Antennas and Propagation: Course Book

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Google Class Code: fthwmru

Prerequisites

The prerequisites of this course include (but not limited to) the following:

- A good understanding of the theory of static electric and magnetic fields.
- The ability to solve mathematical equations using basic algebra, in addition to solving moderately difficult integrals using basic calculus.
- Medium level English language.

Learning Objectives

This course aims to help the students understanding the basics of electromagnetic wave propagation through different types of media. In addition, the course includes a details description of the Antenna theory and applications.

By the end of this course, the student should be able to analyze the propagation of a plane wave through any medium. The student should also be able to design simple antennas, and choose the appropriate antenna for any application.

Course Contents

Subject	**Details**	**Duration (Hours)**
Introduction to Antennas and Propagation	Introducing the course and highlighting the importance of studying the propagation phenomena and the antenna design and implementation.	2
A review of static fields	Reviewing the basic concepts of static electric and magnetic fields	6
Time-varying electromagnetic fields and Maxwell's equations	Faraday's law, Displacement Current, Maxwell's equations in Point Form, Maxwell's equations in Integral form, The Retarded Potential.	8
The Uniform Plane Wave	Wave Propagation in Free Space, Wave Propagation in Dielectrics, The Poynting Vector and Power Considerations, Propagation in Good Conductors: Skin Effects, Wave Polarization.	10
Plane Waves at Boundaries and in Dispersive Media	Reflection of Uniform Plane Wave at normal incidence, Standing wave ratio, Wave reflection from multiple interfaces, Plane wave propagation in general directions, Plane wave reflection at oblique incidence angles, Wave propagation in dispersive media.	8
Fundamental Parameters of Antennas	Radiation pattern, Radiation power density, Radiation intensity, Beamwidth and directivity, Antenna efficiency and gain, Beam efficiency, Antenna radiation efficiency.	6

Radiation Integrals and Auxiliary Potential Functions	The vector potential A for an electric current source J, The vector potential F for a magnetic current source M, Electric and magnetic fields for Electric (J) and magnetic (M) current sources, Solution of the inhomogeneous vector potential wave equation, Far-field radiation, Duality theorem.	8
Linear Wire Antennas	Infinitesimal dipole, Small dipole, Region separation, Finite length dipole, Half-wavelength dipole, Linear elements near or on infinite perfect conductors, Ground effects.	6
Loop Antennas	Small circular loop, Circular loop of constant current, Circular loop with nonuniform current, Ground and earth curvature effects for circular loops, Mobile communication systems applications	8
Array Antennas	Two-element array, N-element linear array, Design procedure, Superdirectivity, Planar array	6
Propagation in Ionosphere	HF, VHF, UHF, and SHF	4
Line of Sight Transmission	Equation of line of sight, curvature of earth, Tropospheric propagation, Scatter propagation	8

Marks Distribution

Generally speaking, the marking of this course will be distributed as follows:

- **30%** Calculated from different tests and homework assignments given during the course.
- **70%** Final Exam (it might include a technical report as well).

Contacting the Lecturer

The lecture will take place in the Microwaves laboratory every Sunday at 10:00am and every other Wednesday at 02:00pm. I am available to answer your questions at any time in the same laboratory or in my office (on the first floor, directly across from your classroom). Alternatively, you can send your questions via email to the address written on the first page of this document and I will reply as soon as I can.

Textbooks and References

Below is a list of books that will be the base of most lecture notes for this year. A soft copy of each book will be available in the google classroom page.

1. Wentworth, Stuart M. *Applied Electromagnetics*. First Edition, 2007.
2. Hayt, William Hart, and John A. Buck. *Engineering electromagnetics*. Vol. 6. New York: McGraw-Hill, 2001.
3. Stutzman, Warren L., and Gary A. Thiele. *Antenna theory and design*. John Wiley and Sons, 2013.
4. Constantine, A. Balanis. *Antenna theory: analysis and design*, third edition, John wiley and sons, 2005.
5. Kraus, John D. *Antennas*, 1988.