Computational Electromagnetics and Applications
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Summary of Week 12

We have come to the end of the 12 th and the last week of this course.

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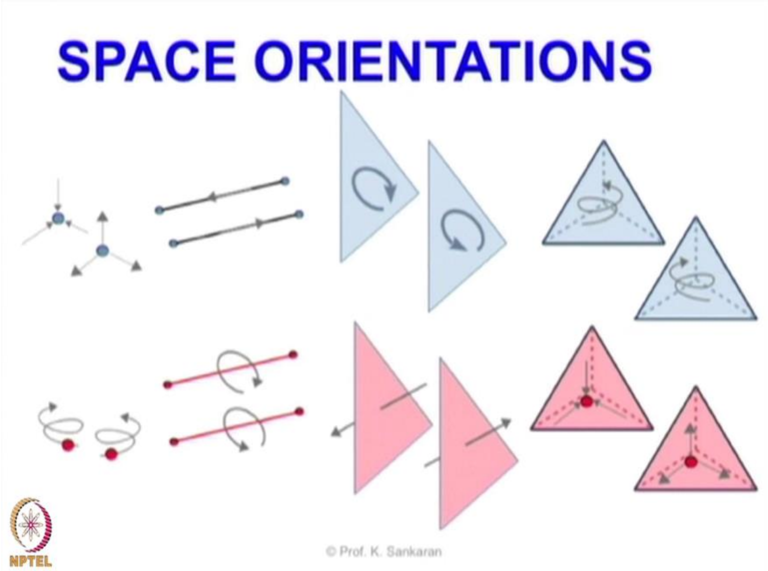

We started with this week with a concept of space orientation. As I mentioned during the lecture this is one of the most neglected concepts in Applied Physics and engineering.

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SPACE ORIENTATIONS

	2-dimensional embedding space, $\mathbf{R}^2$	
Object dimension, k	Inner-orientation, k-dimension	Outer-orientation, (n-k)-dimension
$k = 0$	0-simplex (point)	surface
$k = 1$	1-simplex (line)	line
$k = 2$	2-simplex (surface)	point
$k = 3$	3-simplex (volume)	not-defined
	3-dimensional embedding space, $\mathbf{R}^3$	
$k = 0$	0-simplex (point)	volume
$k = 1$	1-simplex (line)	surface
$k = 2$	2-simplex (surface)	line
$k = 3$	3-simplex (volume)	point

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We studied how the inner and the outer orientations of points, lines, surfaces and volumes can be visualised and used in a computational model.

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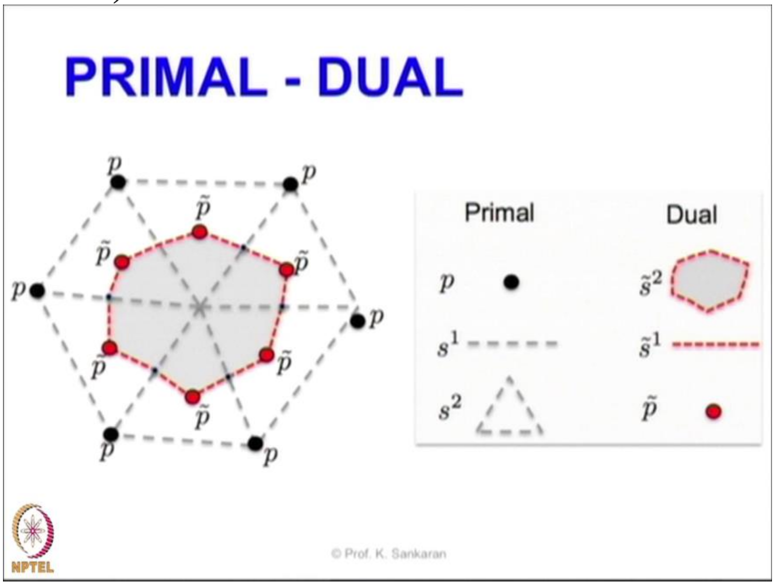

These discussions laid the basis for the underlying need for the primal and dual grids in a computational model like in the case of staggered grid.

