ECE 6345
MICROSTRIP ANTENNAS

Spring 2011

Class Number 21450

Class Time: Tu, Th 4:00-5:30 p.m., E223-D3

Instructor: David R. Jackson, Room W318-D3 (713-743-4426, djackson@uh.edu)

Class Website: http://www.egr.uh.edu/courses/ece/ece6345/web/welcome.html

Texts

Copies of the class lecture notes will be placed on the class webpage as they are developed. You are encouraged to download them and use them to make your own unofficial "textbook."

In addition, three recommended texts that make excellent supplementary reading are:

- *Microstrip Patch Antennas*, by Kai Fong Lee and Kwai Man Luk, Imperial College Press, 2011.
- *Microstrip Patch Antenna Design Handbook*, by R. Garg, P. Bhartia, I. Bahl, and A. Ittipiboon, Artech House, 2001.
- *Microstrip Patch Antennas: A Designer's Guide*, by Rodney B. Waterhouse, Kluwer Academic Publishers, 2003.

Grading Policy

The grading will be based on homework assignments and a class project. Many of the homework assignments will involve numerical calculations, implementing the methods discussed in class. The homework will be placed on the class website. Tentatively, 75% of the class grade will be based on the homework, and 25% on the class project.

Tentative Course Outline

Introduction to Microstrip Antennas

- IEEE AP-S Short Course (Rodney B. Waterhouse)
- Short course notes by David R. Jackson

Basic Concepts

- CAD model of microstrip antenna
- Q of a microstrip antenna
- Impedance bandwidth of microstrip antenna

- ◊ Circular polarization (CP)
- ◊ Impedance and axial-ratio bandwidth of CP microstrip antenna
- ◊ Q components: dielectric, conductor, space-wave, and surface-wave
- ◊ Radiation efficiency and its relation to the Q factors

Probe Inductance Formulas

- ◊ Uniform current
- ◊ Cosine current
- ◊ Gap source
- ◊ Magnetic Frill
- ◊ Image correction for patch effects

Radiation Models

- ◊ Review of the equivalence principle
- ◊ Radiation models for microstrip antennas (electric and magnetic current models, infinite-substrate and truncated-substrate models)
- ◊ Electric and magnetic current models for rectangular patch
- ◊ Electric and magnetic currents models for circular patch

Far-Field Patterns and Radiated Power for Rectangular Patch

- ◊ Far field of infinitesimal electric dipole on substrate
- ◊ Far Field using electric current model for rectangular patch
- ◊ Far field of infinitesimal magnetic dipole inside substrate
- ◊ Far field using magnetic current model for rectangular patch
- ◊ Radiated power of rectangular patch (using electric current model)
- ◊ CAD formula for radiated power
- ◊ CAD formula for space-wave Q
- ◊ CAD formula for directivity

Far-Field Patterns and Radiated Power for Circular Patch

- ◊ Far field using magnetic current model for circular patch
- ◊ Radiated power of circular patch (using magnetic current model)
- ◊ CAD formula for radiated power
- ◊ CAD formula for space-wave Q
- ◊ CAD formula for directivity

Spectral-Domain Analysis

- ◊ Spectral-Domain Immitance (SDI) method
- ◊ Fields of an infinitesimal electric dipole on a substrate
- ◊ Surface-wave power of an infinitesimal dipole
- ◊ Radiation efficiency of an infinitesimal dipole
- ◊ CAD formula for radiation efficiency of an infinitesimal dipole
- ◊ Radiation efficiency of a rectangular patch

Input Impedance Models

- ◊ RLC circuit model
- ◊ Transmission line model
- ◊ Cavity model (eigenfunction expansion)
- ◊ Cavity model (mode matching)
- ◊ Moment-method solution with filamentary probe feed

Other possible topics, if time permits:

Input Impedance for arbitrary-shaped patches

- ◊ Segmentation/desegmentation methods
- ◊ Method of moments in the space domain

Mutual Coupling

- ◊ Mutual coupling between two patch antennas using the SDI method
- ◊ Lateral-wave and surface-wave coupling

Finite Array Analysis

- ◊ Phased array principles
- ◊ Grating lobes and scan blindness
- ◊ Scan input impedance
- ◊ Effects of mutual coupling
- ◊ Scan element pattern

Infinite Array Analysis

- ◊ SDI method for periodic structures
- ◊ Relation between active element pattern and array properties

Other Possible Topics

- ◊ Reduced Surface Wave (RSW) antennas
- ◊ Other types of Printed Circuit Antennas (PCA) such as printed log-periodic antennas, printed spiral antennas, etc.
- ◊ EBG materials and metamaterials