Course name: EMI /EMC and Signal Integrity: Principles, Techniques and Applications.
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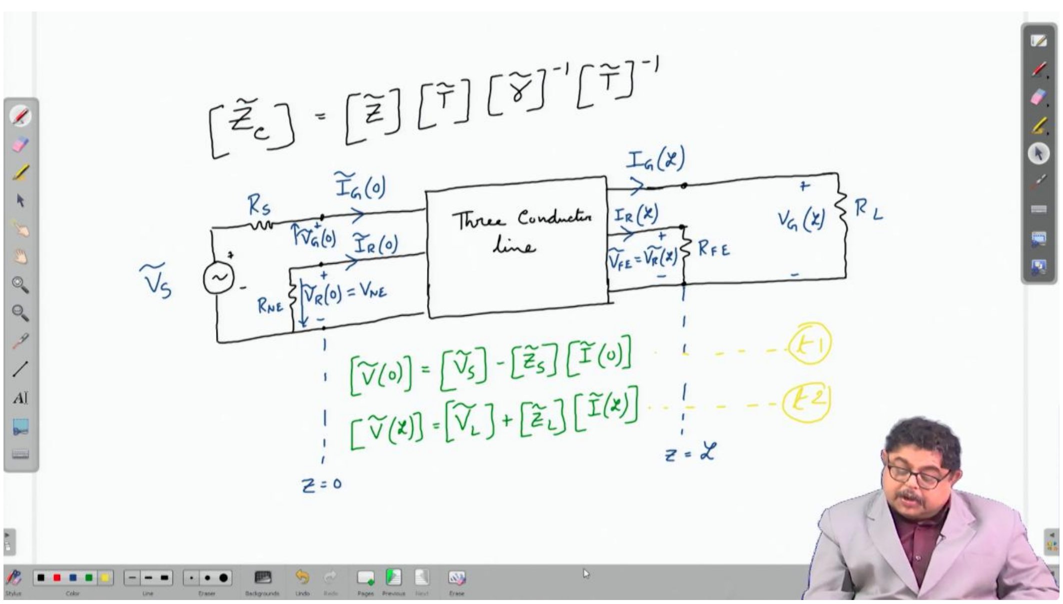
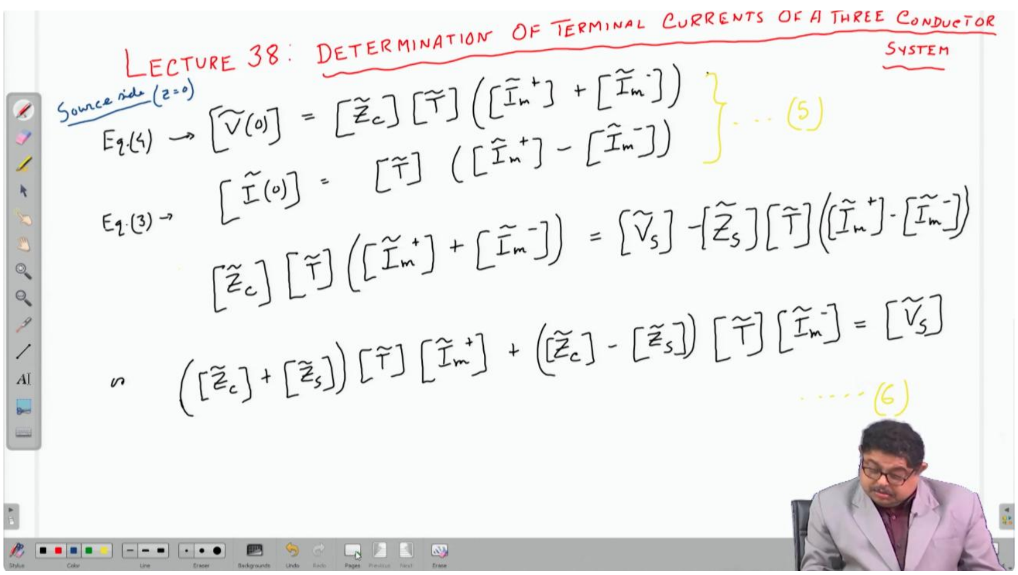
Week :08
Lecture 38: Determination of Terminal Currents of a three conductor system

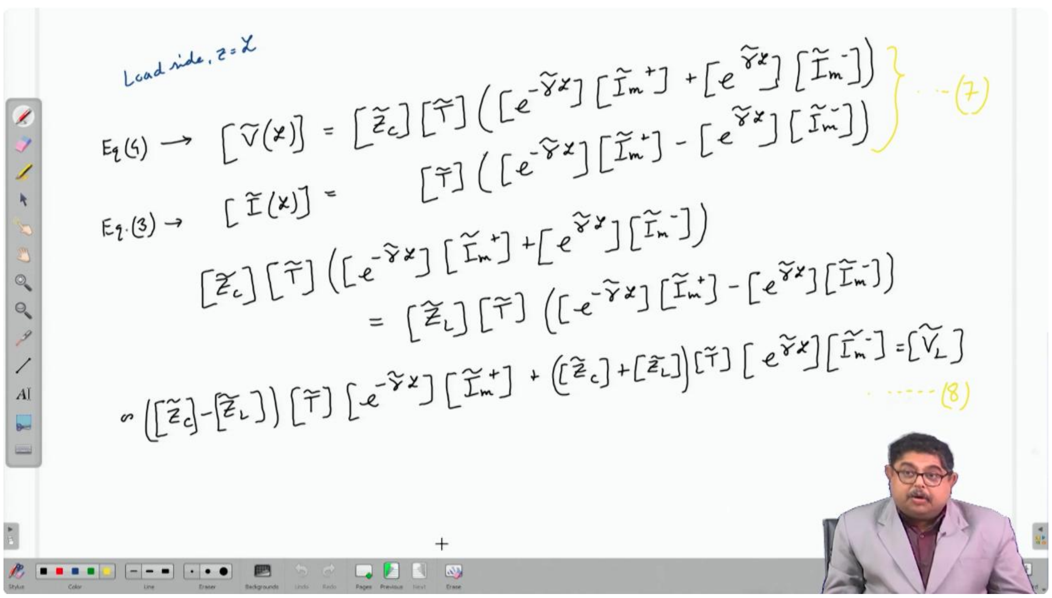
Welcome to the 38th lecture of the course on EMIMC and Signal Integrity Principles, Techniques and Applications. In the last class, we were discussing how to find the terminal currents of a three conductor line system. So, today we will do that. In the last class, I just introduced these that this is the structure and I have written two equations actually you can think them as boundary condition, but for lines we call them terminal conditions T 1, T 2 that and we also define there that you see that there were this V s matrix, V s is the excitation we are only exciting the generator. So, that is why it is a V s is a vector 2 into 1 vector. So, V s for generator it is V s the voltage source and for receptor there is no excitation that is why it was 0.Similarly, in the right hand side also we have kept a provision for excitation, but so that that matrix is V l matrix you see here this V l matrix, but you have noticed that there is no excitation to the generator or receptor on the load side that is why you have put 0 0 to V l matrix and we have Z s etcetera. So, appropriately they were given.