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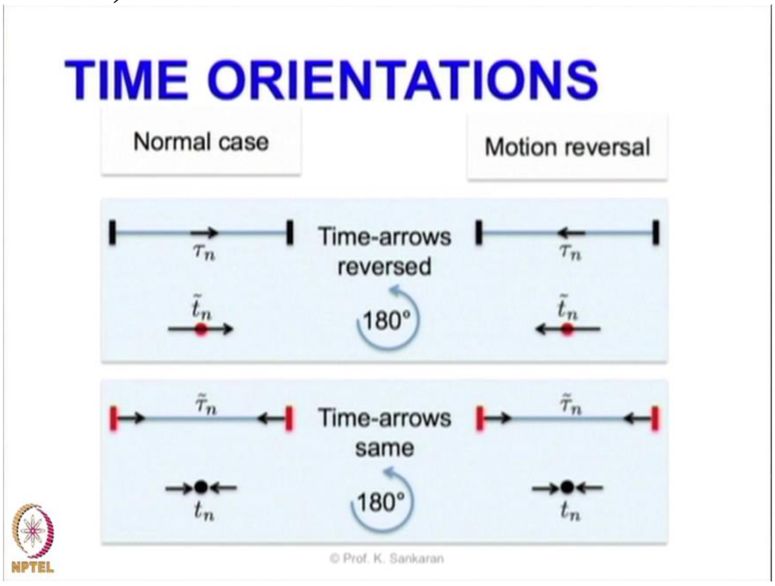

Later we extended this concept of space orientation to time where we studied using the ideas of motion reversal and time reversal to explain inner and Outer orientations of time.

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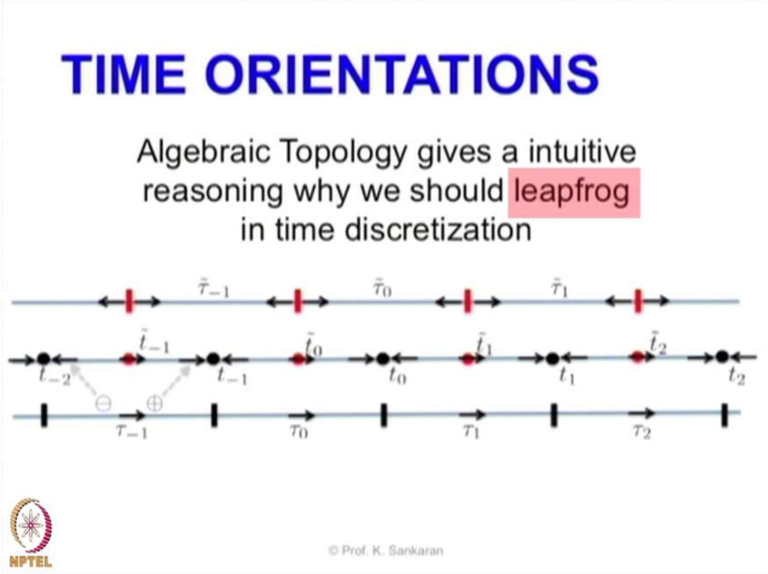

We related the standard leapfrog and stepping scheme 2 Primal and dual time grids similar to the standard spatial grid. We discussed all the basic concepts of algebraic topology for computational electromagnetic.

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MAXWELL EQUATIONS

Variable name	Associated space	Associated time	Notation
Electromagnetic source variables			
Charge content	dual-volume: $\tilde{s}^3$	primal-instant: t	$Q_c(\tilde{s}^3, t)$
Charge flow	dual-surface: $\tilde{s}^2$	primal-span: τ	$Q_f(\tilde{s}^2, \tau)$
Electric flux	dual-surface: $\tilde{s}^2$	primal-instant: t	$\Psi(\tilde{s}^2, t)$
Magnetomotance	dual-line: $\tilde{s}^1$	primal-span: τ	$U(\tilde{s}^1, \tau)$
Electromagnetic configuration variables			
Electromotance	primal-line: s^1	dual-span: $\tilde{\tau}$	$V(s^1, \tilde{\tau})$
Magnetic flux	primal-surface: s^2	dual-instant: $\tilde{t}$	$\Phi(s^2, \tilde{t})$

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And we finally modelled the Maxwell equations without using vector calculus for for differential equations as we promise while introducing the algebraic topological method we have completely avoided the differential equations and vector calculus and we have directly derived discreet algebraic equations for modelling electromagnetic problems.

