

EE 710

Microwave Circuits

Fall 2006

Required Text: *Microwave Engineering*, David Pozar, Addison Wesley, 3rd edition.

Instructor: Patrick Roblin 292-0998
Room 379 Caldwell Lab

Office Hours: To be posted on the class webpage.
Use email for simple questions: roblin@ee.eng.ohio-state.edu

Class Web Page: <http://eewww.eng.ohio-state.edu/~roblin/ee710.html>
Username: ee710 Password: sp2006

Course Plan:

| Lectures | Chapter | Topic |
|-------------------------|---------|-----------------------------------|
| Mar 27 | 1 | Introduction |
| Mar 29, 31, Apr 3, 5 | 2 | Transmission lines (review) |
| Apr 7, 10, 12, 14, 17 | 3 | Broadband impedance matching |
| Apr 19, 21, 24, 26 | 4 | Scattering parameters |
| Apr 28, May 1, 3, 5, 8, | 5 | Passive devices components |
| May 10, 12, 15, 17, | 6 | Resonators and narrowband filters |
| May 19, 22, 24, 26 | 7 | Broadband filters |
| May 31, June 2 | 2 | Presentation of Design Projects |

Grading Scheme: HW 1/4
Laboratory 1/4
Midterm 1/4
Take Home Final 1/4

- **Homework** will be assigned in class
 - Homework # 1 is due **April 7**
 - Homework # 2 is due **April 19**
 - Homework # 3 is due **April 28**
 - Homework # 4 is due **May 8**
- **Midterm** is May 3, closed book and closed notes — 1 crib sheet allowed.
- **Final Exam** will be a take home distributed May. 19 and due June 6 at 12:00 PM (noon).

All examinations in this course will be administered in accordance with the EE Honor System. If you have a question about the EE Honor System, contact your instructor or a member of the EE Student Council at:

<http://www.service.ohio-state.edu/students/EESC/>

Lecture Topics Covered in EE 710

1. **Introduction**
2. **Transmission Line Theory** (Review) (Chapter 3 in Pozar)
 - 2.1 Introduction
 - 2.2 Transmission line equations
 - 2.3 Transmission line circuit theory
 - 2.4 Reflection coefficients and Smith Chart
 - 2.5 Applications of the Smith Chart
 - 2.6 Voltage standing wave ratio
3. **Broad Band Impedance Matching** (Chapter 5 in Pozar)
 - 3.1 The quarter-wave transformer
 - 3.2 Multi-section transformer
 - 3.3 Maximally flat (binomial) transformer
 - 3.4 Chebyshev transformer
 - 3.5 Non-uniform transmission line
 - 3.6 Richard's synthesis theorem (handouts)
4. **Scattering Parameters** (Chapter 4 in Pozar)
 - 4.1 Impedance matrix (Collin 4.5)
 - 4.2 Scattering parameters
 - 4.3 Passive reciprocal loss-less two-port junctions (Collin 4.8)
 - 4.4 General two-ports
 - 4.5 Power gain/loss
 - 4.6 Signal flow graph
 - 4.7 Transducer power gain/loss
 - 4.8 ABCD parameters
5. **Passive Components (and Applications)** (Chapter 7 in Pozar)
 - 5.1 1 & 2 Port passive components
 - 5.2 Tees
 - 5.3 Circulator
 - 5.4 Power divider
 - 5.5 Directional coupler
 - 5.6 Rat race and branch line couplers
 - 5.7 Coupled lines
6. **Microwave Resonators and Narrowband Filters** (Chapter 6 in Pozar)
 - 6.1 Review of resonant circuits
 - 6.2 Direct-coupled and capacitively coupled resonators
 - 6.3 Narrowband bandstop filters
 - 6.4 Narrowband bandpass filters
 - 6.5 Multisection bandpass filters
7. **Broadband Filters** (Chapter 8 in Pozar)
 - 7.1 Darlington's insertion loss filter synthesis
 - 7.2 Richard's transformation and applications
 - 7.3 Kuroda identities and applications
 - 7.4 Coupled line realization (bandstop filters) (handout)
 - 7.5 Design of a coupled-line bandpass filter.

