the core for yourself .

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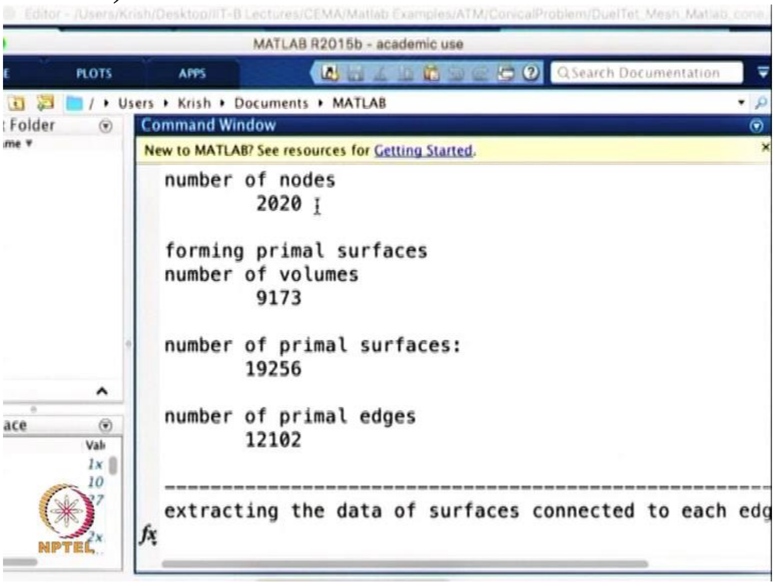

So let's run the programme and see what is happening . There are totally 2020 modes , 9173 primal volumes and the number of primal surfaces is 19256 , number of primal edges is 12102.

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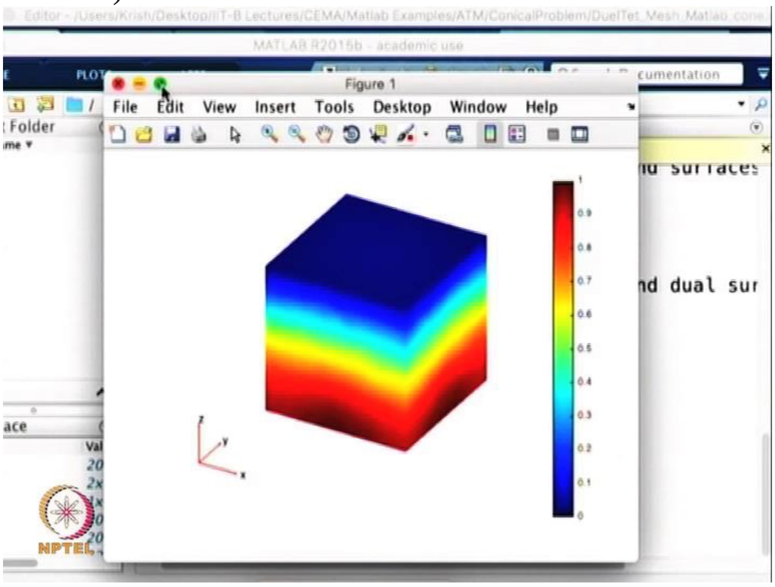

We are extracting the data so as to create the A1 A2 and a 3 matrix which are nothing but the connectivity matrix we are able to solve the problem and we are able to get the results as we expected. Sso in this case of problem geometry so is having the cone at the bottom and the zero voltage is applied on the top this is the same thing as doing it the other way round top part is 1 and the bottom part is zero.

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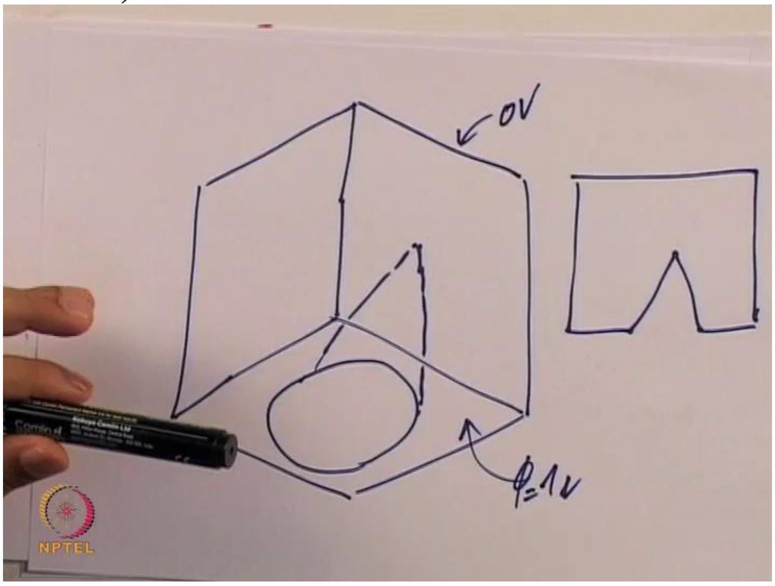