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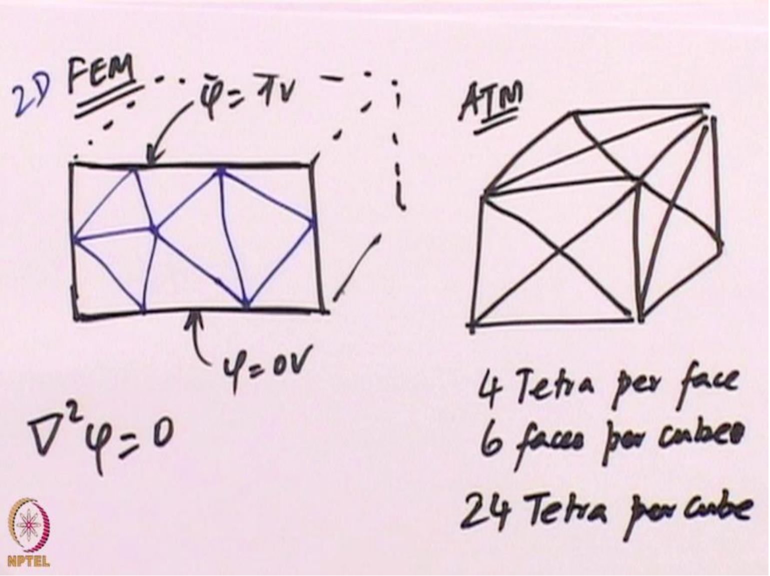

As a practical example we looked at a conical dipped capacitor using the method of algebraic topology.

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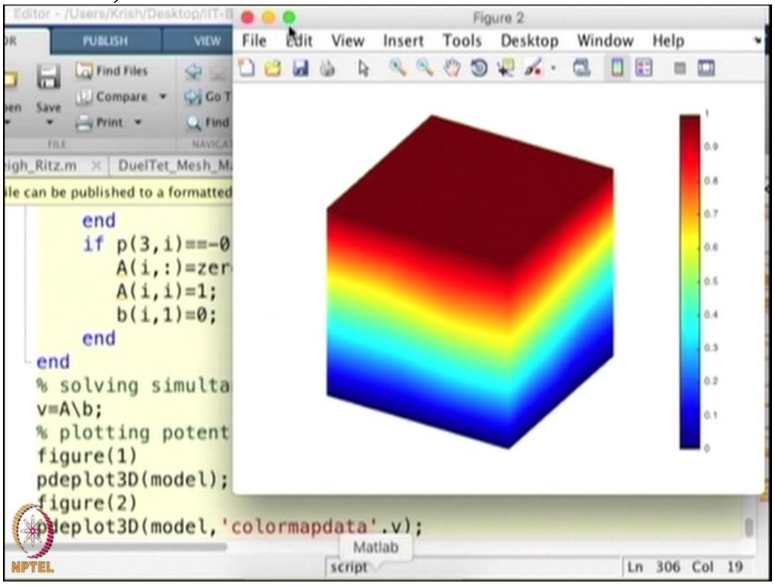

We discussed how we can use Matlab and environment to simulate such a problem .

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Towards the end of this week's lecture we also introduced yet another advanced method which is called as mimetic method . This method mimics the continuous differential operator using discrete approximation of underline partial differential equations.

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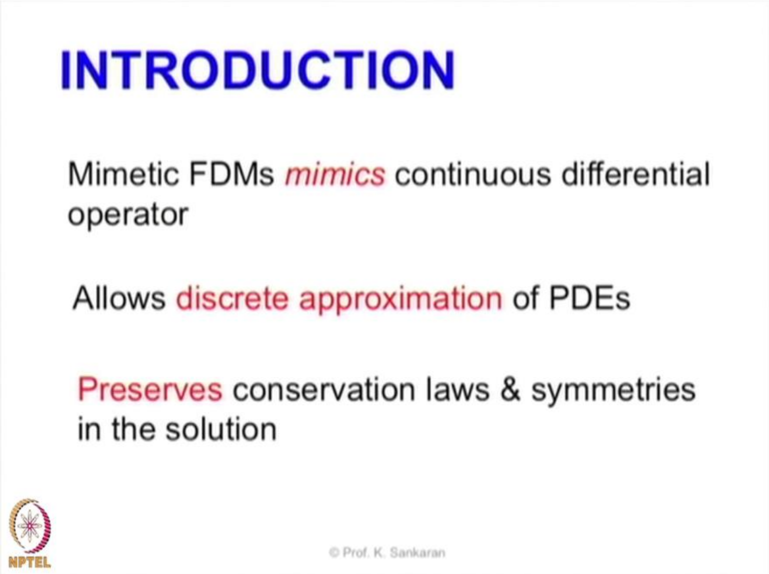

