ELC 3335 – Signals and Systems
Fall 2011
Test 2 – April 3, 2012
Closed Book/Closed Notes/Formula Sheet Provided
1 hour and 15 minutes

1. The exam is closed-book/closed-notes. Only the formula sheet provided with the exam may be used.

2. A calculator may be used to assist with the test. No laptops or PDAs are allowed. No cellular phones may be used in any way during the test. Unauthorized electronic device use will result in disqualification.

3. You must circle or box your answers to get full credit.

4. All work and steps toward a solution must be clearly shown to obtain credit.

5. Partial credit may be given provided that the grader can clearly follow your work to the extent that an understanding of the problem is demonstrated.

6. No collaboration is allowed on this examination. Only the exam proctor may be consulted for clarification.

7. You may attach extra sheets to the exam if necessary. Each page should contain your name, the problem number, and the page number for that problem.

Please sign the statement below. YOU MUST SIGN THE STATEMENT OR YOU WILL GET A ZERO FOR THIS EXAMINATION!!!

I hereby testify that I have neither provided or received information from unauthorized sources during the test and that this test is the sole product of my effort.

Signed ________________________________ Date____________________
PROBLEM 1 (25 points): Consider the periodic function \( f(t) \):

(a) (5 points) Find the value of \( a_0 \) in the cosine/sine trigonometric Fourier series.

(b) (10 points) Find the value of \( a_n \) (in terms of \( n \) for \( n \geq 1 \)).
(c) (10 points) Find the value of $b_n$ (in terms of $n$ for $n \geq 1$).
PROBLEM 2 (20 points): The exponential Fourier series of a certain periodic signal is given by
\[
f(t) = 4e^{j(-4t+\pi/2)} + 6e^{j(-2t+\pi/4)} + 1e^{j(-t-\pi/3)} + 3 + 1e^{j(t+\pi/3)} + 6e^{j(2t-\pi/4)} + 4e^{j(4t-\pi/2)}
\]

(a) (7 points) Sketch the exponential Fourier series spectra (that is, provide plots of $|D_n|$ and $<D_n$ versus $\omega$). Clearly label all radian frequencies, amplitudes, and phases of the spectral components on your plots.

(b) (6 points) From the exponential spectral plots, plot the trigonometric Fourier series magnitude and phase spectra. Clearly label all radian frequencies, amplitudes, and phases of the spectral components on your plots.
(c) (7 points) By inspection of the plot in part (b), write the compact trigonometric Fourier series expression for f(t).
PROBLEM 3 (20 points): Using the definition of the Fourier transform, find the Fourier transform of \( f(t) \), where \( f(t) \) is shown below and defined as follows:

\[
f(t) = \begin{cases} 
1 & -2 \leq t < 0 \\
e^{-2t} & 0 \leq t < 3 \\
0 & \text{elsewhere}
\end{cases}
\]
PROBLEM 4 (15 points): Use Table 4.1 and Table 4.2 to find the Fourier transform of the following function $f(t)$. Do not use the definition; use an appropriate pair from Table 4.1 and an appropriate property from Table 4.2.
PROBLEM 5 (20 points): Determine the Nyquist sampling rate and the Nyquist sampling interval for the signal

\[ f(t) = 3 \text{sinc}(10\pi t) \text{sinc}^2(8\pi t) \]