ECE 6345
MICROSTRIP ANTENNAS

Fall 2024

Class Number 24999

Class Time: M, W 5:30-7:00 p.m., E220-D3

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

Canvas Site

Canvas will be used to distribute all information in the class. This includes the class notes, the homework, the class project, handouts, etc. Please read the announcements section of the Canvas site often, as you are responsible for any announcements that are placed here.

Class Notes

Copies of the class lecture notes will be placed on the class Canvas site as they become available. You are encouraged to download them and use them to make your own unofficial "textbook." Please note that the class notes are subject to change until after they have been completely presented in class.

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

- ◊ *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.
- ◊ *Microstrip and printed Antenna Design,* by Randy Bancroft, Scitech, 2009.
- ◊ *Microstrip Patch Antennas*, by Kai Fong Lee and Kwai Man Luk, Imperial College Press, 2011.

Please note that the class material from the last time this class was taught (Spring 2015) are available on the Engineering webserver: http://courses.egr.uh.edu/ECE/ECE6345

MathType

MathType is used to make all the equations in the class PowerPoint notes. It is strongly recommended that you download MathType to your computer, so that the fonts used for symbols and equations in the class notes will appear correctly. The College of Engineering has a site license for MathType, and you may obtain a copy of it by filling out and submitting the form that is found at this link: https://forms.office.com/r/sd0agNuawV. Also, please note that the

pdf version of the class notes will usually be less susceptible to font problems than the Word version (both versions are posted on the Canvas site).

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. Tentatively, 75% of the class grade will be based on the homework, and 25% on the class project.

Homework

The homework will be placed on the class Canvas site. Students are expected to work on the homework individually. Having general discussions with fellow students about the concepts in the course is fine, but what you turn in on the homework should be completely your own work.

Tentative Course Outline

Introduction to Microstrip Antennas

- ◊ IEEE AP-S Short Course (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

- ◊ Parallel-plate models (uniform current, cosine current, frill model)
- ◊ Cavity model

Radiation Models

- ◊ Review of the equivalence principle
- ◊ Radiation models for microstrip antennas (infinite and truncated substrates)
- ◊ 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 formulas for rectangular patch

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 formulas for circular patch

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)
- ◊ Full-wave methods (HFSS, CST)

Mutual Coupling

- ◊ Mutual coupling between patch antennas
- ◊ Lateral-wave and surface-wave coupling

Array Analysis

- ◊ Phased array principles
- ◊ Grating lobes and scan blindness
- ◊ Scan input impedance