GPGN 404
2nd Midterm Exam
November 20, 2009 **Name:** _____

Question:	1	2	3	4	Total
Points:	18	18	16	3	55
Score:					

Question 1 ..... (18 points)

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

(a) [3 points] $x[n] = \delta[n-2]$

(b) [3 points] $x[n] = 2\delta[n+2] - 3\delta[n-2]$

(c) [3 points] $x[n] = \left(\frac{1}{4}\right)^n u[n]$

(d) [3 points] $x[n] = \left(\frac{1}{4}\right)^{n+1} u[n+1]$

(e) [3 points] $x[n] = \left(\frac{1}{4}\right)^n u[n+1]$

(f) [3 points] $x[n] = 4^n u[-n-1]$

Question 2 ..... (18 points)

Consider a system with z-transform

$$H(z) = 1 + z^{-2}, \quad |z| > 0.$$

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

Question 3 ..... (16 points)

Assume that you are given a sampled sequence $x[n] = x_c(nT)$, where the sampling interval $T = 4$ ms.

(a) [2 points] What is the sampling frequency F_s?

(b) [2 points] What is the Nyquist frequency F_n?

(c) [4 points] Sketch the amplitude spectrum $A(F)$ of a non-zero continuous (not yet sampled) signal $x_c(t)$ for which the corresponding sampled sequence $x[n]$ *is not aliased*. In your sketch, (1) label the frequency axis F with units of Hz, (2) include both negative and positive frequencies, and (3) indicate both the sampling frequency F_s and Nyquist frequency F_n.

(d) [2 points] Make a similar sketch for which the sequence $x[n]$ *is aliased*.

(e) [2 points] Assume that the sequence $x[n]$ is not aliased, and sketch the amplitude spectrum $A(\omega)$ of this sequence for frequencies $-2\pi < \omega < 2\pi$. In this sketch, the units of frequency ω are radians/sample.

(f) [4 points] Assume that the sequence $x[n] = x_c(nT)$ is not aliased, and write a computer program fragment with two loops (one nested inside the other) that will compute a new sequence $y[n] = x_c(t_0 + nT)$, where $t_0 = 1$ ms.

```
private static float sinc(float x) {
  // assume this method exists
}
...
  int nt = sx.getCount();
  float dt = (float)sx.getDelta();
  float t0 = 0.001f;
  float pi = (float)Math.PI;
  // TODO: good (but slow) implementation of sinc interpolation
```

Question 4 ..... (3 points)

After his most recent haircut, how much did Dr. Hale tip his barber?