Course name: EMI /EMC and Signal Integrity: Principles, Techniques and Applications.
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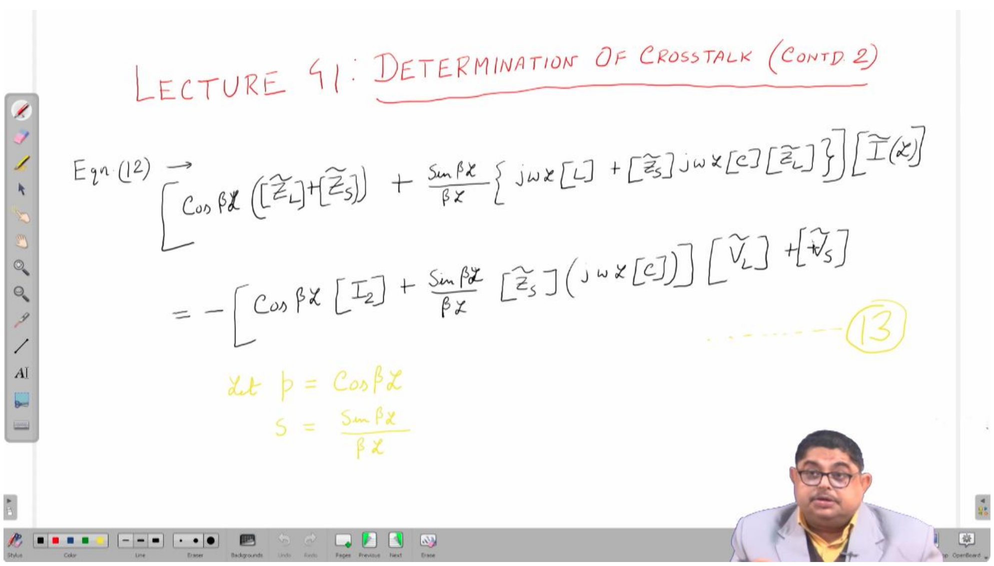
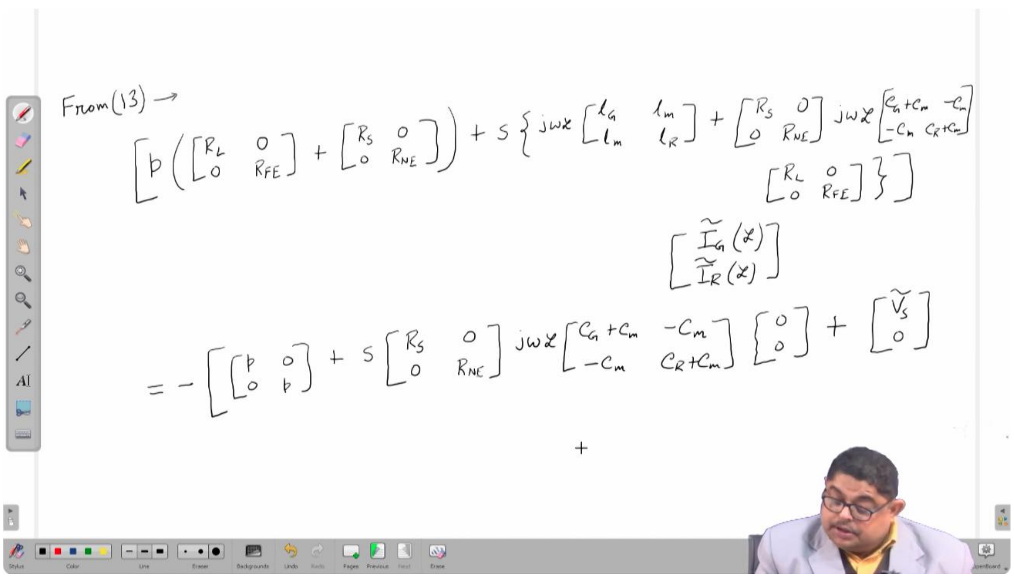
Week :09
Lecture 41: Determination of Crosstalk (continued)

Welcome to the lecture of the course on EMI EMC and Signal Integrity Principles Techniques and Applications. In the last class we have determined I 0 that means, the current at the receptor at the source end or at the near end. Now using reciprocity we are doing a trick to find easily from that expression the current in the far end. So, with that replacement, if we put that into equation 12 we get. So, this is our equation 13 where we have got the value of I SL IL. So, if we expand this equation 12 and 13 we get the terminal currents that is I 0 and I 2 and then we can easily solve for it because these are two simultaneous equations. Now to simplify the notations what we will do we will put some simplification because every time this cos beta L and sin beta L by beta L is coming. So, for them we assume that let P is equal to cos beta L and S is equal to sin beta L by beta L.

