NOC:Computational Electromagnetics & Applications - Video course

COURSE OUTLINE

Accurately predicting the behaviour of electromagnetic systems is a key element in developing novel applications. Computational electromagnetics is an interesting domain bridging theory and experiment. This course is for people who are interested in deepening their knowledge about modelling electromagnetic systems and who wanted to build a strong foundation in the underlying physics. In this course, in addition to important modelling techniques widely used for electromagnetic applications, we will also introduce algebraic topology based modelling method which is not widely known to engineering community.

The course is targeted at students and researchers from science, engineering and applied mathematics background who wanted to understand the dynamics of electromagnetic systems. People working in R&D in industries will also benefit from this course. We also use simulations to explain some of the underlying physics and mathematics.

COURSE DETAIL

Week	Topics
1.	**Finite Difference Method (FDM) - I** Lecture 1: Motivation & Background Lecture 2: Finite Differencing – 1 Lecture 3: Finite Differencing – 2 Exercise 1: Laplace Equation Exercise 2: Poisson Equation Exercise 3: Heat Diffusion Equation Lab Tour - 1 Summary
2.	**FDM - II** Lecture 4: Accuracy, Dispersion Lecture 5: Stability, Example Exercise 4 Exercise 5 Exercise 6 Summary
3.	**FDM - III** Lecture 6: Maxwell PDE System Lecture 7: Maxwell FDTD System Lecture 8: Maxwell FDFD System Exercise 7 Exercise 8 Summary
4.	**Boundary Conditions (BCs)** Lecture 9: Introduction Lecture 10: Absorbing Boundary Conditions (ABCs) Exercise 9 Lab Tour - 2 Summary

NP-TEL

NPTEL

http://nptel.ac.in

Electrical Engineering

Pre-requisites:

Vector Calculus ,Partial Differential Equations, Linear Algebra, Basic Electromagnetics

Coordinators:

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5.	**Variational Method (VM)** Lecture 11: Background, Calculus of Variations Lecture 12: Rayleigh-Ritz Method Lecture 13: Method of Weighted Residuals Lecture 14: Galerkin Method, Functional from PDE Exercise 10 Exercise 11 Summary
6.	**Finite Element Method (FEM) - I** Lecture 15: Background, FEM from Weighted Residuals Lecture 16: Formulation (Basis Function, Mapping) Lecture 17: Poisson Equation, Time Domain FEM (FETD) Exercise 12 Exercise 13 Exercise 14 Summary
7.	**FEM - II** Lecture 18: FETD, Examples Exercise 15 Exercise 16 Exercise 17 Lab Tour - 3 Summary
8.	**Method of Moments (MoM)** Lecture 19: Galerkin Method Integral Equation, Integral Equation to Matrix Form Lecture 20: Pocklington Integral Lecture 21: Hallen Integral Convergence Comparison Lecture 22: Antenna Example Exercise 18 Exercise 19 Summary
9.	**Finite Volume Method (FVM) - I** Lecture 23: Motivation and Background Lecture 24: Background Derivation of Eigenvalue Equation Lecture 25: Discretization Maxwell Equation Lecture 26: Flux Calculation: Gudnov, MUSCL, Central Flux, Truly Upwind Scheme Lecture 27: Truly Upwind Scheme, Geometrical Reconstruction Exercise 20 Summary
10.	**FVM - II** Lecture 28: Domain Truncation Techniques Lecture 29: Applications - I Lecture 30: Applications - II Lecture 31: Challenges Exercise 21 Lab Tour - 4 Summary
11.	**Algebraic Topological Method (ATM) - I**

	Lecture 32: Introduction, Motivation, Theoretical Background Lecture 33: Cochains Lecture 34: Boundary Operator Summary
12.	**ATM - II & Mimetic Method** Lecture 35: Coboundary Operator Lecture 36: Space Orientation Lecture 37: Time Orientation Exercise 22 Lecture 38: Introduction to Mimetic Method Lecture 39: Formulation Lecture 40: Comparison to Other Methods (ATM, FDM) Summary Grand Summary

References:

- Davidson, D. B,¸*Computational Electromagnetics for RF and Microwave Engineering*,¸Cambridge University Press, 2005.
- Sadiku, M. N. O,¸*Numerical Techniques in Electromagnetics*, CRC Press, 1992.
- Bondeson, A., Rylander, T., Ingelstr¸m, P.,¸*Computational Electromagnetics*, Springer, 2005.
- Sankaran, K.¸*Accurate Domain Truncation Techniques for Time-Domain Conformal Methods*, ETH Zurich, 2007.¸Weblink: ¸https://www.researchgate.net/publication/282120723_Accurate_domain_truncation_techniques_for_time-domain_conformal_methods