GPGN 404
2nd Midterm Exam
November 18, 2011 **Name:** _____

Question:	1	2	3	4	5	Total
Points:	15	12	12	8	3	50
Score:						

Question 1 ..... (15 points)

Consider the response $H_1(z) = 1 + z^{-1}$ (with region of convergence $|z| > 0$) of a linear time-invariant system.

(a) Sketch the poles and zeros of this system.

(b) Sketch the impulse response $h_1[n]$ of this system.

(c) Sketch the amplitude response $A_1(\omega)$ and phase response $\phi_1(\omega)$ of the system H_1, for frequencies ω (in radians/sample) in the range $[-\pi, \pi]$.

(d) If the time sampling interval is 1 ms, what frequency (in Hz) is most attenuated by this system?

(e) Specify the response $H(z)$ for a system that attenuates the same frequency, but with less attenuation (and less phase distortion) for other frequencies.

Question 2 ..... (12 points)

Consider the system response $H_2(z) = zH_1(z)$, where $H_1(z)$ is defined as in Question 1.

(a) Sketch the poles and zeros of the system H_2.

(b) What is the region of convergence for the system H_2? Is the system H_2 stable and/or causal? Explain.

(c) Sketch the amplitude response $A_2(\omega)$ and phase response $\phi_2(\omega)$ of the system H_2, for frequencies ω (in radians/sample) in the range $[-\pi, \pi]$.

(d) Assume that a sequence $x[n]$ is input to both systems H_1 and H_2 to obtain corresponding output sequences $y_1[n]$ and $y_2[n]$. Show how to compute the output sequence $y_2[n]$ directly from only the output sequence $y_1[n]$.

Question 3 ..... (12 points)

Consider the system response $H_3(z) = 1/H_1(z)$, where $H_1(z)$ is defined as in Question 1.

(a) Sketch the poles and zeros of the system H_3.

(b) What is the region of convergence for the system H_3? Is the system H_3 stable and/or causal? Explain.

(c) Sketch the amplitude response $A_3(\omega)$ and phase response $\phi_3(\omega)$ of the system H_3, for frequencies ω (in radians/sample) in the range $[-\pi, \pi]$.

(d) Write a linear constant-coefficient difference equation that relates the output sequence $y[n]$ of the system H_3 to the input sequence $x[n]$.

Question 4 ..... (8 points)

Suppose that you are sampling some geophysical signal in an environment with a lot of noise at a frequency of 2 cycles/day. The geophysical signal is bandlimited, with no significant energy at frequencies above 6 cycles/day.

(a) To avoid aliasing, but without oversampling, how many times per day must you sample this signal? (In other words, what is your sampling frequency F_S, in samples/day?)

(b) What is your Nyquist frequency F_N, in cycles/day?

(c) What is your time sampling interval T, in hours?

(d) If you chose a sampling interval $T = 12$ hours, at what frequency (in cycles/day) would the noise be apparent in your sampled signal?

Question 5 ..... (3 points)

Consider the system $y[n] = x[-n]$ that reverses its input. The impulse response for this system is $h[n] = \delta[n]$, which implies that its frequency response is $H(\omega) = 1$, both of which imply that this system does nothing! What is wrong with this reasoning?