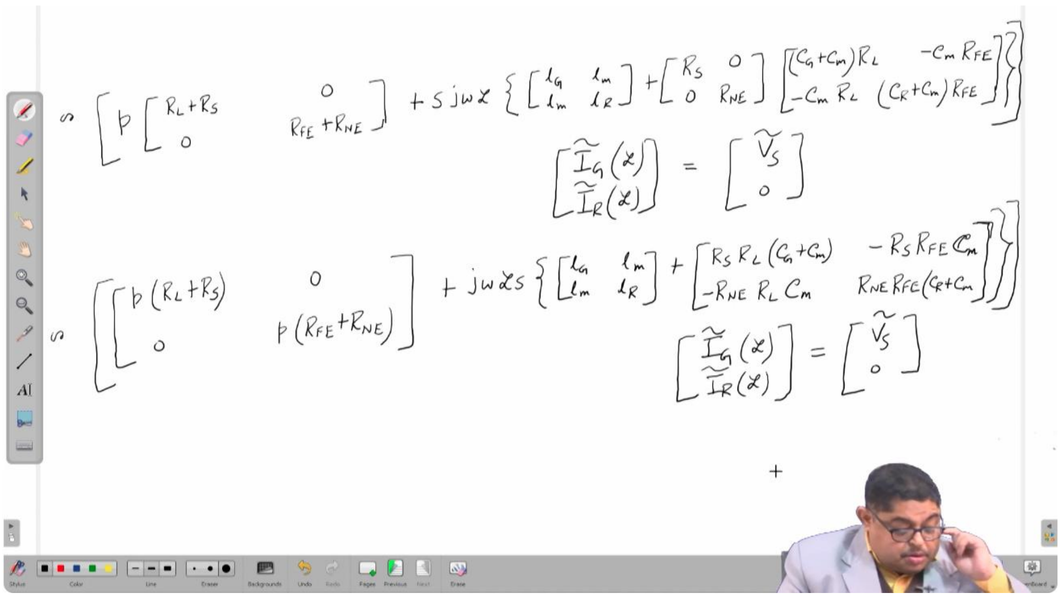


So, we can write it now by expanding the see these there are Z L matrix Z S matrix L matrix C matrix Z L V L matrix V S matrix. So, these we already know because when we draw the circuit we have determined them . So, we will now make use of those definitions. So, P is P is P into this Z L. So, in place of Z L I may write R L 0 these are given earlier you may recall R f e plus Z L plus Z S. So, Z S matrix is R S 0 0 R m e plus S 0 0 R m e plus J omega L then L matrix. So, that we know is L g L m L m L r plus R S what was the term ah L plus Z S. So, Z S is again R S 0 0 R m e then J omega L then C matrix. So, C g plus C m minus C m minus C m C r plus C m and then Z L is C L again. So, into Z L is R L 0 0 R f e into I L. So, I L is nothing, but I g L m L r and I R L. So, this will be equal to minus minus you see P into I 2. So, I can write P 0 0 P plus S into Z S Z S is R S 0 0 R m e into J omega L. So, this is J omega L C J omega L C matrix. So, C g plus C m minus C m minus C m C r plus C m into V L. Now, our V L is there is no excitation at the load end. So, it is 0 0 plus we have V S. So, V S is we are energizing the generator we are not energizing the receptors. So, V S 0.