So let’s look at this problem here in our case what we have done is we have just tilted this problem this way. So the bottom part is going to be at 1 volt Phi equal to 1 volt the top part is going to be at zero volt. We did that so as to change the problem slightly so as to compare the results.

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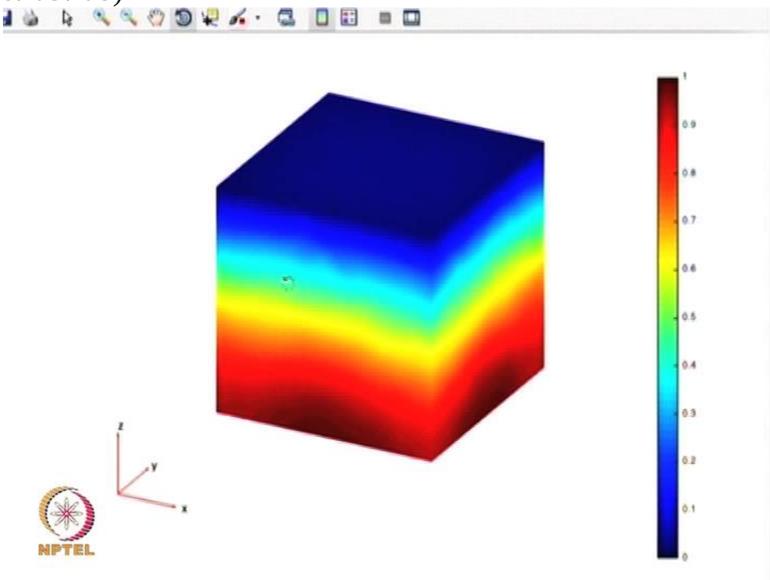

So what we see is we see that clearly there are good replications for the conditions that we have given.

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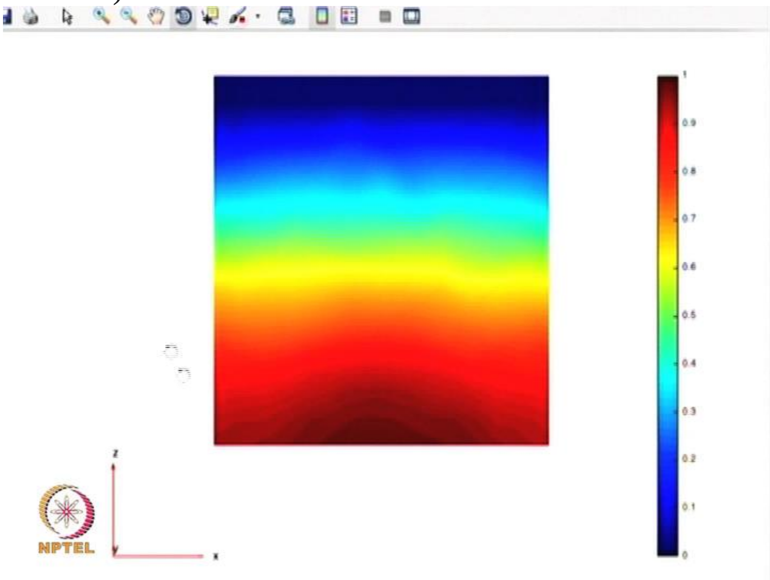

We see the cone; the cone is sitting here and its value is going that is going to be a equipotential surface and what We also noticed is the the as we go closer and closer to the top plate which is in this case at the zero potential the equipotential surfaces are no longer curved as they are almost parallel.

