ECE301 Signals and Systems **Exam 3**
Exam 3 **Friday, April 18, 2008**

Cover Sheet

Test Duration: 55 minutes.
Coverage: Emphasis on Chaps. 5 and 7
Open Book but Closed Notes. One loose sheet allowed.
Calculators allowed.
This test contains **two** problems.
All work should be done in the blue books provided.
You must show all work for each problem to receive full credit.
Do **not** return this test sheet, just return the blue books.

For EACH of the part of this problem:

- You need only plot the magnitude of the DTFT over $-\pi < \omega < \pi$, but it is very important to keep in mind that a DTFT is always periodic with period 2π.
- You must clearly label the DTFT magnitude plot requested and show as much detail as possible, clearly pointing out regions over $-\pi < \omega < \pi$ for which the DTFT is zero.
- You MUST show all work and explain how you got your answer concisely but with sufficient detail to receive full credit.
- The unit of T_s is seconds for all parts.

Problem 1.

Consider the continuous-time signal $x(t) = \left\{\frac{\sin(3t)}{\pi t}\right\}^2 \cos(4t)$. A discrete-time signal is created by sampling $x_1(t)$ according to $x[n] = x(nT_s)$ for $T_s = \frac{2\pi}{16}$.

(a) Plot the magnitude of the DTFT of $x[n]$, $|X(\omega)|$, over $-\pi < \omega < \pi$.

(b) $x[n]$ is passed through a DT linear system with impulse response $h_a[n] = \left\{\frac{\sin(\frac{\pi}{8}n)}{\pi n}\right\} \cos\left(\frac{7\pi}{8}n\right)$ yielding the output $y_a[n]$. Plot the magnitude of the DTFT of $h_a[n]$, $|H_a(\omega)|$

(c) Plot magnitude of the DTFT of $y_a[n]$, $|Y_a(\omega)|$, over $-\pi < \omega < \pi$.

(d) Determine the numerical values of the energy $\sum_{n=-\infty}^{\infty} y_a^2[n]$

(e) $x[n]$ is passed through a DT linear system with impulse response $h_b[n] = \frac{\sin(\frac{\pi}{4}n)}{\pi n}$ yielding the output $y_b[n]$. Plot the magnitude of the DTFT of $h_b[n]$, $|H_b(\omega)|$.

(f) Plot magnitude of the DTFT of $y_b[n]$, $|Y_b(\omega)|$, over $-\pi < \omega < \pi$.

(g) Determine the numerical values of the energy $\sum_{n=-\infty}^{\infty} y_b^2[n]$

Problem 2.

Consider the continuous-time signal below equal to a sum of four sinewaves.

$$x(t) = \cos(3t) + \cos(6t) + \cos(7.5t) + \cos(9t) + \cos(10.5t) + \cos(12t)$$

A discrete-time signal is created by sampling $x(t)$ according to $x[n] = x(nT_s)$ for $T_s = \frac{2\pi}{12}$.

(a) Plot the magnitude of the DTFT of $x[n]$, $|X(\omega)|$, over $-\pi < \omega < \pi$.

(b) $x[n]$ is passed through a DT linear system described by the difference equation

$$y[n] = -x[n+1] + 2x[n] - x[n-1]$$

Plot the magnitude of the DTFT of the impulse response of the system, i.e., the frequency response, $|H(\omega)|$, over $-\pi < \omega < \pi$.

(c) Plot magnitude of the DTFT of the output $y[n]$, $|Y(\omega)|$, over $-\pi < \omega < \pi$.