GPGN 404
1st Midterm Exam
September 28, 2012 **Name:** _____

Question:	1	2	3	4	5	Total
Points:	6	6	14	12	12	50
Score:						

Question 1 ..... (6 points)

(a) Specify two different non-negative frequencies f for which the sequence $x[n] = \cos(2\pi f n)$ is periodic with period $N = 8$ samples.

(b) Specify a frequency f for which the same sequence $x[n]$ is not periodic.

Question 2 ..... (6 points)

Consider the causal system represented by the following linear constant-coefficient difference equation: $y[n] = y[n-1] + x[n] - x[n-5]$.

(a) Sketch the impulse response of this system.

(b) Rewrite this system as a convolution sum, by completing the equation below with only input samples x on the right-hand-side.

$y[n] =$

Question 3 ..... (14 points)

Consider two linear time-invariant systems with impulse responses

$$h_1[n] = \delta[n] - \delta[n-1]$$
$$h_2[n] = \delta[n+1] - \delta[n]$$

(a) Sketch the two impulse responses $h_1[n]$ and $h_2[n]$.

(b) For an input unit-step sequence $x[n] = u[n]$, sketch outputs $y_1[n]$ and $y_2[n]$ for these two systems.

(c) For the same input $x[n] = u[n]$, sketch *both* the impulse response $h[n]$ and output $y[n]$ of the composite system with impulse response $h[n] = h_1[n] * h_2[n]$, where $*$ denotes convolution.

(d) For the same input $x[n] = u[n]$, sketch *both* the impulse response $h[n]$ and output $y[n]$ of the composite system with impulse response $h[n] = \frac{1}{2}(h_1[n] + h_2[n])$.

Question 4 ..... (12 points)

Let $x[n]$ and $y[n]$ denote system input and output, respectively, and consider two linear time-invariant systems with impulse responses $h_1[n] = (1/3)^n u(n)$ and $h_2(n) = (1/3)^n u(n-1)$, where $u(n)$ denotes the unit-step sequence.

(a) Sketch the impulse responses of these two systems.

(b) Both systems are stable. For each system, express the bound B_y on the output in terms of the bound B_x on the input.

(c) Write two computer program *fragments* that show how you would compute output sequences `y1[n]` and `y2[n]` for any input sequence `x[n]`, for all `n = 0, 1, ..., nt-1`. Omit statements that construct arrays, get `nt`, etc.

Question 5 ..... (12 points)

Consider a linear time-invariant system with impulse response

$$h[n] = \delta[n-1] + \delta[n] + \delta[n+1].$$

(a) Sketch the impulse response $h[n]$ for this system.

(b) Express the output $y[n]$ of this system in terms of the input $x[n]$.

(c) For input $x[n] = u[n]$ (the unit-step sequence), sketch the output $y[n]$.

(d) What is the real-valued (no complex numbers) frequency response $H(\omega)$ of this system?

(e) What frequencies ω in the interval $[-\pi, \pi]$ are zeroed by this system?

(f) How could you modify this system so that the DC (zero-frequency) response $H(0) = 1$, while preserving the shape of its impulse response $h[n]$?