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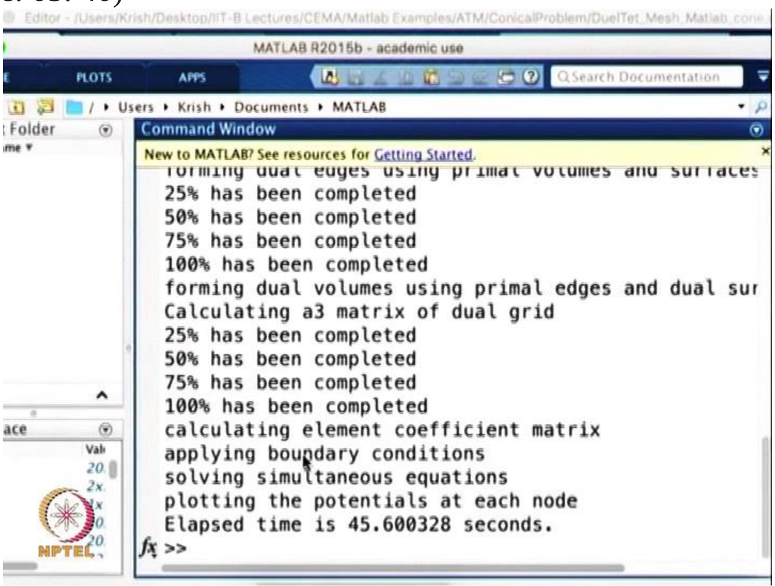

I would like you to program your own algebraic topological method codes so as to test various problems simple problems like this o helps you understand how to compute A1 matrix A2 matrix and A3 matrices for a primal grade and similarly the counterpart for the dual grade and how one can extract the information so as to compute a laplace equation.

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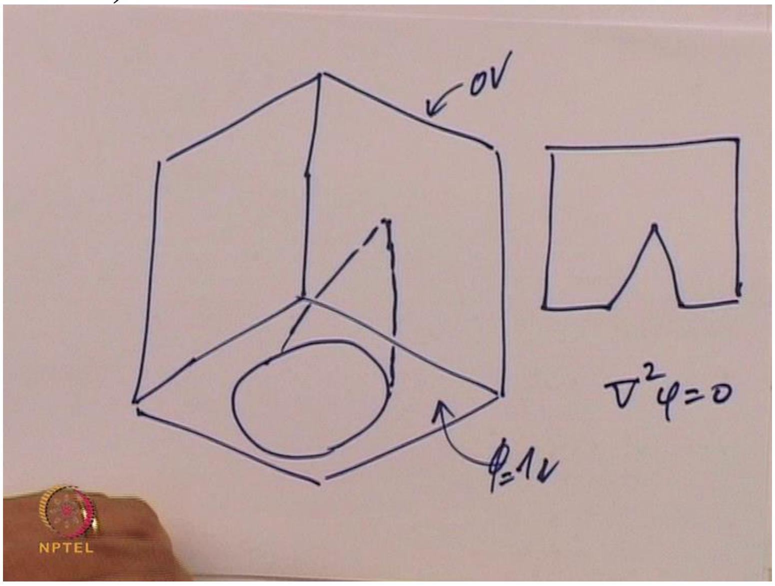

So in this case we did the divergence of d equal to 0 and in the case of the finite element method we did a Laplace Equation where we solved for the del square Phi is equal to zero and this is more or less the same problem only thing is the way we approach the problem is different in the case of the finite element.

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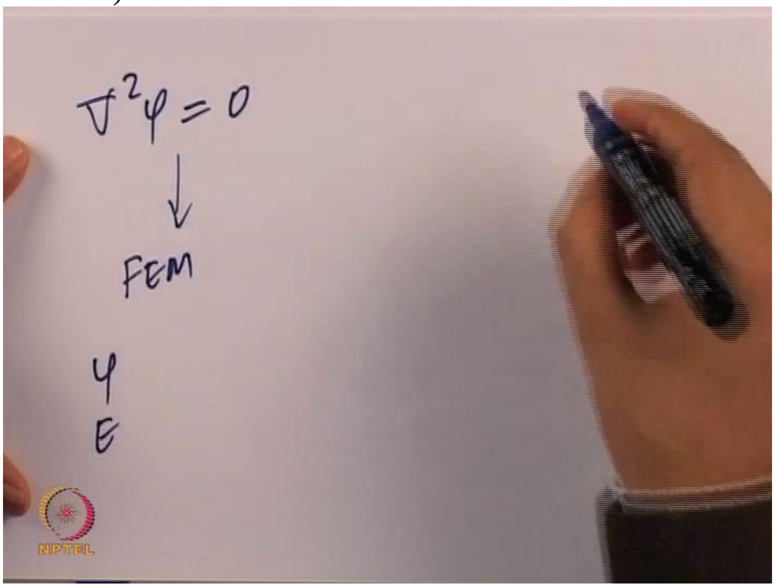

What we did is we started with directly the laplatian of phi equal to zero whereas in the case of the so we did the finite element of the approximation And we computed the potential in computed in the electric field so on and so forth.

