EE 451 - Exam 1

September 27, 2000

Name: _____

Closed book. You may use a calculator and one page of notes. Show all work. Partial credit will be given. No credit will be given if an answer appears with no supporting work.

1. A continuous-time signal

$$x_a(t) = 5\sin(600\pi t) + 2\cos(3000\pi t) - 2\sin(3400\pi t) - 3\cos(5000\pi t)$$

is sampled with a sampling frequency of 2 kHz to generate the discrete-time signal x(n).

(a) What continuous-time frequencies are present in $x_a(t)$?

(b) What discrete-time frequencies are present in $x(n)$? Be sure to normalize these frequencies to lie between $-\pi$ and π.

(c) What is $x(n)$?

(d) Is $x(n)$ periodic? If so, what is the period of $x(n)$?

(e) If $x(n)$ is passed through an ideal D/C converter (a D/A converter with an ideal reconstruction filter) what is the reconstructed signal $y_a(t)$?

2. Consider a system described by the difference equation

$$y(n) = 5x(n-1) - 4x(n-2) + y(n-1) + 2y(n-2)$$

(a) What is the characteristic polynomial for this system?

(b) What is the form of the impulse response of the system? (Note: You do not need to solve for the constants such as C_1 and K.)

(c) What is the transfer function $H(z)$ of the system?

(d) Sketch the pole-zero diagram for $H(z)$. What is the region of convergence of $H(z)$?

(e) Is the system stable? Explain.

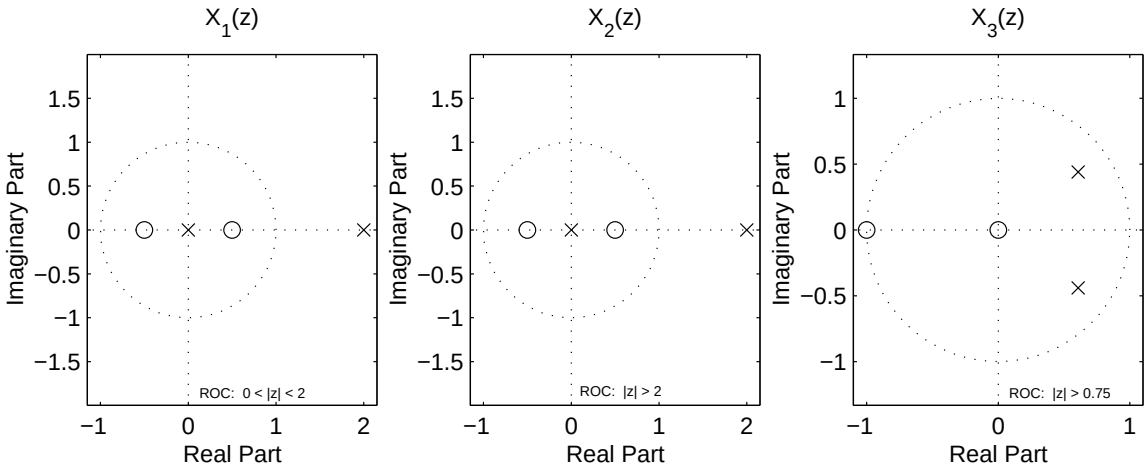
(f) Find the impulse response of the system by finding the inverse z-transform of $H(z)$

(g) On the next page, sketch the direct-form II implementation of the system.

Direct-form II implementation of

$$y(n) = 5x(n-1) - 4x(n-2) + y(n-1) + 2y(n-2)$$

3. Consider the pole-zero diagrams below:



Do the following without explicitly finding the inverse z-transforms.

(a) Sketch the approximate form of the signal $x_1(n)$.

(b) Sketch the approximate form of the signal $x_2(n)$.

(c) Sketch the approximate form of the signal $x_3(n)$.

4. When the input to a linear time-invariant system is

$$x(n) = 5u(n),$$

the output is

$$y(n) = \left[2\left(\frac{1}{2}\right)^n + 3\left(-\frac{3}{4}\right)^n\right] u(n).$$

(a) Find the system function $H(z)$ of the system.

(b) Plot the poles and zeros of $H(z)$, and indicate the region of convergence

(c) Write the difference equation which characterizes the system

(d) Is the system stable? Is it causal? Explain.