Computational Electromagnetics
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Method of Moments
Lecture – 8.1.2
Surface Integral equations for PEC

So the final module is where we summarize what you have learnt about integral equations so far.

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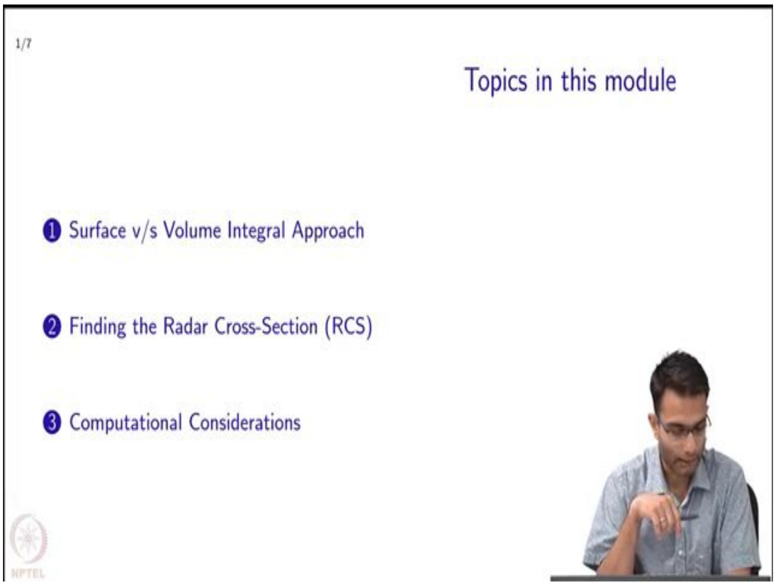

And this is going to be the outline. Two main methods that we have seen are surface and volume integrals. So, we will just list out the differences between them. The new concept over here is going to be that of the radar cross section which is abbreviated as RCS.

So, that is like you know all the theory that we have learnt how do we finally, put it into used to calculate something it is useful ok. And a little bit a small word about what are the some of the computational issues that you will face in this ok.

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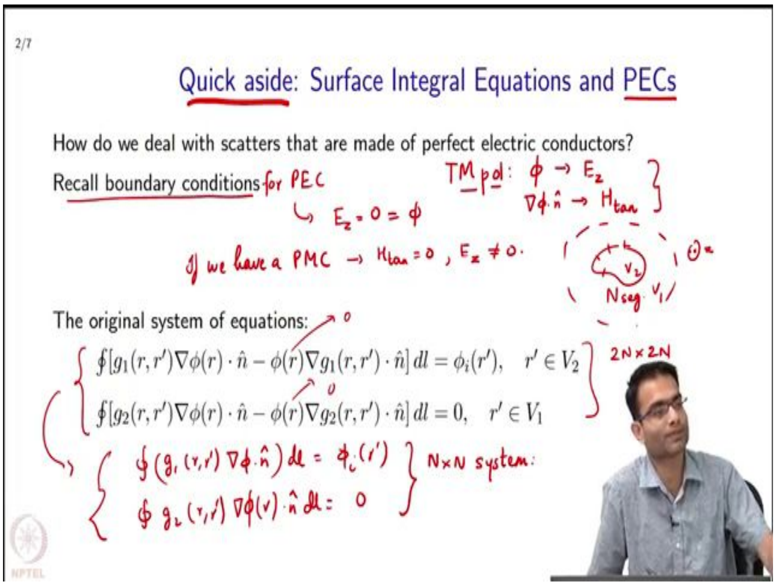

So, before we go into surface and the difference between surface and volume, I want to take a quick aside, one sec, about surface integral equations in the presence of PECs. So, what is the PEC? A PEC is a perfect electric conductor; so a perfect electric conductor is one which I mean colloquially you will call like a perfect metal. So, what is the property of a perfect metal? That connectivity is infinite therefore, we have studied all of this before it charges don't reside in the volume they all go to the surface.

