

# **ECE 301 Transmission Lines & Networks Laboratory**

## **Spring 2004**

**Lecture & Laboratory** : TA: Christopher “Mark” Denning  
Email: cmdenning@wisc.edu

**Rooms** : Lecture 3444 EH (Time : 12:20 – 1:10 every other Tuesday)  
Laboratory 3546 EH (Time : 2:25 – 5:25 every other Tuesday)  
Office Hours: 502 ERB (Time : Friday 1-2pm)

**Supervising Professor**: Professor Ronald Vernon (3546A EH, vernon@enr.wisc.edu)

### **Introduction**

This lab is primarily about electromagnetic transmission systems. The emphasis will be on transmission lines and transmission line concepts but much of the material will apply to any EM propagation problems.

All of the material in the class, including homeworks and the final exam, is prepared and presented by the TA.

### **Homework and Labs**

On every other Tuesday I will give a presentation about the upcoming lab and pass out handouts. The handouts will include the lab procedure, notes on the theoretical background of the labs, and prelab homework. The following Tuesday I will collect any prelab assignments at the beginning of the lab. It is important to be well prepared for lab by completing the prelab homework and thoroughly reading the theoretical notes. Your lab will go much more smoothly if you are well prepared. Lab reports are due at the beginning of the next Tuesday lecture after the experiment is performed. One point per day will be counted off for any late labs. A short extension may be granted if you come to me before the labs are due with a good excuse. Since I will be discussing the lab results from one lab at the next lab, I will not accept any reports later than 2:25 on Tuesday of the next lab.

In lab courses total final grades are often grouped fairly closely together so losing points on late labs can be very detrimental. Lab reports are to be done on a word processor and graphs should be done on a graphical software package or very neatly done on graph paper. Answer all the questions in the lab procedure thoroughly. Start doing the lab write-up early so that if you have any questions you can give me time to respond. I may not answer all questions but I will make a reasonable effort to respond to e-mail. The quality of your lab reports will be the most important factor when determining your final grade.

Working together on the lab reports will increase your efficiency and can increase your understanding of the material through discussion. However, each individual must participate in the experiments, think for themselves, and hand in their own homework and reports. Although group work is encouraged to an extent, I expect each individual student to provide their own analysis and conclusions in their lab report.

I also want to encourage people to become as familiar as possible with the equipment. By the end of this semester you should be able to use most of the common functions of an oscilloscope, understand and be able to use a VSWR meter, and be familiar with various probes, generators, amplifiers, and other equipment used in the lab.

### **Grading**

Each lab report = 10%	60%
Final Exam (1hr, written)	20%
Lab preparation & lab performance	10%
Homework	10%

### **Lab Report Format (Total 10 points.)**

Title page with experiment name and number, your name and date of experiment.

(2 points) Lab procedure and steps in your own words, along with answers to any questions in the lab procedure.

(5 points) Data/Analysis: Data obtained in experiment, with analysis, organized logically. Include graphs and tables.

(3 points) Conclusion: Include theoretical concepts verified, and discrepancies between measured and theoretical values with possible causes. (Very important)

## **Tentative Schedule for ECE 301**

### **Experiments:**

#### **1. Low Pass Filters**

**Lec: Jan 20    Lab: Jan 27**

**HW** : Graphing a transfer function's phase in degrees and magnitude in dB.

**Goals** : Learn how to use a Z-Y bridge to measure complex impedance.

Learn how to measure a phase shift with the scope.

Learn how to measure attenuation.

Learn to recognize the difference between assumptions and conditions.

#### **2. Artificial Transmission Lines**

**Lec Feb 3    Lab Feb 10**

**HW** : Relationships between phase velocity,  $\epsilon$ , time delays, distance,  $f$ , and  $\lambda$ .

**Goals** : Understand relationship of lumped element cascaded circuits to transmission lines. Introduce the concept of dispersion. Develop an understanding of time delays and their relationship to  $f$ ,  $\lambda$ , and cycles.

### **3. Transients on Transmission Lines**

**Lec: Feb 17**

**Lab: Feb 24**

**HW** : Bounce diagrams for steps and pulses.

**Goals** : Understand the differences between steady state and transient operation. Learn how to explain transient responses on transmission lines. Observe the effects of dispersion and attenuation. Learn about a directional coupler with magnetic coupling.

### **4. Impedance Measurements at 500 MHz**

**Lec: Mar 2**

**Lab: Mar 9**

**HW** : Determination of a load from a VSWR and an electrical length.

**Goals** : Learn how to use a VSWR meter. Learn how to use a slotted line. Become familiar with the Smith chart. Understand how changes in  $\epsilon$  effect electrical length. Learn how to determine a load impedance from transmission line measurements. **(Reports due Mar 25)**

### **Spring Break: March 13-21**

### **5. Impedance Matching by Means of Stubs**

**Lec: Mar 23**

**Lab: Mar 30**

**HW** : Single stub matching with short circuit and open circuit stubs.

**Goals** : Understand how lengths of stubs and distances along transmission lines are related to the two types of circles on the Smith chart. Go beyond the “cookbook” double stub and understand how it works. Understand why some double stub configurations cannot match all loads. Realize that the “rotated  $g = 1$  circle” can be rotated any amount.

### **6. Introduction to Microwaves**

**Lec: Apr 6**

**Lab: Apr 13**

**HW** : S-parameters, delivered power. Can power be reflected to a generator?

**Goals** : Exposure to microwave concepts and measurement techniques. Learn something about microwave devices. Learn something about waveguide modes. Understand a simple microwave filter. If time permits we may be able to do some antenna experiments. **(Reports due Nov 26)**

### **7. Review and Exam** (These dates are tentative)

**Review: Apr 20**

**Exam: Apr 27**