EE341 Exam 1
March 14, 2003
Closed Book, Justify all work

Good Luck

NAME_____________________

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1) (21) Consider a baseband signal with $M(\omega) = \Pi(\omega/(2\pi))$.

a) Plot magnitudes of the Fourier Transforms of the following signals carefully labeling significant points.

$$x(t) = 200m(200t)\cos(2000\pi t)$$

$$y(t) = 200m(400t)\cos(1000\pi t) - 200\hat{m}(400t)\sin(1000\pi t)$$

$$z(t) = 50m(100t) \sum_{k=-\infty}^{\infty} \delta(t - k/1000)$$

b) From part a) determine which of the signals will pass relatively undistorted through the system $h(t)$ specified below. If a signal is distorted, specify the type of distortion.

![Graphs showing magnitude and phase of H(w)]
2) (14) An FM signal $x(t)$ is input into a superheterodyne receiver shown below that translates the signal down to 10.7MHz. We have that $x(t)$ is centered at 96.3MHz.

\[ x(t) \rightarrow HR(\omega) \rightarrow x \rightarrow cos(\omega_0t) \rightarrow HI(\omega) \rightarrow y(t) \]

a) Find a frequency $f_0$ that does the correct translation. Associated with this $f_0$ find the corresponding image frequency $f_I$ and discuss desired characteristics of the bandpass filter $H_R(\omega)$.

b) Repeat for the other frequency $f_0$ that also does the correct translation.
3) (15)

a) Find matlab commands to generate \( x(t) \) an AM signal with carrier frequency \( \omega_0 \). In matlab, you are given the baseband information signal \( m \) and the time index \( t \). For AM ensure that envelope of signal is always greater than zero (no overmodulation). Also find matlab commands to recover \( m(t) \) from \( x(t) \) assuming baseband signal, \( m(t) \) has bandwidth \( B_m << \omega_0 \).

b) Use matlab commands to generate a random baseband signal of bandwidth 10Hz.
4) (20) Consider the following FDM signal \( x(t) \) that is composed of three modulated baseband signals; \( a(t) \), \( b(t) \), and \( c(t) \). The three baseband signals all have bandwidth \( B = 20K \pi \) radians. We have \( |a(t)| < 1 \), \( \hat{a}(t) \) representing the Hilbert transform of \( a(t) \), and \( \omega_0 = 2M \pi \) radians.

\[
x(t) = a(t) \cos(\omega_0 t) + \hat{a}(t) \sin(\omega_0 t) + b(t) \cos((\omega_0 + 2B)t) + c(t) \sin((\omega_0 + 2B)t).
\]

a) For the transmitted signal \( x(t) \), draw a diagram in the frequency domain where modulated versions of \( a(t) \), \( b(t) \), and \( c(t) \) reside.

b) If possible, construct receivers to recover the three baseband signals from the transmitted signal \( x(t) \).
5) (25) Let $M(\omega)$ be a baseband signal shown below. Assume that $B_M << \omega_0$. Consider the following system below. Plot the spectrum of $A(\omega), B(\omega), C(\omega), D(\omega),$ and $X(\omega)$.