Massachusetts Institute of Technology
Department of Aeronautics and Astronautics
Cambridge, MA 02139

16.03/16.04 Unified Engineering III, IV
Spring 2004

Problem Set 14

Name: ______________________

Due Date: Not Due

	Time Spent (min)
CP21-23	
S19	
S20	
S21	
S22	
Study Time	

Announcements: Final on Wednesday, 5/19, 9am.

Unified Engineering II **Spring 2004**

Problem S19 (Signals and Systems)

Do problems 7.1–7.4 in Oppenheim and Willsky. Note: The solutions are in the back of the book.

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Problem S20 (Signals and Systems)

Do problem 7.26 in Oppenheim and Willsky.

Problem S21 (Signals and Systems)

Consider the signal

$$g(t) = (1 + |t|)e^{-|t|}$$

1. Plot the signal. Do you expect the signal to have a "good" duration-bandwidth product, meaning that the product is close to the lower bound?
2. Find the duration of the signal, Δt.
3. Find the bandwidth of the signal, $\Delta\omega$. You may want to use the time domain formula for the bandwidth.
4. How close is the answer to the theoretical lower bound? Explain why the answer is or is not close to the bound.

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Problem S22 (Signals and Systems)

Consider a pulse similar to the Loran-C pulse, given by

$$h(t) = t^3 e^{-t/\tau}\sigma(t)\sin(2\pi f t) = g(t)w(t)$$

where

$$g(t) = te^{-t/\tau}\sigma(t)$$
$$w(t) = \sin(2\pi f t)$$

(a) Find the *centroid* of the pulse envelope, given by

$$\bar{t} = \frac{\int t g^2(t)\, dt}{\int g^2(t)\, dt}$$

(b) Find the duration of the envelope, given by

$$\Delta t = 2\left(\frac{\int (t-\bar{t})^2 g^2(t)\, dt}{\int g^2(t)\, dt}\right)^{\frac{1}{2}}$$

(c)

$$\Delta\omega = 2\left(\frac{\int \dot{g}^2(t)\, dt}{\int g^2(t)\, dt}\right)^{\frac{1}{2}}$$

(d) How does the duration-bandwidth product compare to the theoretical minimum?