GPGN 404
2nd Midterm Exam
November 19, 2010 **Name:** _____

Question:	1	2	3	4	Total
Points:	18	17	14	6	55
Score:					

Question 1 ..... (18 points)

Find system responses $H(z)$, including regions of convergence, for linear time-invariant systems with the following impulse responses:

(a) $h_1[n] = \delta[n+3]$

(b) $h_2[n] = \delta[n+3] - \delta[n-3]$

(c) $h_3[n] = u[n+3] - u[n-3]$

(d) $h_4[n] = \left(\frac{1}{2}\right)^n u[n]$

(e) $h_5[n] = \left(\frac{1}{2}\right)^{-n} u[-n]$

(f) $h_6[n] = \left(\frac{1}{2}\right)^{|n|}$ $(= h_4[n] + h_5[n] - \delta[n])$

Question 2 ..... (17 points)

Consider a system with z-transform

$$H(z) = z - z^{-1}.$$

(a) Plot the poles and zeros in a sketch of the complex z-plane.

(b) Sketch the amplitude response $A(\omega)$ and phase response $\phi(\omega)$ of this system for frequencies $-\pi < \omega < \pi$.

(c) Write a difference equation for this system.

(d) Sketch the impulse response of this system.

(e) Is this system stable? Why or why not?

(f) If applied to a sequence $x[n]$ with sampling interval $T = 4$ ms, what frequencies F (in Hz) are most attenuated by this filter?

Question 3 ..... (14 points)

Sampling in time causes replication in frequency. Assume that you are given a sampled sequence $x[n]$, where the sampling interval $T = 10$ ms.

(a) What is the sampling frequency F_s?

(b) What is the Nyquist frequency F_n?

(c) Assume that, before sampling, the continuous signal $x_c(t)$ was contaminated with noise at 75 Hz. Sketch one possible amplitude spectrum $A(F)$ of the continuous signal $x_c(t)$ In your sketch, (1) label the frequency F axis with units of Hz, (2) include both negative and positive frequencies, (3) indicate both the sampling frequency F_s and Nyquist frequency F_n, and (4) make the noise apparent at ± 75 Hz.

(d) Assume that sampling was performed such that $x[n] = x_c(nT)$. Sketch the corresponding amplitude spectrum $A(\omega)$ of the sequence $x[n]$ for frequencies $-2\pi < \omega < 2\pi$. (Units of frequency ω are radians/sample.) Your sketch should highlight the replication caused by sampling, and indicate all frequencies at which noise is apparent.

(e) Can you recover the continuous signal $x_c(t)$ from the sampled sequence $x[n]$? If so, how? If not, why not?

Question 4 ..... (6 points)

In digital signal processing, sampled sequences must often be time-shifted, for example, to align them with other sequences. Assume an input sequence $x[n]$ with sampling interval $T = 4$ ms. Write equations for the output sequences $y[n]$ in terms of the input for digital systems that:

(a) Delay the input by 8 ms.

(b) Delay the input by 10 ms.