EE 710 Adjunct Microwave Laboratory

The EE 710 Adjunct Microwave Laboratory is designed to run in parallel with EE 710. The time commitment is estimated to be in average two to three hours a week (including preparation).

Laboratory Manual: A Laboratory manual describing the laboratory and a network analyzer manual are posted in the class web page. Only print the lab section of the manual. The labmanual can be browsed electronically in the lab computers.

Lab Assistant: Cui Xian (Sam)
Email: cuix@ee.eng.ohio-state.edu
Room: CL367 Caldwell Lab

Office Hours: to be posted on the class webpage

Laboratory Plan:

Lab 1: Microwave Measurements of 1 port devices.

Lab 2: Microwave Measurements of 2, 3, and 4 port devices.

Lab 3: Design, fabrication, and testing of a distributed microwave circuit. To ensure a variety of design projects, the number of teams per types of devices (e.g., transformer, coupler, and so on) is limited to two.

| <u>Due Date</u> | <u>Lab #</u> | <u>Delivery</u> |
|-----------------|--------------|-----------------------|
| April 5 | 1 | Report |
| April 17 | 2 | Report |
| May 5 | 3 | 1 page proposal |
| May 8-10 | 3 | Layout approval by TA |
| May 10-12 | 3 | Final layout delivery |
| May 26 | 3 | Report & Poster |
| May 31 June 2 | 3 | Presentations |

A short **Laboratory Report** is due for each lab and will be turned in by the specified due date. A few guidelines are given below:

- Include on the first page: Laboratory # and student name.
- Include a table of contents showing the organization of your report.
- Write a caption on each figure and plot.
- Discuss any problems encountered.

The reports should be typed to improve clarity. The reports do not need to be long, just well organized. Include a summary describing the goal of the laboratory, your experience, and suggest some improvements for the lab (we will welcome your help too). To encourage team work, only one report per team is expected.

The result of the Design Project (Laboratory 3) will be presented orally. A single page/poster summarizing your team results should be distributed to the class. The poster will be displayed on the Caldwell/Dreese bridge. PDF copies of the design proposal, poster and final report need also to be emailed to the TA for posting on the class webpage. Previous reports are available in the class webpage for consultation.

Grading Scheme:

- Lab 1 Report 1/4
- Lab 2 Report 1/4
- Lab 3 Report 1/4
- Lab 3 Poster 1/4

EE 710 — Laboratory Policy

1. A sign-up sheet will be placed on the door of Room 305 Caldwell Lab. Schedule your fabrication and measurement time at least one day in advance; you can reserve up to 2 hours per day, twice a week. Open time is, however, available on a first come, first served basis if the time slot has not been reserved.
2. Read your Laboratory Manual and make a plan of work before coming to the lab.
3. You can obtain the laboratory key against your ID card at the front desk of the EE Department (Room 205 Dreese Lab). (The receptionist should check that you are on the EE 710 class Roster; remind him/her to do so!)
4. **Make sure that the laboratory door is CLOSED when you leave the room – even for a short period!** The key holder is responsible for the material, turning off equipment and lights, and *closing the door* when done.
5. Care for the measurement cables and connectors (refer to Appendix G of your Laboratory Manual) and the equipment in general. The measurement will be made using SMA terminated coaxial test cables. Do Not disconnect the SMA/coaxial test cables from the Network Analyzer.
6. Read soldering, drilling, and cutting tips in the Appendices D, E, and F of your Laboratory Manual to insure a proper use of the tools and to assure your protection. If you are uncomfortable with a particular laboratory procedure request help from the Instructor.
7. Report damage or malfunction immediately.

Honor Rule: I have read the laboratory regulations and agree to abide by them. I take responsibility for my acts and will not take part in dangerous behavior endangering myself or others.