EXAM #1 **ELEG403** **Wednesday October 22, 2003**

- Closed book
- Read all problems carefully before proceeding.
- There are four problems that are equally weighted (25 points each).
- There is also a bonus problem worth an additional 10 points.

Problem #1

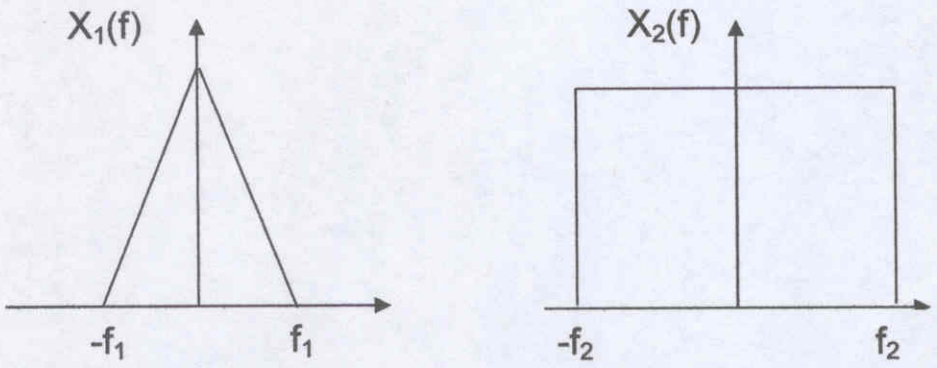
Using your knowledge of the Fourier transform and its properties, compute the spectrum of y(t) where

$$y(t) = [x(t-t_0) * (dx(t)/dt)] \cos \omega_c t$$

The symbol * represents convolution in time. Assume that x(t) = sinc 40t.

Problem #2

Consider the bandlimited energy signals, $x_1(t)$ and $x_2(t)$, with the following spectra



where f_1 = 5 kHz and f_2 = 10 kHz. These signals are combined to give

$$y(t) = x_1(t) + 2x_2(t) \cos \omega_c t$$

where f_c = 30 kHz.

a.) Compute Y(f) in terms of $X_1(f)$ and $X_2(f)$ and sketch Y(f).
b.) What is the bandwidth of y(t)?
c.) Given y(t), how would you recover $x_1(t)$ and $x_2(t)$?

Problem #3

The signal $m(t) = \text{sinc}^2 40t$ is transmitted using standard AM with $k_a < 1$.

a.) Sketch the double-sided spectrum of s(t), the standard AM signal.
b.) What is the transmission bandwidth?
c.) How would you demodulate this signal?
d.) If no carrier were present in transmission, how would you demodulate the received signal?

Problem #4

A sinusoidal waveform with amplitude $A_m = 5$ Volts and frequency $f_m = 15$ kHz is used to frequency modulate a carrier. The modulator has a frequency sensitivity $k_f = 3$ kHz/Volt.

a.) Write the expression for the transmitted FM signal.
b.) What is the peak frequency deviation?
c.) Find the transmission bandwidth by using Carson's rule.
d.) Describe one approach to recovering the message from the frequency modulated waveform.

Bonus Problem (extra 10 points)

You are talking on a cordless phone, which uses amplitude modulation, when someone turns on a motorized appliance, causing static on the phone. You switch to your new FM cordless phone, and the call is clear. Explain.