GPGN 404
1st Midterm Exam
September 26, 2008 **Name:** _____

Question:	1	2	3	4	5	Total
Points:	8	5	20	8	9	50
Score:						

Question 1 ..... (8 points)

Let $x_c(t)$ denote a continuous signal and $x[n] = x_c(nT)$ a corresponding sampled sequence for some time sampling interval T.

(a) [2 points] For $x_c(t) = \cos(20\pi t)$, where time t is measured in seconds (s), what is the frequency F in cycles per second (Hz) of this signal?

(b) [2 points] Assuming a sampling interval $T = 0.01$ s, what is the frequency f in cycles per sample of the corresponding sampled sequence $x[n]$?

(c) [2 points] For $x_c(t) = \cos(20\pi t^2)$, the frequency $F(t)$ varies with time t. What is the function $F(t)$?

(d) [2 points] Give an example of a frequency f for which the sequence $x[n] = \cos(2\pi f n)$ is *not* periodic.

Question 2 ..... (5 points)

Sketch (with labeled axes) the sequences

(a)

$$x[n] = \begin{cases} 1, & \text{if } 0 \le n \le 4 \\ 0, & \text{otherwise} \end{cases}$$

(b) $y[n] = x[n] * x[n]$ (where $*$ denotes convolution)

Question 3 ..... (20 points)

For each of the following linear time-invariant digital systems with specified impulse responses $h[n]$,

- sketch (with labeled axes) the impulse response,
- describe in plain English (no math) what the system does,
- indicate whether the system is causal or not,
- indicate whether the system is stable or not, and
- if stable, give the bound B_y on the output $y[n]$ in terms of the bound B_x on the input $x[n]$.

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

(b) $h[n] = \delta[n+1] - \delta[n]$

(c) $h[n] = u[n]$ (the unit-step sequence)

(d) $h[n] = \frac{1}{7}(u[n+3] - u[n-4])$

(e) $h[n] = \frac{1}{2}^{|n|}$

Question 4 ..... (8 points)

In both theory and practice, linearity and time-invariance are two important properties of systems for processing digital sequences.

(a) [2 points] Give an example of how either or both of these properties can be important in practice.

(b) [3 points] Give a simple example of a system that is not linear, and prove that it is not linear.

(c) [3 points] Give a simple example of a system that is not time-invariant, and prove that it is not time-invariant.

Question 5 ..... (9 points)

Consider a causal stable system described by the constant-coefficient difference equation $2y[n] + y[n-1] = \frac{1}{2}x[n-2]$.

(a) [2 points] What is the frequency response $H(\omega)$ of this system?

(b) [3 points] For an input sequence $x[n] = \cos(\pi n)$, what is the output sequence $y[n]$? (Show your analysis with your answer.)

(c) [4 points] Write computer code to compute $y[n]$ for $n = 0, 1, 2, ..., N-1$, given input $x[n]$ for $n = 0, 1, 2, ..., N-1$.