Student: Surface.

Right so in the formulation that we had so far which is shown over here this was an original formulation. We had given the physical interpretation to the variables right. So, when I looked at TM polarization, so, what was my phi? What physical quantity was my phi?

Student: Electric field.

Electric field right so, particularly ϕ was E the z component right and $\nabla\phi \cdot \hat{n}$ we had given an interpretation as; what we did what was it proportional to? We had worked it out; it was proportional to the H tangential on the surface ok. So, we have interpreted these equations as sort of a linear combination of the tangential electric and magnetic fields this was in TM polarization; similarly, if you for TE polarization you would get E tangential and H_z.

So, if the conductor is made I mean if the object is made out of a perfect electric conductor. What are the I mean should we just use these system of equations as a should be change them somehow? So, what are the boundary conditions what do boundary conditions for PEC say or any of these two guys zero or both are nonzero?

Student: E tangential below.

E tangential right so, remember this was my problem right. So, z was coming out of the board that was my z axis; and E_z is which where it is purely along the surface of the conductor that is coming out of the plane. So, E_z is going to be 0 because on a perfect metal the surface the fields are always what.

Student: It is normal.

Purely normal right so, the fields are always normal, but. So, in TM polarization E is force to be E_z and H is in xy plane. So, therefore, there is going to be no component of electric field in the z direction in TM polarization right. So, for PEC we can say that E_z is equal to 0. Can I say anything about H_{tan}? We cannot say anything right it will be whatever it will depend on the problem right. So, for a PEC E_z is equal to 0. Can you think of any other possibility? Can you think of a possibility where phi is non zero, but $\nabla\phi \cdot \hat{n}$ is zero; what kind of a material would it be?

Student: PMC.

PMC, right that is right. So, if I had if we have perfect.

Student: Magnetic.

Magnetic conductor in that case H_{tan} will be 0. E_z will not be equal to 0.

What is a perfect magnetic conductor right? It is a hypothetical object. It is just like how in Maxwell's equations earlier we had an electric current, but no magnetic current right, but we added a magnetic current to give symmetry to the system of equations. So, similarly I just for the sake of completeness where talk of PEC I also talk about PMC ok. It may be useful if I use some of the equivalence theorems that is why I am mentioning it over here because by using equivalence theorems I can introduce a fictitious.

Student: Current.

Magnetic current or electric current so that is why I am saying that that is I want to make a note of it. So, what happens to my system of equations now? Earlier supposing I broke up this surface into N segments, capital N segments. So, how many variables were there in this equation? What is the size of this system of equations? $2N \times 2N$ right; now in the case of PEC what happens? Is there any what all terms from here we will survive what we will not survive?

Student: ϕ would be 0 .

Right. So, this term over here and this term over here these are both.

Student: 0.

0 and 0 right so only these two term survive. So, I will just have

$$\oint (g_1(r,r') \, \nabla\phi \cdot \hat{n}) \, dl = \phi_i(r')$$

$$\oint g_2(r,r') \, \nabla\phi(r) \cdot \hat{n} \, dl = 0$$

So, this is going to give me a $N \times N$ system right. So, in some sense it is an easier problem to solve can you tell me one more reason why it is easier than the earlier system of equations; which term did I not have to worry about?

Student: Grad g.

$\nabla g \cdot \hat{n}$ and was there a particular problem with $\nabla g \cdot \hat{n}$.

Student: The singularity.

The singularity cause more of a trouble with $\nabla g \cdot \hat{n}$ and to be very careful how are integrated I got a $+1/2$ or $-1/2$, but for a perfect electric conductor that problem is not there because the ∇g term is gone away I am just left with g and g had a singularity which was integrable ok. So, this is how you would start, I mean this is how you would solve problem with a perfect metallic conduct I mean perfect electric conductor ok. So, in some sense it is the easier thing we could have started the whole discussion with you know PEC and then built it to dielectric objects, but we have done in that other way.