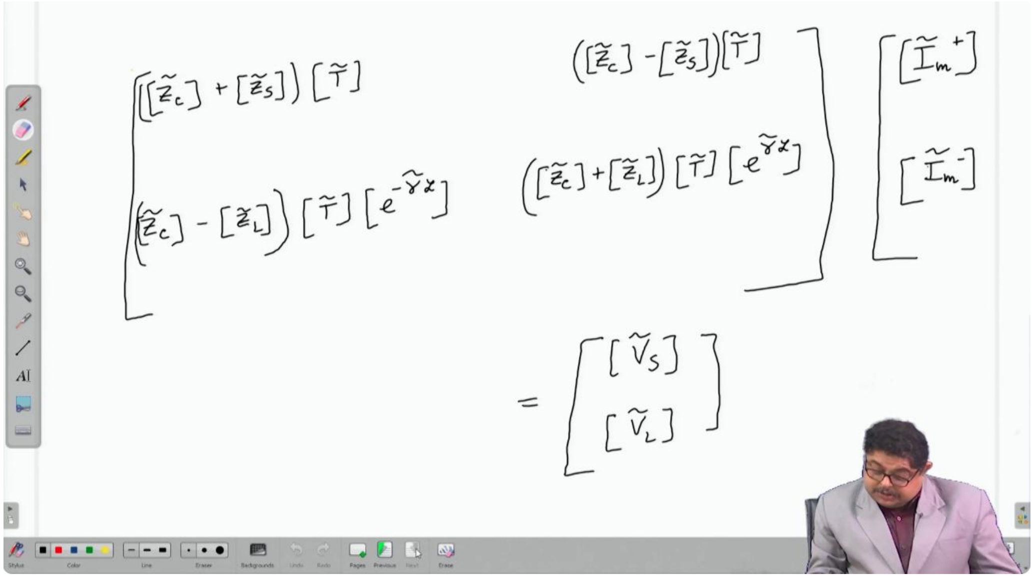
Now, with respect to that diagram now I will proceed. So, first I will we have in our equation 3 and 4 you can see that we have written a general expression for voltage and current at any point on the line V z and I z. Now, we will specialize that to the terminals. So, if we specialize that to Z is equal to 0 we get so from equation 4 if we put Z is equal to 0 we get V 0 matrix is equal to Z c into T matrix transportation matrix then. Similarly, the current that will come from equation 3 in this general equation if I put Z is equal to 0. So, it will give me. So, these two equations let me call equation number 5 and. So, this equation we can put into the terminal condition that means in here we have also V naught. So, we can equate these two and if I do that then I get. So, this is our equation number 5. So, this is our equation number 5. So, this is our equation number 5. So, this is our equation number 5. So, this is our equation number 5. So, this is our equation number 5. So, this now if we manipulate I can get in left hand side if I collect all the current terms right hand side will be only the source term then I can write that. So, this is our equation number 5. So, this is our equation number 5. So, the source term is here. Now, this equation I can name as equation 6. So, this is that all the two current terms I m plus two modal currents I m plus and I m minus are in one side. Similarly, we can this is in the by doing it in the source side we can. So, we can write that this we have done at source side that is z is equal to 0.



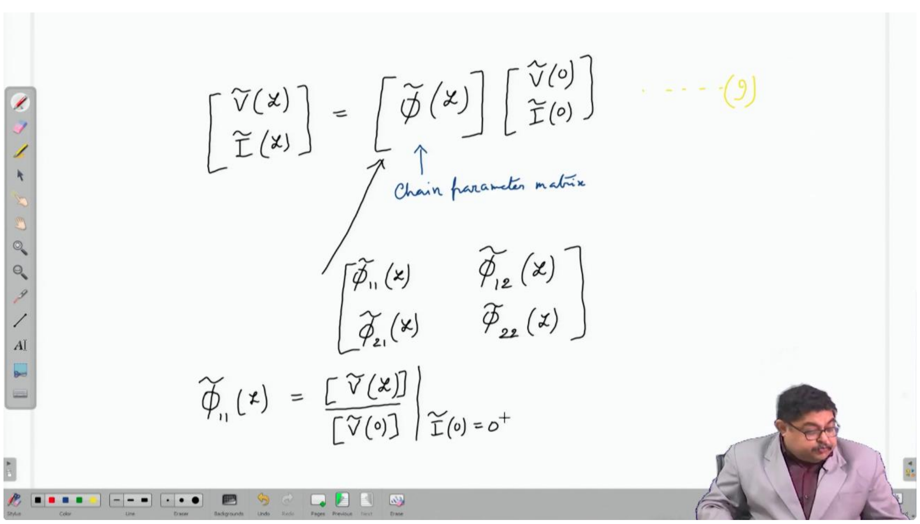
The next one we will do at load side same thing z is equal to L. So, again from equation 4 which is a general equation there we will put z is equal to capital L. So, that will give us V L is equal to characteristic impedance z c t e to the power minus gamma L. I m plus and equation 3 it will give me I L is equal to t L. So, this is the equation number 5. So, this is equation number 5. So, this is equation number 6. I m plus minus e to the power gamma L. So, these two equations I am calling equation number 7. So, again this one if I put into terminal condition at L that means this V L is equal to this V L has another expression. I have derived another expression. So, these two I will equate. So, this is equation number 7. So, now just manipulating these. So, we can write Z c minus Z L. So, we got another equation. This is our equation number 8. So, 6 and 8 you can see 6 that is also a similar type that was at the source end or Z is equal to 0 end and 8 is at Z is equal to L. So, they can be combined and in a compact form.