We briefly stated that the mimetic method preserves the conservation laws and the symmetries that are present in the solution .Furthermore the method yields results that are free of spurious modes which is one of the biggest problems in some of the numerical methods such as nodal finite element method.

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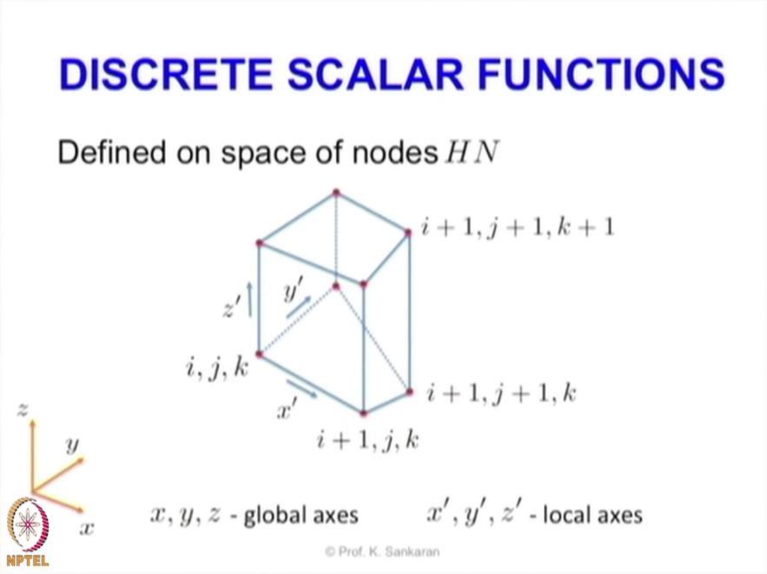

We also discussed briefly that the mimetic method is discrete models identical to algebraic topological formulations on a structured standard grid the mimetic method resembles the standard East finite difference stand on my method.

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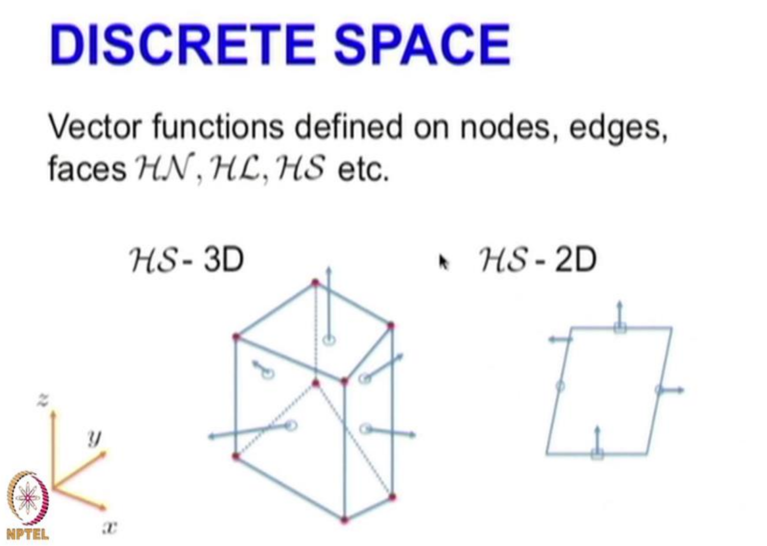

I understand that some of you might find the discussions on mimetic method quite difficult for a course like this however I wanted to introduce this method very briefly for those curious minds who always want something more from a hopes.

We will be happy to share with you some of the reference materials available on this method and also answer your questions about this method.

I very much enjoyed teaching this course and I hope you enjoyed the journey as well.

Thank you!