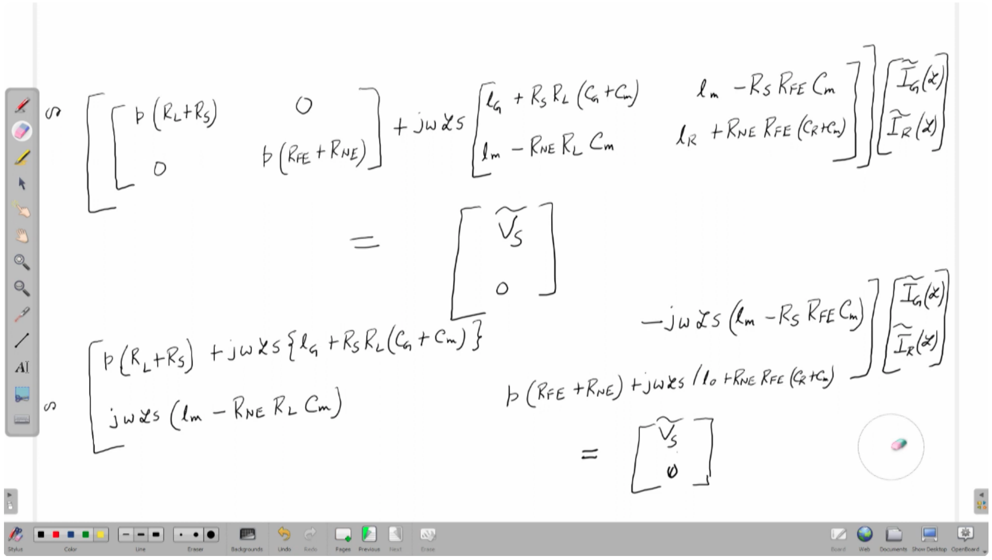


So, this from this we can just do one more simplification some matrix terms take you see the first one if I take I can make I can take P common and from that with a smaller third bracket I can write R L plus R S 0 0 R f e plus R m e plus S J L J omega L. So, J omega L L matrix is L g L m L m L r plus. So, R S 0 0 R m e into here we are clubbing this C matrix into the J L matrix. So, we are getting C g plus C m into R L minus C m into R f e minus C m R L into R m e minus C m R L plus C m into R f e. I think it is write another third bracket will come yes another I think third bracket will come then we have I g L I R L and right side you see that the first term is fully 0. So, we are left with only P S and

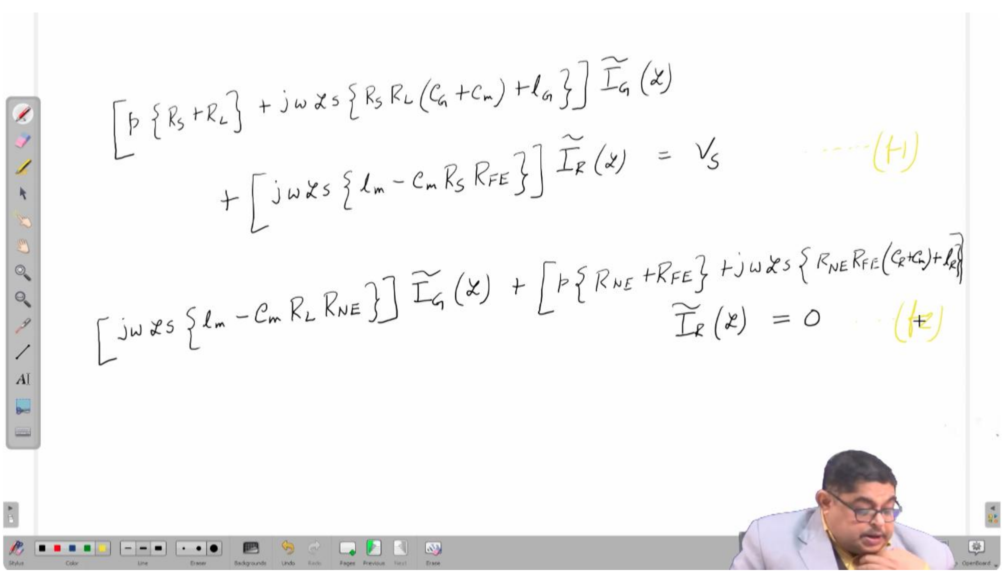
0. We can further simplify that P we can take inside this. So, P R L plus R S into 0 into P R a P plus R m e plus J omega L S L g L m L r plus R m e plus R m e plus J omega L g L m L m L r plus R S R L C g plus C m minus C m into R f e minus C m R L into R f e minus R S R a P C m minus R m e R L C m R m e R a P minus R m e minus R f e minus R m e R a P C r plus C m and this one is C r plus C m. Then the second bracket should end the third bracket should be 0. Then multiplied with this I g L I R L is equal to 0.



