EE 306 – Introduction to Radio Frequency and Microwave Design
Sabanci University
Spring 2021

Instructor: Ilker Kalyoncu, ikalyoncu@sabanciuniv.edu
Office Hours: Appointment
Teaching Asst: Tahsin Alper Ozkan, talper@sabanciuniv.edu
Grading Policy: Homework 20%, Midterm 20%, Projects 30%, Final 30%
Lectures: Monday 13:40-16:30, Online (Zoom)
Recitations: Tuesday 17:40-19:30, Online (Zoom)

Tentative Outline

Date	Topic	Bretchko	Pozar
Feb 22	Intro	Ch. 1.1-1.5	Ch. 1.1-1.4
Mar 1 Mar 8	Transmission lines	Ch. 2.1-2.3, 2.6-2.11	Ch. 2.1, 2.3-2.8 Ch. 3.5, 3.7, 3.8, 3.10
Mar 15 Mar 22	Smith Chart and matching networks	Ch. 3.1-3.4 Ch. 8.1-8.2	Ch. 2.4 Ch. 5.1-5.5
Mar 29 Apr 5	Two port networks, S-parameters	Ch. 4.1-4.4	Ch. 4.2-4.6
Apr 12 Apr 19	Amplifier design, stability	Ch. 9.1-9.5, 9.7	Ch. 12.1-12.5
Apr 26	Extra …	-	-
May 3	Dividers and couplers	App. G	Ch. 7.1-7.3, 7.5-7.8
May 10	Holidays		
May 17	Noise and distortion	App. H	Ch. 10.1-10.4
May 24	Extra …	-	-

Project 1 Quarter-wave transformer (around the midterm)
Project 2 Transistor amplifier at 1 GHz (towards the end of the term)

I will not strictly follow any textbook. You have to attend the lectures and take notes. You will be responsible from the material covered in the lectures. However, the following two texts are recommended.

- RF Circuit Design, Theory and Applications by R. Ludwig & P. Bretchko.
- Microwave Engineering by David M. Pozar.

In some recitation sessions, there will be demos and/or you will learn how to use the RF equipment (network analyzer, spectrum analyzer, etc.) and simulation tools (ADS), in addition to regular problem-solving sessions.

The midterm will be held in early April.

Bretchko, RF Circuit Design: Theory and Applications, 2000

1. INTRODUCTION
   - 1.1. Importance of radio frequency design
   - 1.2. Dimensions and units
   - 1.3. Frequency spectrum
   - 1.4. RF behavior of passive components
   - 1.5. Chip components and circuit board considerations
2. TRANSMISSION LINE ANALYSIS
   - 2.1. Why transmission line theory
   - 2.2. Examples of transmission lines
   - 2.3. Equivalent circuit representation
   - 2.6. Summary of different line configuration
   - 2.7. General transmission line equation
   - 2.8. Microstrip transmission lines
   - 2.9. Terminated lossless transmission lines
   - 2.10. Special termination conditions
   - 2.11. Sourced and loaded transmission line
3. THE SMITH CHART
   - 3.1. From reflection coefficient to load impedance
   - 3.2. Impedance transformation
   - 3.3. Admittance transformation
   - 3.4. Parallel and series connections
8. MATCHING AND BIASING NETWORKS
   - 8.1. Impedance matching using discrete components
   - 8.2. Microstrip line matching networks
4. SINGLE AND MULTIPORT NETWORKS
   - 4.1. Basic definitions
   - 4.2. Interconnecting networks
   - 4.3. Network properties and applications
   - 4.4. Scattering parameters
9. RF TRANSISTOR AMPLIFIER DESIGNS
   - 9.1. Characteristics of amplifiers
   - 9.2. Amplifier power relations
   - 9.3. Stability considerations
   - 9.4. Constant gain
   - 9.5. Noise figure circles
   - 9.7. Broadband, high-power, and multistage amplifiers
G. COUPLERS
H. NOISE ANALYSIS

Pozar, Microwave Engineering, 2012

1. ELECTROMAGNETIC THEORY
   - 1.1. Introduction to microwave engineering
   - 1.2. Maxwell's equations
   - 1.3. Fields in media and boundary conditions
   - 1.4. The wave equation and basic plane wave solutions
2. TRANSMISSION LINE THEORY
   - 2.1. Lumped-element circuit model for a transmission line
   - 2.3. The terminated lossless transmission line
   - 2.4. The Smith Chart
   - 2.5. The quarter wave transformer
   - 2.6. Generator and load mismatches
   - 2.7. Lossy transmission lines
   - 2.8. Transients on transmission lines
3. TRANSMISSION LINES AND WAVEGUIDES
   - 3.5. Coaxial line
   - 3.7. Stripline
   - 3.8. Microstrip line
   - 3.10. Wave velocities and dispersion
5. IMPEDANCE MATCHING AND TUNING
   - 5.1. Matching with lumped elements (L-networks)
   - 5.2. Single-stub tuning
   - 5.3. Double-stub tuning
   - 5.4. The quarter-wave transformer
   - 5.5. The theory of small reflections
4. MICROWAVE NETWORK ANALYSIS
   - 4.2. Impedance and admittance matrix
   - 4.3. The scattering matrix
   - 4.4. The transmission (ABCD) matrix
   - 4.5. Signal flow graphs
   - 4.6. Discontinuities
12. MICROWAVE AMPLIFIER DESIGN
   - 12.1. Two-port power gains
   - 12.2. Stability
   - 12.3. Single-stage transistor amplifier design
   - 12.4. Broadband transistor amplifier design
   - 12.5. Power amplifiers
7. POWER DIVIDERS AND DIRECTIONAL COUPLERS
   - 7.1. Basic properties of dividers and couplers
   - 7.2. T-junction power divider
   - 7.3. Wilkinson power divider
   - 7.5. Quadrature 90deg hybrid coupler
   - 7.6. Coupled line directional couplers
   - 7.7. Lange coupler
   - 7.8. The 180-deg hybrid
10. NOISE AND NONLINEAR DISTORTION
   - 10.1. Noise in microwave circuits
   - 10.2. Noise figure
   - 10.3. Nonlinear distortion
   - 10.4. Dynamic range