

**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, [REDACTED]  
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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's 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%