PEI305: COMPUTATIONAL ELECTROMAGNETIC

L	T	P	Cr
3	1	0	3.5

Course Objectives: To understand the concepts of computational electromagnetics, to enable analysis of numerical stability and dispersion

Overview: Background: The Heritage of the 1980's , The Rise of Partial Differential Equation Methods , Interdisciplinary Impact of Emerging Time-Domain PDE Solvers, History of Space-Grid Time-Domain Techniques for Maxwell's Equations , General Characteristics of Space-Grid Time-Domain Approaches : Classes of FD-TD and FV-TD Algorithms , Predictive Dynamic Range , Scaling to Very Large Problem Sizes : Algorithm Scaling Factors , Computer Architecture Scaling Factors , Defense Applications, Dual-Use Electromagnetics Technology.

One–Dimensional Scalar Wave Equation: Propagating-Wave Solutions , Finite Differences , Finite-Difference Approximation of the Scalar Wave Equation , Dispersion Relations for the One-Dimensional Wave Equation , Numerical Phase Velocity, Numerical Group Velocity, Numerical Stability: The Time Eigenvalue Problem, The Space Eigenvalue Problem, Enforcement of Stability .

Introduction to Maxwell’s' Equations and the Yee Algorithm: Maxwell's Equations in Three Dimensions , Reduction to Two Dimensions : TM Mode, TE Mode , Reduction to One Dimension : TM Mode , TE Mode, Equivalence to the Wave Equation in One Dimension , Yee Algorithm.

Numerical Stability: Basic-Stability Analysis Procedure, TM Mode, Time Eigenvalue Problem, Space Eigenvalue Problem, Enforcement of Stability, Extension to the Full Three-Dimensional Yee Algorithm, Generalized Stability Problem: Boundary Conditions, Variable and Unstructured Meshing, Lossy, Dispersive, Nonlinear, and Gain Materials

Numerical Dispersion: Basic Procedure, Substitution of Traveling-Wave Trial Solution, Extension to the Full Three-Dimensional Yee Algorithm, Comparison with the Ideal Dispersion Case, Reduction to the Ideal Dispersion Case for Special Grid Conditions, Dispersion-Optimized Basic Yee Algorithm, Dispersion-Optimized Yee Algorithm with Fourth-Order Accurate Spatial Central Differences: Formulation, Example, Pros and Cons

Minor Project: Nil

Course learning outcome (CLO): After the completion of the course the students will be able to

1. Apply partial differential equation and time-domain methods for analysis.
2. Use one–dimensional scalar wave equation
3. Handle the concept of maxwell’s' equations and yee algorithm
4. Apply the numerical stability schemes

5. Apply the numerical dispersion techniques.

Recommended Books:

1. *Taflove, A. and Hagness, S.C., Computational Electrodynamics, Artech House (2006).*
2. *Sullivan, D.M., Electromagnetic Simulation Using the FDTD Method, IEEE Computer Society Press (2000).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
	EST	45
	Sessionals (May include Assignments/ Projects/ Tutorials/ Quizes/ Lab Evaluations)	25