Computational Electromagnetics
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FDTD: Materials and Boundary Conditions
Lecture - 13.19
Summary of FDTD

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So, this brings us to an end of the FDTD method right.

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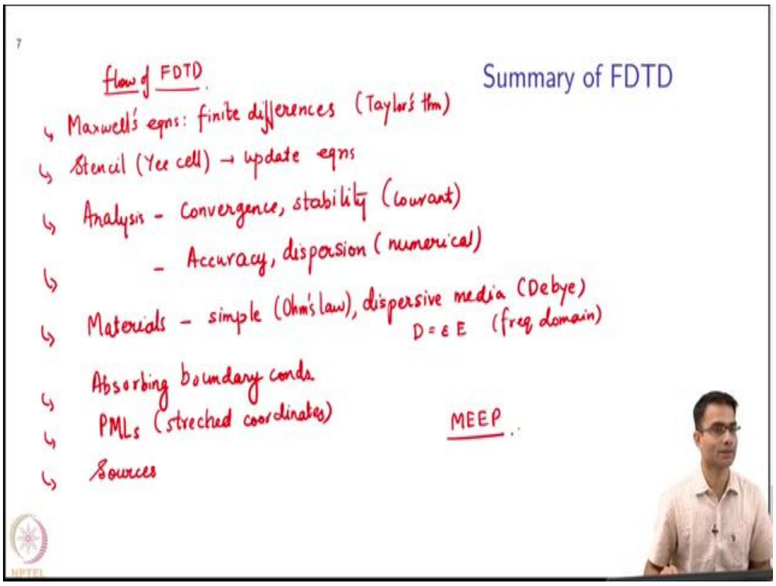

So, we will just or to summarise the various aspects that we looked at right. So, what did we start with? So, the flow of because there were many modules over here we started with, what do the first thing that we did? We took Maxwell's equations and then and did finite differences right so, finite.

What are the key concept for finite differences that we used to get accurate representations of the partial derivatives? Taylor's theorem; Taylor's theorem allowed us to see how to get the lowest error right.

So, once we had the finite differences what could we do? What did we do rather? We discretise it right. So, we made a stencil right, this stencil was the Yee cell right and from here we got the so, called update equations which allowed us to step the fields in space and time. After that what did we do? So, we had our update equations we knew how to step it in space and time, we looked at stability and before stability well yeah.

So, we looked at we did analysis, convergence we did and stability this is where we got our Courant parameter right. And, we have that Lax Richtmyer theorem as well. After that what did we look at? We assumed Courant stability factor is being satisfied, still we found that solutions were not always accurate, what was that dispersion right.

So, we looked at analysis, we looked at accuracy and in accuracy we looked at for example, dispersion numerical. After having done that so, far we were still dealing with free space then we introduced materials right. So, we looked at materials, we looked at simple materials which used Ohm's law right and after that?

Student: Boundary conditions.

No, not boundary conditions what we looked at another kind of material, no one big we spend a lot of time on this frequency dependent dispersive materials and which kind of model?

Student: Debye

Debye model right; so, we looked at dispersive media and in that we took the Debye model right. So, we are able to and this was important because in FDTD we want time update and we here we got the correct relation between D and E right.

So, the correct the relation D is equal to epsilon E is theoretically correct only when these are in the frequency domain not in the time domain right. So, we saw that exactly then after that we looked at materials are done, then we looked at absorbing boundary conditions; simple first order absorbing boundary condition right so, absorbing. Then we looked at the inaccuracy of absorbing boundary conditions for example, evanescent waves are not absorbed by ABC. So, then thus remedy was perfectly matched layers right.

So, we looked at PMLs, we looked at the theory via stretched coordinates and then we looked at the implementation in FDTD. We were saying that absorbing boundary condition the first order ABC even if I have, if I implement it in a lossy medium where there are evanescent waves even in a 1D case the ABC does not gives you a reflection and gives some reflection. So, it was a disadvantage of ABC ok.

After having looked at PML's the last aspect that we looked at was sources right. So, did I leave out anything? No ok so, the last thing that I want to show you is this software which I have mentioned to you previously, I will show you so, they have I mean I will show you the reason is I mean like Meep there are many many softwares.

So, one big advantage of it is a software made by a academic group at MIT. So, it is open source and you know you do not have to pay money for, it is free right. So, it is one reason to promote it. We look at one of their worked out examples to show you FDTD in action ok. So, we will just work through this.