So, we can write. So, you can see that these actually comprises a set of four simultaneous equations. You see V s is 2 into 1, V L is 2 into 1. So, there are four equations I m is I m plus is 2 into 1, I m minus is 2 into 1. So, that means, there are four set of simultaneous four equations in the four unknowns which is our I m g plus, I m g minus, I m r plus, I m r minus. Now, they can be solved to get voltage or current along any point on the line. However, we are not so interested to solve them generally, but we are interested to solve the terminal voltages V r 0, V r L etcetera because V r 0 is our V n e, the near end voltage in the receptor. Similarly, V r L is our far end voltage on the receptor. So what we do, we just make a trick. Please look at equation 5 and 7. This is equation 7. You see it is V L I L, right hand side is in terms of I m, I, I m, I m plus, I m minus. Let us go to 5, where is 5 here, 5. Here also V and I are in terms of I m plus and I m minus.



So, that says us that we can write V of L, I of L, right hand side is V L I L as a matrix I L. That means, since equation 5 and 7, both are in terms of I m plus and I m minus, we know that there will be a relation between V L I L and V 0 I 0 and that we are representing by a matrix I L that is called chain parameter matrix.Before that, let me give a number to this one. This will be our equation 9. So how to get this chain parameter matrix? Obviously, from equation 5 and 7, if we eliminate I m plus and I m minus, we will get this type of equation. So, this one is called chain parameter matrix. So, what is psi L? It will be a 2 by 2 matrix. And the moment I write this, I can define what is psi L? Each element of this matrix, what is phi 11 L? From this easily I can find out that it is V L by V 0 given I 0 is equal to 0. What is the meaning of I 0 is equal to 0? Let us look at equation 5. So, I 0 is equal to 0 implies I m plus is equal to I m minus.



So, I can write that from equation 5, I 0 is equal to 0 implies I m plus is equal to I m minus. So, now I will have to evaluate with this knowledge, what is V 0, what is V L? Then I will have to divide and I will get it. So, what is V 0? So, if I put V 0, for V 0 you can what is the equation? V 0 is this. So, Z c t into 2 I m plus I can write Z c t into 2 I m plus and so I m plus. Z c t into 2 I m plus is equal to half t inverse Z c inverse V 0. You see the order while inverting the post multiplier here, it comes as pre multiplier that you should remember. So, now, this one you put into equation 7 that means for V L. So, putting in equation 7, we get V L is equal to equation 7 you can see V L Z c t e to the power minus gamma L I m plus e to the power gamma L I m minus. So, that is what I will write Z c t then e to the power minus gamma L plus e to the power gamma L I m plus. So, in place of I m plus I will put half t inverse Z c inverse V naught. So, now, I am in a position V L by V 0. So, I can write the first element of the chain parameter matrix e to the power minus gamma L plus e to the power gamma L t close it t inverse and Z c inverse. So, this is the first element of the matrix. So, similarly, we will determine the other chain parameter matrix other elements of the chain parameter matrix and then we can relate the V f e and V n e with the source conditions source we know. So, from that we will be able to find out V f e and V n e that we will see in the next class. Thank you.