GPGN 404
2nd Midterm Exam
November 16, 2012 **Name:** _____

Question:	1	2	3	4	Total
Points:	10	15	13	12	50
Score:					

Question 1 . . . . . (10 points)

Find (you need not sketch) impulse responses $h[n]$ for linear time-invariant systems with the following system responses $H(z)$:

$$H(z) = \Big(1 + 3z\Big)\Big(1 - 2z^{-1}\Big) \quad ; \quad 0 < |z| < \infty$$

$$H(z) = \frac{1}{\Big(1 - \frac{1}{2}z^{-1}\Big)\Big(1 - \frac{1}{3}z^{-1}\Big)} \quad ; \quad \frac{1}{2} < |z|$$

Question 2 ..... (15 points)

For input and output sequences $x[n]$ and $y[n]$, consider the linear time-invariant system:

$$y[n] = \frac{1}{2}x[n+1] + x[n] + \frac{1}{2}x[n-1]$$

(a) Sketch the impulse response $h[n]$ of this system. (Label axes.)

(b) Sketch the frequency response $H(\omega)$ for $-\pi \leq \omega \leq \pi$. (Label axes.)

(c) What is the system response $H(z)$ for this system? (Include the ROC.)

(d) Sketch locations of pole(s) and zero(s) in the complex z-plane.

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

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

Question 3 ..... (13 points)

Assume that the maximum frequency in a continuous signal $x_c(t)$ is 8 Hz, and that we have sampled this signal to obtain a sequence $x[n]$ with sampling interval $T_x = 0.05$ s.

(a) For the sequence $x[n]$, what is the

- sampling frequency F_S (in Hz)?
- Nyquist frequency F_N (in Hz)?

(b) Is the sequence $x[n]$ aliased? Why or why not?

(c) For frequencies F in the interval $[-F_N, F_N]$, sketch a possible Fourier transform $X(F)$ for the sequence $x[n]$. Include in your sketch some non-zero amplitude at the maximum frequency 8 Hz.

(d) Suppose we resample $x[n]$ to create a new sequence $y[n]$ with sampling interval $T_y = 0.08$ s. Write an equation that shows how you would compute the sequence $y[n]$ from the sequence $x[n]$.

(e) For the new sequence $y[n]$, what is the

- sampling frequency F_S (in Hz)?
- Nyquist frequency F_N (in Hz)?

(f) Is the new sequence $y[n]$ aliased? Why or why not?

(g) Sketch the Fourier transform $Y(F)$ for the new sequence $y[n]$.

Question 4 ..... (12 points)

Assume that we want to eliminate noise at frequency 25 Hz from a sequence $x[n]$ for which the time sampling interval is 0.01 s. We will design a notch filter with two zeros and two poles and the following linear constant-coefficient difference equation:

$$y[n] = b_0 x[n] + b_1 x[n-1] + b_2 x[n-2] - a_1 y[n-1] - a_2 y[n-2]$$

(a) What is the Nyquist frequency (in Hz) for the input and output sequences?

(b) Sketch the locations of poles and zeros in the complex z-plane.

(c) Derive coefficients b_0, b_1, b_2, a_1 and a_2 for the difference equation to attenuate the noise at 25 Hz, while not altering any signal at 0 Hz.

(d) Suppose that we want to preserve only the noise at 25 Hz, while attenuating all other frequencies. How should we modify the coefficients of our difference equation to do this?