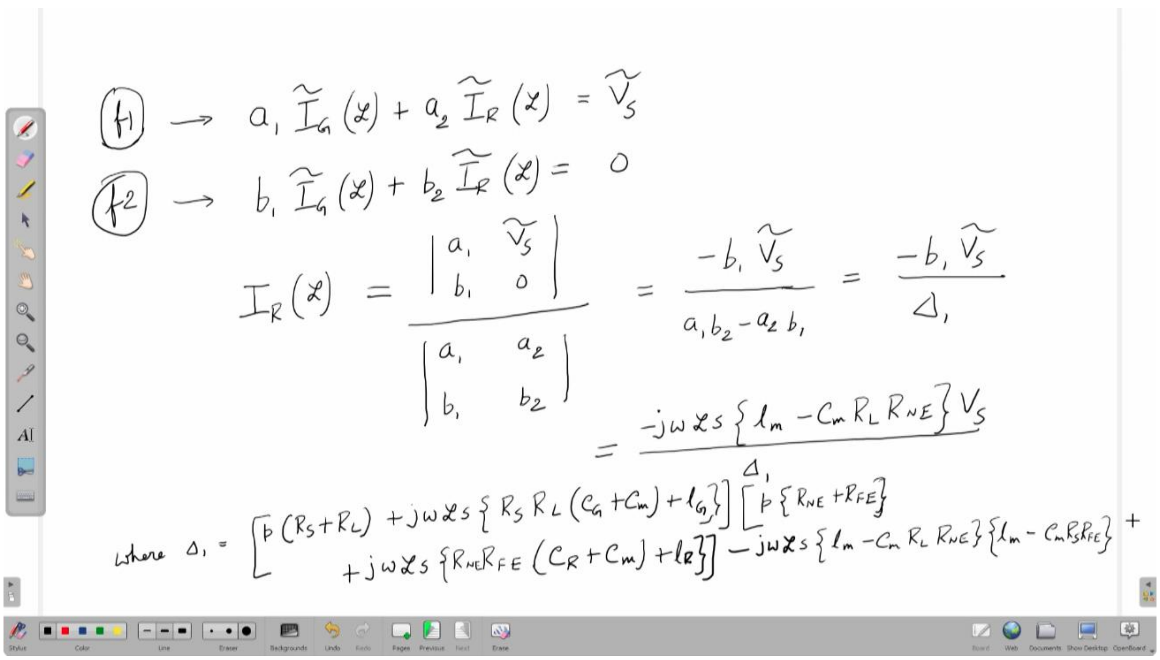
we are doing one by one matrix multiplication. So, that is why so many steps are coming. So, we have R a P L m minus R S R a P C m L m minus R m e R L C m minus R f e minus C m L r plus R m e R f e C r plus C m. Now, we will do another one. One more this addition needs to be done. So, for P R L plus R S plus J omega L S plus R L G plus R S R L C G plus C m minus J omega L S L m minus J omega L m minus J omega L G plus R S R a P C m J omega L S L m minus R f e. R plus R m e R a P C r plus C m into I g L plus R m e R f e into R f e into R f e into I R L is equal to your P S 0. So, let us also give this is P S 0. Let us give it some name. Suppose I call it f 1. No, I need not call it any equation. So, actually this will give me two simultaneous equation. So, one for I g L, another is for one for this V S, another is for this 0.



So, that let us do then we will name them. So, from the first row we get that P. So, P R S plus R L plus J omega L S R S R L G plus C m G plus C m G plus C m G plus I g L C g plus C m plus L g I g L plus J omega L S R L G plus R f e into R f e into R f e into L s L m minus C m R S R f e I R L is equal to V S. Now, we have got J omega L S and J omega L S L m minus C m R L R m e I g L S minus C m g L plus P R n e plus R f e plus J omega L S R f e. Now, we have got J omega L S plus R f e plus J omega L S plus R f e plus J omega L S plus R L is equal to 0. So, these two follows from this one, this one into I g L minus this one into I R L is equal to V S and this one into I g L plus this one into I R L is equal to 0. So, these two I want to name. So, let us name something what is coming to my mind f e. So, there are two simultaneous equations in the unknowns I g L and I R L.



So, they can be solved by Cramer's rule. So, for that what I do I write that f sorry that f 1 equation that I write as a 1 I g L plus a 2 I R L is equal to P S and P R n is equal to P S. So, f 2 I write as b 1 I g L plus b 2 I R L is equal to 0. So, my intention is to find I R. So, I can easily apply Cramer's rule and write that as a 1 b 1 b 2 is equal to minus b 1 P S by a 1 b 2 minus a 2 b 1 or I can call it minus b 1 V S by delta 1. So, what is minus V S ah minus b 1 V S b 1 you you can see is minus j omega L S L m minus C m R L R n e into P S by delta 1 where delta 1 is equal to minus delta 2 is equal to P R S plus R L plus j omega L S R S R L C g. So, plus C m plus L g into P R n e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus R f e plus C m plus L R minus j omega L S L m minus C m R L R n e. This is equal to minus C m R L R n e into P S by delta 1 minus C m R L R n e into P S R s R f e ok. So, this is so, we got the value of I R L. Similarly from the equation 12 we can go get the value of I R 0 also. So, then since we know the resistances R f e and R n e we can find cross talk that part we will do tomorrow.



So, I think we can give some name now to this value or we can before ending we can find the near end cross talk. So, we can say that what is V f e since we have got I R L. So, V f e is nothing, but R f e into I R L. So, that means, we have got j omega L S C m R L R n e minus L m R R f e by delta 1 into P S. This we have got the far end cross talk. So, earlier one I have given V 1 I f 1. So, let me call this is an important thing that V f e we have determined. So, this I will say that we have achieved something that V f e is this. So, the cross talk at the far end we have determined in the next class we will determine the V n e that is cross talk at the near end. Thank you.