

GEORGIA INSTITUTE OF TECHNOLOGY
School of Electrical and Computer Engineering

ECE 4410

Study Guide for Quiz No. One

September 15, 2006

General Information

- (a) The quiz will be closed book and notes.
- (b) Only those topics covered in class, covered in the homework assignments, or listed in this guide will be on the quiz.
- (c) You should be able to work all homework problems, practice problems, and example problems. However, problems that require extensive algebra or arithmetic will not be given.
- (d) All answers must be circled, underlined or otherwise indicated. Give numerical answers as a decimal number to four significant figures. Give units with all answers. Be sure to indicate if work is continued on another page. No credit will be given for unsupported answers.
- (e) Lap-top or palm-top computers MAY NOT be used on the quiz. Likewise, calculators may not be used in "solve" mode and root-finders may not be employed. You must show all steps in your calculations.
- (f) This document is thought to be reasonably complete. However, some minor topics of interest may have been inadvertently omitted. However, you remain responsible for all material covered in class and in the several assignments.

Chapter 1: Introduction

Sections Covered: Entire chapter

What you should know:

- (a) Understand the nature of analog signals and the characteristics of ideal and practical analog filters. Be able to sketch the frequency response characteristics of the ideal filters.
- (b) Understand the significance of the filter specification quantities such as the passband ripple, the stop-band attenuation and the transition-band ratio.
- (c) Be able to write transfer functions of simple circuits. Understand the nodal and ladder methods of analysis.
- (d) Understand and be able to use the concepts of frequency and impedance scaling.
- (e) Understand what steps are involved in the design of analog filters.

Chapter 2: The Approximation

Sections Covered: Entire chapter

What you should know:

- (a) Know that the low-pass characteristic is the reference characteristic from which all other filters can be generated. Know the general form of the low-pass characteristic, i.e., Eq. (2.2).
- (b) Know the definition of the Butterworth characteristic as given by Eq. (2.4). What is meant by describing the Butterworth function as "maximally flat?" Know the general shape of the Butterworth characteristic.
- (c) Know how the pass-band attenuation α_p and the stop-band attenuation α_s are obtained from the Butterworth function.
- (d) Know the definition of the Chebyshev characteristic as given by Eq. (2.22). What is meant by describing the Chebyshev function as having an "equal ripple" bandwidth. Know the general shape of the Chebyshev characteristic.
- (e) Know how the pass-band attenuation α_p and the stop-band attenuation α_s are obtained from the Chebyshev function. You will be provided with the relationship:

$$C_n(\omega) = \cosh(n \cosh^{-1} \omega)$$

- (f) It is not necessary to know the forms of the Chebyshev high-pass and Chebyshev inverse characteristics. However, if given its definition, you should be able to qualitatively analyze any characteristic.
- (g) Understand the important properties of the elliptic-function low-pass approximation and be able to sketch the characteristic.

Chapter 3: Network Functions

Sections Covered: Entire chapter

What you should know:

- (a) Know the general procedure for generating network functions from the magnitude squared representation. Be able to obtain valid network functions from the magnitude-squared representation.
- (b) Know the definition of Hurwitz polynomials and the significance of minimum phase functions. Know what is required for a network function to be realizable.
- (c) Know how the poles of the Butterworth function are arranged in the complex plane. Know how to determine the Butterworth poles from your knowledge of this arrangement.

- (d) Know how the poles of the Chebyshev function are arranged in the complex plane. In particular, how do their locations differ from the locations of the Butterworth poles. You will not be required to locate the Chebyshev poles from their s-plane arrangement.
- (e) What is the most significant difference between the s-plane portrayal of the elliptic functions as compared to the Butterworth and Chebyshev functions? Qualitatively, understand how the poles and zeros of the elliptic function are arranged in the complex plane.
- (f) Of what use are the Bessel-Thomson filter functions? How do these functions compare to the other filter functions? How are all-pass functions made from the Bessel-Thomson functions. Of what use are all-pass functions.
- (g) What is a delay equalizer? How is a delay equalizer constructed?

Chapter 4: Frequency Transformation

Sections Covered: Entire chapter

What you should know:

- (a) Know the mathematical form of the low-pass to high-pass transformation and be able to use it to create high-pass functions. Be able to find the poles and zeros of the high-pass function.
- (b) Have a general idea how the frequency variation of low-pass and high-pass characteristics are related. Know how the poles and zeros of the two filter types are arranged in the s-plane.
- (c) Be able to construct a high-pass filter from the circuit diagram of a prototype low-pass filter.
- (d) Know the mathematical form of the low-pass to band-pass and low-pass to band-reject transformations. Be able to use these transformations to create and find the poles and zeros of band-pass and band-reject functions. Equations (4.4) and (4.12) will be given, but they will not be identified as to function.
- (e) Have a general idea how the frequency variation of the low-pass characteristic is related to the band-pass and band-reject characteristics. Know the pole and zero locations for the band-pass and band-reject filters and how these locations are related to the low-pass filter.
- (f) Know how to construct band-pass and band-reject filters from the circuit of the prototype low-pass filter.