ELEC 411 – Performance Objectives – Module 1 – RF Test & Measurement

1. SPECTRUM ANALYSIS

a. Explain how measuring the spectrum of an RF signal assists in characterization of noise and interference, measurement of distortion (both intermodulation and harmonic), characterization of amplitude, phase, frequency or pulse modulated signals and estimation of spectrum usage and occupancy.

b. Describe alternative methods for measuring the spectrum of physical signals, including an analog filter bank, analog-to-digital conversion followed by a discrete Fourier transform, a tunable bandpass filter and a swept frequency spectrum analyzer, and give their strengths and limitations.

c. Sketch the block diagram of a typical swept-frequency spectrum analyzer.

d. Explain the function and operation of a swept-frequency spectrum analyzer.

e. Describe the key differences between spectra obtained using Fourier theory and spectra measured using a spectrum analyzer.

f. Configure a spectrum analyzer to measure a given signal with specified amplitude and bandwidth.

g. Show or explain how the choice of resolution bandwidth affects the noise floor (Displayed Average Noise Level) and sweep time of a spectrum analyzer.

2. NETWORK ANALYSIS

a. Explain the difference between and give examples of signal analyzers and stimulus response test sets.

b. Describe the different ways that one can interpret the reflection and transmission coefficient associated with one-way two-port measurements.

c. Sketch the block diagram of a typical vector network analyzer.

d. Explain the function and operation of a vector network analyzer.

e. Configure a vector network analyzer to characterize a two-port network with given bandwidth and gain.

3. S-PARAMETERS

a. Show how S-parameters characterize a two-port network in terms of forward and backward travelling waves.

b. Use signal flow graphs to represent complex networks of devices that are described by S-parameters.

c. Use distortion matrices to change the reference plane for the S-parameters of a two-port network.

d. Define group delay and explain its significance.

UBC Radio Science Lab	Title: **POs – Module 1 – RF Test & Measurement**		Notes:
	Drawn by: David G Michelson	Date: 7 Sep 2016	
	E-mail: davem@ece.ubc.ca	Approved by: DGM	

ELEC 411 – Performance Objectives – Module 1 – RF Test & Measurement

4. TRANSFORMATION OF S-PARAMETER DATA

a. Transform a measured frequency response into a channel impulse response by applying a chirp-Z transform.
b. Describe how the channel impulse response is distorted when the bandwidth of the frequency response is finite.
c. Explain how this distortion can be suppressed.

5. SMITH CHART

a. Use a bilinear transformation (a special conformal mapping) to map the rectangular impedance plane onto the polar complex reflection coefficient plane to yield a Smith Chart.
b. Use Foster's reactance theorem to interpret impedance as a function of frequency when plotted on a Smith Chart.
c. Sketch Smith charts for reflection coefficients woth magnitude less than one and greater than one.

6. VNA CALIBRATION

a. Explain the causes, significance and mitigation of systematic, random and drift errors in VNA-based measurements.
b. Show how systematic errors can be modeled using signal flow graphs.
c. Show how systematic errors can be characterized by measuring the response of a set of calibration standards.
d. Describe and apply the three calibration options available to users of conventional two-port VNAs.
e. Describe the calibration standards used to calibrate VNAs.
f. Derive the calibration equations that apply to one-port measurements.

7. APPLICATIONS OF VNAs IN ANTENNAS AND PROPAGATION

a. Use a VNA to measure the input impedance of both reactive and resonant circuits across a range of frequencies, plot the responses on a Smith Chart, and interpret the result.
b. Use a VNA to measure the path loss, complex frequency response and channel impulse response of the wireless channel between two antennas.
c. Suppress spurious responses in VNA-based transmission measurements.