Universidad Nacional de Colombia
Engineering Faculty
Electric and Electronics Engineering Department

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Transmission Lines and Antennas (2016503)
Groups 1-2, 2012-3
Course syllabus

Objectives

At the end of the course the student will be able to:

1. Describe qualitatively and quantitatively the transmission, propagation (both in bounded and unbounded media), and reception of electromagnetic waves and determine relevant parameters such as wave polarization, power and efficiency.
2. Analyze and design physical transmission lines, waveguides and antennas for practical applications using paper calculations and computer simulation at varying levels of accuracy.
3. Design and implement microstrip lines and antennas and characterize their performance using the vector network analyzer.

Course Subjects

1. INTRODUCTION - REVIEW OF BASIC CONCEPTS
   (a) Maxwell's equations.
   (b) Boundary conditions.
   (c) Plane waves in free space and material media, skin depth for good conductors, surface impedance.
   (d) Plane wave parameters: propagation constant, phase velocity, wavelength, polarization.
   (e) Reflection and transmission of plane waves at material interfaces, Brewster angle, total reflection, surface waves.
   (f) Poynting Theorem, power balance.
2. TRANSMISSION LINE THEORY
   (a) Lumped-element model for transmission lines.
   (b) Terminated transmission lines, special cases.
   (c) Lossy transmission lines, distortionless lines, perturbation method.

(d) The Smith Chart, impedance and admittance chart.
(e) Impedance matching with lumped elements and with stubs.
(f) Microwave network analysis: the scattering matrix, the transmission matrix.
(g) Network properties from S-matrix.

3. PHYSICAL TRANSMISSION LINES AND WAVEGUIDES
   (a) Guided waves: TE, TM and TEM waves.
   (b) Dielectric and conductor loss in guided waves.
   (c) Rectangular waveguide.
   (d) Coaxial line.
   (e) Printed lines: stripline and microstrip.
   (f) Guided waves in dielectric slabs.
   (g) Phase and group velocity.

4. INTRODUCTION TO RADIATION AND ANTENNAS
   (a) Antenna definition, dual behavior radiation pattern-input impedance.
   (b) Antenna parameters: directivity, gain, bandwidth, effective area, vector length.
   (c) Antenna field regions.
   (d) Friis equation and applications.
   (e) Introduction to radiation, electrodynamic potentials and radiation integral, infinitesimal sources.
   (f) Antenna arrays.
   (g) Wire antennas.
   (h) Microstrip antennas.

Grading system

The course is composed of a theoretical part and a practical part. Grades are computed based on five indicators, three related to theory (two exams and oral presentations) and two to practice (designs):

- First exam: 20%
- Second exam: 20%
- Final exam: 20%
- Two Projects: 15% each
- Home assignments/ participation in class: 10%. This is to be chosen from:
  - Expositions
  - Written report
  - Exams

References

[1] R. E. Collin, *Foundations of Microwave Engineering.* IEEE press, 2001.

[2] R. S. Elliot, *Antenna Theory and Design.* IEEE press, 2003.

[3] D. M. Pozar, *Microwave Engineering.* John Wiley & sons, 1998.

[4] C. A. Balanis, *Antenna Theory: Analysis and Design*, 3rd ed. Wiley-Interscience, April 2005.

[5] J. D. Kraus, *Antennas.* McGraw-Hill Education, May 1988.

[6] S. Ramo, J. R. Whinnery, and T. V. Van Duzer, *Fields and Waves in Communication Electronics.* Wiley, January 1994.

[7] M. N. Sadiku, *Elements of Electromagnetics (4th ed.).* Oxford University Press, 2006.