University of Waterloo
ECE 675 Course Outline, Fall 2022

Term and Year of Offering: Fall 2022

Course Number and Title: ECE 675, Radiation and Propagation of Electromagnetic Fields

Lecture Times, Building and Room Number: TBA

Instructor's Name, Office Location, Office Hours, Contact: Omar M. Ramahi, EIT 4154
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Course Description:
This course is intended to lay the foundation for advanced studies in all fields of electromagnetics. The course starts with a generalized treatment of transmission lines using Green' function theory. The wave phenomenon is then presented with focus on primary characteristics of the wave including dispersion. Current sheets are presented as a mathematical tool to generate arbitrary waveforms including specific modes in waveguiding structures. The scattering phenomenon is then introduced through scattering from multi-layered simple and complex (anisotropic) media. Throughout this course, emphasis will be placed on the admissibility of solutions to the wave equation in the presence of boundaries and media with relevance to surface waves and plasmonics. The course concludes with key electromagnetic theorems and wave transformation techniques.

Course Objectives: At the end of the course you should be able to:

1. Understand the concept of Green's function, especially as it relates to time-harmonic electromagnetic fields
2. Formulate the problem of scattering and refraction from multi-layer media
3. Understand the dispersion relationship arising from Maxwell equations
4. Be able to formulate the radiation/scattering problems in terms of spatial harmonics
5. Understand the fundamental concepts behind radiating systems such as antennas and apertures
6. Understand the concept of surface waves
7. Understand and formulate problems of wave propagation in isotropic and anisotropic media and the concept of backward waves and negative and positive media
8. Understand the concept of waveguiding structures
9. Understand the basic construction of the electromagnetic radiation/scattering problem in non-Cartesian coordinates such as cylindrical and spherical coordinates, and understand the concept of cylindrical and spherical harmonics
10. Understand basic electromagnetic theorems

Required Text: Lecture Notes (provided)

Topics to be covered in Lectures:

Date	Lecture Topic
Week 1:	Introduction and review of Maxwell equations
Week 2:	Material properties, power concepts and wave-matter interaction
Week 3:	Dispersion relationship and spatial harmonics
Week 4:	Radiation from infinite and finite sources
Week 5:	Scattering and refraction from multi-layer structures
Week 6:	Transverse Resonance, surface waves and plasmonics
Week 7:	Radiating systems and antennas
Week 8:	Propagation through isotropic and anisotropic media
Week 9:	Waveguides in Cartesian coordinates
Week 10:	Eigenvalue problems in electromagnetics
Week 11:	Cylindrical harmonics
Week 12:	Electromagnetic theorems
Week 13:	Advanced Topics

Evaluation: The course grade will be based on approximately eight homework assignments, a paper review, and a final examination. The breakdown is as follows:
Assignments 30%
Paper Review/project 20%
Final Examination 50%