ELEC454 — Microwave Engineering
Spring 2006
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Course Objectives

After completing the course and laboratory, students should be able to do the following:

1 Analyze microwave components and circuits in terms of scattering parameters.

2 Determine the electrical characteristics of waveguides and transmission lines through electromagnetic field analysis.

3 Design microwave amplifiers and oscillators based on stability, bandwidth, power gain and noise figure criteria.

4 Generate layouts and measure the performance of such components.

Lecture 1: Objectives

1.1 Get acquainted — Personal, Environment and Process.

1.2 Technicalities — Syllabus, Laboratory and Marking.

1.3 General Introduction — Course Context, Relevance and Applications.

Lecture 2: Objectives

2.1 Review Wave Propagation on
- 2.1.1 Transmission Lines (TLs)
- 2.1.2 Equations; Definitions; Process

2.2 Review Field Analysis of Transmission Lines
- 2.2.1 Geometry -> Fields -> Electrical Parameters

Lecture 3: Objectives

3.1 Review — *Termination of Transmission Lines, Reflection Coefficient; Standing Waves* and *Matching*

3.2 Review — Foundations of Smith Chart, Conformal Mapping between Complex Impedance and Complex Reflection Coefficient.

Lecture 4: Objectives

4.1 Review Foundations of Smith Chart (continued)
- 4.1.1 Impedance and Admittance Representation
- 4.1.2 Impedance Transformation

Lecture 5: Objectives

5.1 Review Foundations of Smith Chart (continued)
- 5.1.1 Impedance-Admittance Conversion

5.2 Introduce Impedance Matching
- 5.2.1 Stub Impedances, Series Matching
- 5.2.2 Impedance-Admittance Conversion
- 5.2.3 Stub Admittances and Shunt Matching
- 5.2.4 Quarter Wave Transformers

Lecture 6: Objectives

6.1 Review Scattering Parameters
- 6.1.1 Definition of Power Waves
- 6.1.2 Definition of Scattering Parameters

6.2 Properties of Scattering Parameters
- 6.2.1 Passivity
- 6.2.2 Reciprocity
- 6.2.3 Losslessness
- 6.2.4 Extension of Reference Planes
- 6.2.5 Measurement of S-Parameters
- 6.2.6 Important Example — S_{11} of 2–Port with Load

Lecture 7: Objectives

7.1 Gain Definitions for Two-Ports
- 7.1.1 Power Gain
- 7.1.2 Available Gain
- 7.1.3 Transducer Power Gain

Lecture 8: Objectives

8.1 Design for Transducer Power Gain
- 8.1.1 General Amplifier Configuration
- 8.1.2 Bilateral and Unilateral Gain Formulas

8.2 Stability of Amplifiers
- 8.2.1 Conditional and Unconditional Stability
- 8.2.2 Stability Circles
- 8.2.3 Examples of Stability Verification.

Lecture 9: Objectives

9.1 Constant Gain Circles
- 9.1.1 Formulas for Constant Gain
- 9.1.2 Interpretation for Design

9.2 Constant Noise Figure Circles
- 9.2.1 Sources of Noise in Amplifiers
- 9.2.2 Definition of Noise Figure
- 9.2.3 Formulas for Constant Noise Figure

Lecture 10: Objectives

10.1 Design for Maximum Gain
- 10.1.1 Condition for Conjugate Matching
- 10.1.2 Matching Network Design

10.2 Unilateral Figure of Merit
- 10.2.1 Definition
- 10.2.2 Error Margin for Unilateral Assumption