EE 3801 Fall 2006

Midterm 1

October 12, 2006

INSTRUCTIONS:

- **Carry only one side of a $8\frac{1}{2}$" $\times$ 11" note and a pencil or a pen with you. The exam is closed-book, closed-note. No calculator is allowed.**
- **The duration of the exam is 75 minutes.**

Problem	Points
I	/10
II	/10
III	/10
IV	/10
V	/10
VI	/10
VII	/10
VIII	/10
IX	/10
X	/10
Total	/100

Name:

Problem I [10 pts]
State whether each of the following statements is TRUE or FALSE.

1. A linear system is time-invariant, but a time-invariant system is not necessarily linear.

2. If $f(t)$ is even, then $-f(t)$ is odd.

3. A periodic signal $f(t)$ is always equal to its Fourier series expansion at every t.

4. The sum of two periodic signals is also periodic.

5. The trigonometric Fourier series and the exponential Fourier series of a periodic signal are equivalent.

Problem II [10 pts]

1. Write the following complex number in polar form:

$$z = -1 + \sqrt{3}j$$

2. Write the following expression in the form of $C\cos(\omega_0 t + \theta)$:

$$f(t) = \cos\omega_0 t - \sin\omega_0 t$$

Problem III [10 pts]
Consider the signal shown below.

1. Express this signal by a single expression.

2. Plot $f(-t/2-1)$.

Problem IV [10 pts]
Is the following system linear or nonlinear? Justify your answer.

1. $y(t) = f(t) + 4$

2. $\frac{dy(t)}{dt} + 5y(t)^2 = 2f(t)$

Problem V [10 pts]
Is the following system time-invariant or time-varying? Justify your answer.

1. $y(t) = f(-t)$

2. $y(t) = \int_{-1}^{1} f(\tau) d\tau$

Problem VI [10 pts]
An LTI system has an impulse response $h(t) = e^{-2t}u(t-2)$. Suppose that the input is $f(t) = e^{-t}u(t-1)$. Calculate the zero-state response.

Problem VII [10 pts]
Calculate the convolution of $f_1(t)$ and $f_2(t)$ *using the graphical method,* where $f_1(t) = u(t+2) - u(t)$, $f_2(t) = t[u(t) - u(t-2)]$.

Problem VIII [10 pts] Simply the following expressions.

1. $\left(\frac{j\omega+2}{\omega^2+9}\right)\delta(\omega)$

2. $\int_{-\infty}^{\infty} e^{x-1}\cos\left[\frac{\pi}{2}(x-5)\right]\delta(x-3)dx$

Problem IX [10 pts]

$f(t)$ is periodic with period $T_0 = 2$, and $f(t) = u(t + 1/2) + u(t - 1/2)$ for $-1 \leq t \leq 1$.

1. Find its trigonometric Fourier series.

2. Find its exponential Fourier series.

Problem X [10 pts]
The trigonometric Fourier series of a periodic signal is given by

$$f(t) = 1 + 2\cos\left(t - \frac{\pi}{2}\right) + 2\sqrt{2}\sin\left(3t - \frac{\pi}{4}\right).$$

1. What is the fundamental period of this signal?
2. Sketch the trigonometric Fourier spectra.
3. Sketch the exponential Fourier spectra.