GPGN 404
2nd Midterm Exam
November 18, 2005 **Name:** _____

Question:	1	2	3	4	Total
Points:	10	14	14	12	50
Score:					

Question 1 ..... (10 points)

CD audio signals $x[n]$ are sampled at a rate of 44,100 samples per second.

(a) [2 points] For CD audio, what is the sampling interval, in seconds?

(b) [2 points] For CD audio, what is the Nyquist frequency, in Hz?

(c) [3 points] Define downsampling by $y[n] = x[2n]$. Under what condition would the signal $y[n]$ be aliased?

(d) [3 points] Assuming that $y[n]$ is not aliased, how can you recover the signal $x[n]$? Write your answer by completing this equation: $x[n] = \sum_m y[m]$...

Question 2 ..... (14 points)

Let $h[n]$ denote a real-valued impulse response of an LTI system, and let $H(\omega)$, $A(\omega)$, and $\phi(\omega)$ denote the corresponding frequency response, amplitude response, and phase response, respectively.

(a) [2 points] For what frequencies ω is the frequency response $H(\omega)$ real-valued for *any* real-valued $h[n]$?

(b) [2 points] Under what conditions on $h[n]$ (in addition to being real-valued) is the frequency response $H(\omega)$ real-valued for *all* frequencies ω.

(c) [2 points] If $A(\pi/4) = 10$, what is $A(-\pi/4)$?

(d) [2 points] If $A(\pi/4) = 10$, what is $A(9\pi/4)$?

(e) [2 points] If $A(\pi/4) = 10$, what is $A_{dB}(\pi/4)$?

(f) [2 points] If $\phi(\pi/4) = \pi/2$, what is $\phi(-\pi/4)$?

(g) [2 points] If $\phi(\pi/4) = \pi/2$, what is $\phi(9\pi/4)$?

Question 3 ..... (14 points)

Let $h[n] = \delta[n+2] - \delta[n-2]$ be the impulse response of an LTI system.

(a) [2 points] Sketch this impulse response. (Label axes.)

(b) [2 points] What is the Z-transform $H(z)$ of this system? (Include the ROC!)

(c) [2 points] Where in the complex Z-plane are the four poles of this system?

(d) [2 points] Where in the complex Z-plane are the four zeros of this system?

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

(f) [2 points] Sketch the amplitude response $A(\omega)$ of this system. (Label axes.)

(g) [2 points] Sketch the phase response $\phi(\omega)$ of this system. (Label axes.)

Question 4 ..... (12 points)

Let $h[n] = (1/3)^n u[n] - 2(1/3)^{n-1} u[n-1]$ be the impulse response of an LTI system. Let $x[n] = 2^n u[-n-1]$ denote the input to this system, and let $y[n]$ denote the corresponding output.

(a) [2 points] What is the Z-transform $H(z)$ of this system? (Include the ROC!)

(b) [2 points] Is the system stable? (Why or why not?)

(c) [2 points] Is the system causal? (Why or why not?)

(d) [2 points] What is the Z-transform $X(z)$ of the input $x[n]$? (ROC!)

(e) [2 points] What is the Z-transform $Y(z)$ of the output $y[n]$? (ROC!)

(f) [2 points] What is the system output $y[n]$?