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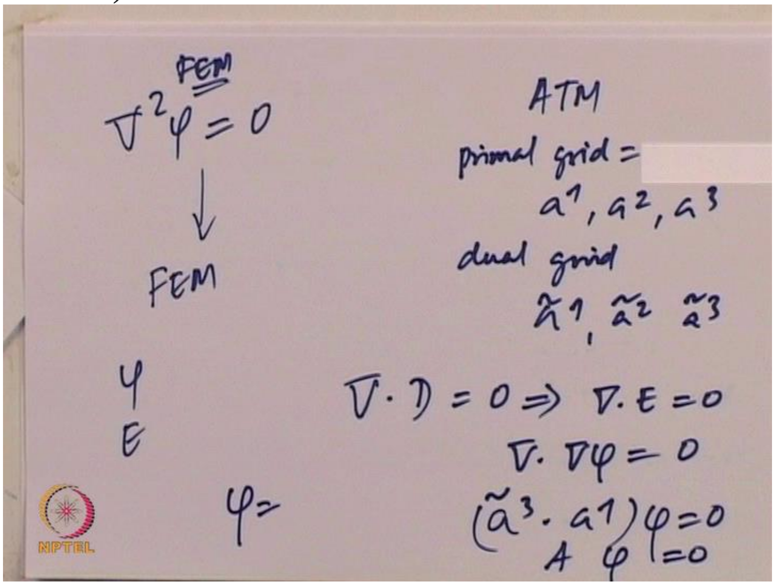

In case of the ATM and this is the FEM approach. In the case of ATM we started with the Primal grid we got the A1, A 2 and A3 matrices. And using that we computed the same counterpart for the dual grid. We got A 1 tilde A2 tilde and A3 tilde. The reason for going for this like this the divergence of D equal to zero we can transform this into the divergence of equal to zero and this and this can be transformed into the divergence dot gradient of Phi equal to zero. And this is the dual grade and this is the final grade we have A3 dual dot A1 of Phi equal to zero and this is the A matrix operator and this is Phi we apply the boundary conditions to compute the value of phi inversing the A matrix.

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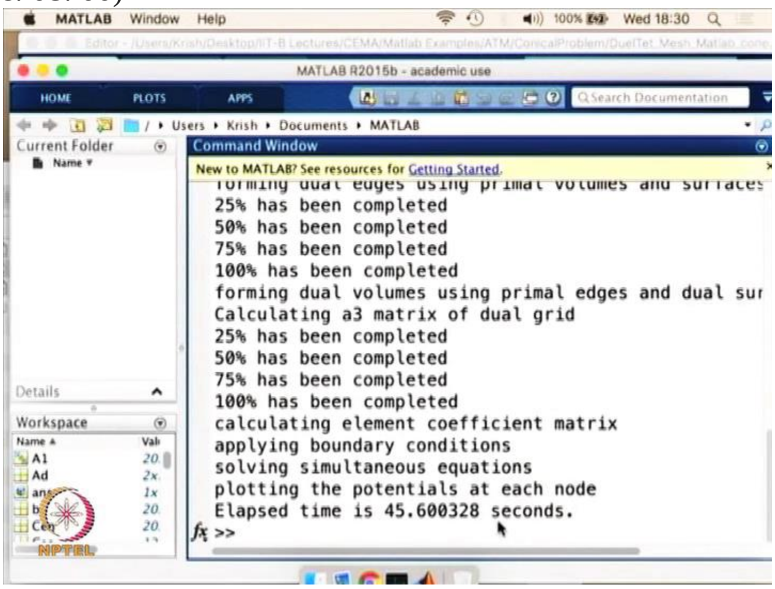

That is what we have done and what we have done in the code is also to see how long it takes for you to compute the result. We have a feeling that once you get a good understanding of the basic algebraic topology coding such problems is not going to be very difficult but of course this is for advanced learners I wouldn’t force you to learn algebraic topology if you are not interested in the computational electromagnetic magnetic as your main research area. If it is going to be only a topic you are interested to know you don’t need to go and code it but if you are a person who is interested in comparing method or know about the value of certain method plus other algebra topological method so it’s a very very good tool for you too compare methods and see accuracy on so what is good and what is not good is the finite element for so on and so forth.

So with that being said I wouldn’t force you on learning this particular program but for people who are interested we encourage you to test the code and practice for yourself. And also see how the Primal grade is constructed and dual grid is constructed and how one can compare and compute the values that we are interested for practical problem solving.

Thank you!