**UNIVERSITY OF ENGINEERING AND TECHNOLOGY**

**MSC. THESIS TOPIC PROPOSAL**

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**Name of Student:**

**Registration No:**

**Registration Date:**

**PART TIME/ FULL TIME:**

**Supervisor**

**[]**

**Department of Electrical Engineering**

**University of Engineering and Technology**

**May 2019**

**Research Title**

**Problem Statement**

Although Multi-Conductor Electric Transmission Lines have been extensively studied, their dual counterpart, Multi-Conductor Magnetic Transmission Lines have received very little attention. Magnetic Transmission Lines are made from a magnetic material with a very high relative permeability, whereas Electric Transmission Lines are made from an electric material with a very high relative permittivity. Magnetic Transmission Lines carry time varying magnetic flux or Magnetic current measured in Volts, whereas Electric Transmission Lines carry electric current measured in Amperes. The magnetic voltage between Magnetic Transmission Lines is measured in Amperes, whereas the voltage between Electric Transmission Lines is measured in Volts. Magnetic Transmission Lines do not involve electric charges, but the Electric Energy is stored in the Electric Field of the dielectric medium.

**Objectives and Aims**

1. Study and compare the Time Domain evolution of Electromagnetic Fields of practical Magnetic Transmission Lines and Electric Transmission Lines.
2. Study and compare the Frequency Domain behavior of Electromagnetic Fields for Magnetic Transmission Lines and Electric Transmission Lines.
3. Study Cross Talk between Multi-Conductor Transmission Lines.
4. Develop Power Flow Equations for Magnetic Transmission Lines in terms of Lumped parameters.
5. Carry out Simulations to study the effects of strong Magnetic Transmission Line fields on humans.

**Literature Survey**

**Methodology**

1. Carry out Finite Difference Time Domain Electromagnetic Field Simulations in MEEP of lossy Magnetic Transmission Lines and Electric Transmission Lines in anisotropic, inhomogeneous, non-liner media. This will help to probe their similarities and differences, stored Electric/ Magnetic Energy Density, geometric parameters, per unit length losses and Transmission Efficiency.
2. Carry out Finite Difference Frequency Domain Electromagnetic Field Simulations in MEEP for Decomposition of Fields into Eigenmodes. The multi-dimensional Laplace transform will be used for the transformation. The frequency Domain Behavior will also be studied using Transfer Function of Equivalent T circuit model.
3. Carry out MATLAB Lumped Circuit Simulations for cross talk between Multi-Conductor Transmission Lines. The Transient responses will also be studied using the T-model Equivalent circuits.
4. Develop Power Flow Equations for Magnetic Transmission Lines in terms of Lumped parameters.
5. Carry out Finite Difference Time Domain Electromagnetic Field Simulations in MEEP for Magnetic Transmission Lines to study safety of operation and the effects of strong fields on humans.

**Experimentation**

MEEP is a script based Finite Difference Time Domain Electromagnetic Fields Simulator for solving Maxwell’s Equations. The C++ interface has the features of variable resolution and normalized units. Each spatial unit is modeled as a Yee’s Cell. This is ideal for modeling nonlinear, anisotropic, inhomogeneous media. Also, sample data for several materials is provided in libraries for building accurate test structures. The space is divided into different chunks so that the program can be run on supercomputers and parallel processors. The boundaries can be modeled as perfectly matched layers to prevent reflection of fields at boundaries. Hence, a wide variety of electric or magnetic current sources can be simulated. The program is solved for all E, H, D and B field components. Many derived components can be evaluated like Curl, Divergence, Energy Density, Potential, Flux, Poynting vector etc. Several Mathematical operations like averaging, symmetry and integration over a line, surface or volume are allowed in cylindrical and rectangular coordinates. The fields can be printed as image or video files as well. A frequency domain solver is also provided for multidimensional Laplace transformation and the decomposition of fields into Eigenmodes.

**Experimental Setup**

**Results Expected and Method of Analysis**

**References**

[1] A. Oskooi, D. Roundy, M. Ibanescu, P. Bermel, J.D. Joannopoulos, and S.G. Johnson, MEEP: A flexible free-software package for electromagnetic simulations by the FDTD method, Computer Physics Communications, Vol. 181, pp. 687-702, 2010 (pdf).

[2] A. Taflove and S.C. Hagness, Computational Electrodynamics: The Finite-Difference Time-Domain Method, Artech: Norwood, MA, 2005.

[3] Jose A. Brandao Faria, Formulation of Multiwire Magnetic Transmission-Line Theory, Progress in Electromagnetics Research B, Vol. 49, 177–195, 2013.

[4] J.A. Brandao Faria, Matrix theory of wave propagation in hybrid electric/magnetic multiwire transmission line systems, Journal of Electromagnetic Waves and Applications, 2015 Vol. 29, No. 7, 925–940.

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In-text: (Paul, Whites and Nasar, 1998)