THE UNIVERSITY OF BRITISH COLUMBIA
Department of Electrical and Computer Engineering

ELEC 411 – Antennas and Propagation

RF Test & Measurement

Introduction to VNAs

Review Questions

The purpose of this short self-quiz is to help you review the essential parts of the module on *RF Test & Measurement: Introduction to VNAs* and prepare to tackle the Problem Set. Most of the answers can be found in the lecture notes.

SQ3R – Survey, Question, Read, Recite, Review!

1. Spectrum Analyzers vs. Network Analyzers

1.1. What are the fundamental differences between a spectrum analyzer and a network analyzer?

1.2. To what class of instruments does a spectrum analyzer belong?

1.3. To what class of instruments does a network analyzer belong?

2. The Vector Network Analyzer Concept

2.1. In general terms, how does a vector network analyzer function?

2.2. Sketch a block diagram of a vector network analyzer and explain its function and operation?

2.3. What response data does a VNA return? Be as specific as possible.

3. S-Parameters

3.1. What do the S-parameters of a two-port network characterize?

3.2. What must be attached to the opposite port of a two-port network when S-parameters of the network are measured?

3.3. To what do the nodes in an RF/microwave signal flow graph correspond?

3.4. How do we interpret the branches in an RF/microwave signal flow graph?

3.5. How is an S-matrix represented using an RF/microwave signal flow graph?

3.6. What are the S-parameters of: a) a matched load, b) a short circuit, c) an open circuit, d) an ideal transmission line of zero length, e) an ideal transmission line of length .

3.7. What is a reference plane?

3.8. How does shifting the reference plane affect S-parameter measurements?

3.9. What is a distortion matrix and what does it characterize?

4. Interpreting Network Analyzer Response Data

4.1. What is group delay?

4.2. How can the impulse response of a device be determined from measurements of the complex frequency response of the device?

4.3. How does the finite frequency span of a measured frequency response affect our ability to estimate the impulse response?

4.4. What is time-domain gating and when would it be applied?

4.5. What is the relationship between a Smith chart, the complex impedance plane and the Γ plane?

4.6. What is a conformal mapping?

5. Vector Network Analyzer Calibration

5.1. What types of errors may affect VNA measurements?

5.2. What causes systematic errors in the response of a VNA and how can they be removed?

5.3. What causes random errors in the response of a VNA and how can they be removed?

5.4. What causes drift errors in the response of a VNA and how can they be removed?

5.5. What is the RST calibration method? How is it applied?

5.6. How can we determine the elements of the R and T distortion matrices?

5.7. What three calibration options are available to the user of a VNA?

5.8. To what does the acronym SOLT refer?

5.9. What is the twelve-term error model and how is it generally expressed?

6. Applications of VNAs in Antennas and Propagation

6.1. How might a designer use a VNA to evaluate the performance of an antenna?

6.2. What steps must a designer take to ensure that a measurement of the input impedance of an antenna is accurate?

6.3. Suppose the input impedance of a circuit over a range of frequencies is measured using a VNA then plotted on a Smith chart.

a. What form does the plot take for a series RC or RL circuit?

b. What form does the plot take for a parallel RLC circuit?

c. How does Foster's Reactance Theorem help us to interpret the result?

6.4. Suppose transmitting and receiving antennas are connected to the output and input ports of a network analyzer, respectively, and the complex frequency response is measured over a suitable range of frequencies. What useful information can an antenna designer or wireless engineer derive from this result?

6.5. What is the physical interpretation of the impulse response of a wireless channel?