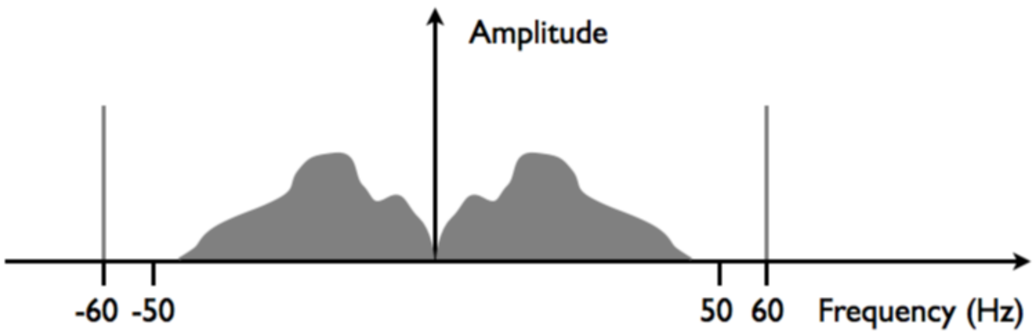
GPGN 404
2nd Midterm Exam
November 9, 2007 **Name:** ______________________

Question:	1	2	3	Total
Points:	22	15	18	55
Score:				

Question 1 . . . . (22 points)

Consider a continuous signal $x_c(t)$ with the following amplitude spectrum:



The spikes in the spectrum at ± 60 Hz are caused by power line noise. Now assume that this signal is sampled uniformly with interval $T = 0.01$ s to obtain a sequence $x[n]$.

(a) [2 points] What is the sampling frequency F_S, in Hz?

(b) [2 points] What is the Nyquist frequency F_N, in Hz?

(c) [4 points] Sampling in time causes replication in frequency. Sketch the amplitude spectrum implied by sampling. (Label any frequencies that are important in your sketch.)

(d) [2 points] Consider frequencies F only in the interval $|F| < F_N$. After sampling, the noise appears to be at what frequencies (in Hz)?

(e) [2 points] Convert the noise frequencies F, in Hz, to frequencies f in cycles per sample.

(f) [4 points] Determine and sketch the locations of two poles and two zeros for a simple digital filter that would eliminate the noise, while having little effect on other frequencies in the signal.

(g) [2 points] Write a difference equation *with real coefficients* for your two-pole, two-zero filter that relates input $x[n]$ to output $y[n]$.

(h) [4 points] Given the noise-free sequence $y[n]$, how would you best implement the transformation $z_c(t) = y_c(\sqrt{t})$ in a digital system? That is, write an expression for a sequence $z[n] \equiv z_c(nT)$ in terms of the sequence $y[n]$.

Question 2 . . . . (15 points)

Find z-transforms $X(z)$, including the regions of convergence, of the following sequences:

(a) [3 points] $x[n] = \delta[n-3]$

(b) [3 points] $x[n] = \left(\frac{1}{3}\right)^n u[n]$

(c) [3 points] $x[n] = \left(\frac{1}{3}\right)^{n+2} u[n+2]$

(d) [3 points] $x[n] = \left(\frac{1}{3}\right)^n u[n+2]$

(e) [3 points] $x[n] = 3^n u[-n-1] + \left(\frac{1}{3}\right)^n u[n]$

Question 3 .... (18 points)

Consider a system with z-transform

$$H(z) = 1 - z^{-3}, \quad |z| > 0.$$

(a) [2 points] How many zeros are in this system? How many poles?

(b) [4 points] Plot the poles and zeros in a sketch of the complex z-plane.

(c) [3 points] Sketch the amplitude spectrum of this system for frequencies $-\pi < \omega < \pi$.

(d) [2 points] Write a difference equation for this system.

(e) [2 points] Is this system stable? Why or why not?

(f) [2 points] Sketch the impulse response of this system.

(g) [3 points] Sketch the output sequence $y[n]$ of this system for the input sequence $x[n] = u[n]$. (In other words, sketch the step response of this system.)