CALIFORNIA STATE POLYTECHNIC UNIVERSITY, POMONA

COLLEGE OF ENGINEERING
COURSE OUTLINE

ET Major	Course Classification: ET Core	Major Core	Tech Elect	GE	Course Title: RF Measurements/Lab Course No ETE 437/437L Prepared by: A. C. Johnson Date of Last Revision: 6/23/99 Revised by: G. K. Herder Approved by:
CET ECET ET			(3/1)		

I. Course Description

ETE 437/437L RF Measurements (3/1)

Electronic measurement equipment and techniques for measurements at radio frequencies of such quantities as power, impedance, standing wave ratio, frequency, voltage, and current, Smith Charts, impedance matching, radio receiver measurements, antenna measurements. Three (3) one-hour lecture/problem solving sessions. Prerequisites: ETE 435/435L.

II. Required Background or Experience

Background/Knowledge in electronic communication systems theory and applications (ETE 435/435L)

III. Detailed Description of the Course

A. Expanded Description of the Course

1. Transmission Line Structures and Propagation (2week)
   a. Traveling Waves
   b. Characteristic Impedance

2. DC transients and Pulse signals on a Transmission Line (2week)
   a. Velocity of Propagation
   b. Reflection Coefficients
   c. Load and Source Effects (Matched, Unmatched)
   d. Lattice Diagrams
   e. Time Domain Reflectometry

3. Classic Transmission Line theory (2week)
   a. The distributed transmission line (R,G,L and C)
   b. Voltage and current on the line as a function of time and distance
   c. Impedance along the line
   d. Load Effects (Matched, Short and Open, Unmatched)
   e. Unmatched Loads

4. Transmission Line Propagation Characteristics (1week)
   a. Nepers, dB's
   b. Transmission Line Components

5. Graphical Solutions (Smith Charts) (2weeks)

B. Methods of Instruction and Evaluation

Instruction: Classroom lecture
Evaluation: Periodic exams and quizzes, homework problems, and computer assignments.

C. Expected Outcomes

Upon successful completion of this course, each student will be able to:

1. Understand the impact of geometry and material on Zo, and vp.

2. The student will learn the glossary of terms and notations used in the RF measurement field.

3. The student will learn the propagation characteristics of DC, pulse and sinusoidal voltage and current signals on transmission lines, matched or unmatched.

4. The student will be able to calculate impedance changes along the transmission line under unmatched conditions.

5. The student will be able to calculate and determine graphically with the Smith Chart transmission line solutions.

D. Minimum Student Materials

Textbook, writing materials, calculator, Smith charts, graphical construction aids.

E. Minimum University Facilities

Standard classroom for lectures, with black (or white) board and overhead projector with screen.

IV. Text and References

Text: Sinnema, William, Electronic Transmission Technology; Lines, Waves and Antennas, 2nd Edition Prentice-Hall, 1988, ISBN 0-13-252412-0, REQUIRED TEXTBOOK

References: Chipman, Robert A., Theory and Problems of Transmission Lines, McGraw/Schaum, 1968, ISBN 0-07-010747-5, RECOMMENDED TEXTBOOK

V. Detailed Description of the laboratory

A. Typical laboratory experiments

1. Characteristic Impedance of common Transmission Line structures.
2. Traveling Waves: Slinky Lab (Constructive and Destructive Interference).
3. Common RF connectors and Hardware
4. Computer simulations of signals on transmission lines
5. Transmission Lines measurements, VSWR, impedance, etc.
6. Introduction to the Network Analyzer.

B. Methods of instruction and Evaluation

Instruction: Typical computer laboratory with students working on projects under faculty supervision. This may include some lecture, as appropriate.
Evaluation: Laboratory participation and lab reports.

C. Expected Outcomes

Upon successful completion of this laboratory, each student will be able to:

1. Recognize the significant aspects of common RF Transmission Lines
2. Recognize the significant aspects of common RF Transmission Line connectors
3. Use Software to demonstrate transmission line effects
4. Use RF measurement equipment to perform T/L experiments
5. Understand the basic use of the Network Analyzer

D. Minimum Student Materials

Smith Charts, access to an IBM PC, or equivalent, SPICE software, or equivalent.

E. Minimum University Facilities

Hardware laboratory with RF sources, Standing Wave Indicator, Slotted Line, various RF terminations and connectors. Computers for Transmission Line and Smith Chart software. Access to Network Analyzer including calibration kits

F. Text and References

Text: Laboratory materials are locally prepared.
Reference: Lecture text(s).

ECET Course Outline Addendum

Course Number and Title: ETE 437/437L RF Measurements/Lab (3/1)

Computer usage:

Computer Work is designed to support lecture material through homework problems or laboratory work through pre-lab analysis.

Typical assignments include:

1. Use of advanced spreadsheet tools: IF/Then branching for Microstrip Zo calculation

2. Use of SPICE-type simulator to demonstrate for DC or Pulse transients on a Transmission Line
   a. Transmission Line length/Velocity of propagation affects
   b. Source/Line/Load Impedance effects.

3. Use of specialized software in laboratory for travelling wave simulation and lab data verification

4. Use of advanced spreadsheet tools: complex math operators for transmission line calculations

5. Use of advanced spreadsheet and SPICE tools to illustrate transmission line loading

6. Use of Smith Chart software and techniques for solution of transmission line problems

Laboratory projects [including major items of equipment and instrumentation used]

The laboratory equipment required for this lab include: RF sources, Standing Wave Indicator, Slotted Line systems with various RF terminations and connectors and Network Analyzer access. Laboratory work includes the use of SPICE, most of which will be completed outside of class and/or lab.

Oral and written communication requirements [be specific]

Laboratory reports both summary and formal are the primary written component, there is no formal oral communication requirement. Written reports are to be word-processed summarizing what was learned from the particular exercise, supported with technical details derived from computer and experimental work.

Calculus usage [be specific]

The primary use of calculus in this course is in the solution of Differential Equations describing the Voltage, Current and Impedance along a distributed transmission line under matched and unmatched conditions. The use of the exponential Euler form in representing continuous sinusoids is fundamental to the application of the above solutions.

Library usage:

No direct usage is required in this course and/or laboratory

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