ECE 642 - Midterm Spring 2013

Please justify all your responses (responses without justifications will not be considered). Please label your axes and plot with care.

1. (2 points) The baseband signal $x(t) = 4\cos(8\pi t)$ is amplified using an amplifier that produces the output $y(t) = 2x(t) + 0.1x^2(t)$.

a. Calculate $y(t)$.

b. Calculate and plot $Y(f)$.

c. The signal $y(t)$ goes through a filter with impulse response $h(t) = 12\text{sinc}(12t)$. What is the output of this filter?

2. (2 points) We are given the complex envelope $x_z(t) = 2e^{j6\pi t} + je^{-j6\pi t}$.

a. Calculate $x_I(t)$ and $x_Q(t)$.

b. Calculate and plot the real part of $X_z(f)$. Also, calculate and plot the imaginary part of $X_z(f)$. Comment on the symmetry or lack thereof of the plots.

c. Calculate the passband signal $x_c(t)$ for carrier frequency $f_c = 20$ Hz.

d. Calculate and plot the real and imaginary parts of $X_c(f)$. What is the bandwidth B_T?

3. (2 points) Consider the baseband message $m(t) = \text{sinc}(4t)$. The message is transmitted using DSB-AM with $A_c = 2$ and carrier frequency $f_c = 10$ Hz.

a. Choose an appropriate sampling frequency for the passband signal $x_c(t)$.

b. Write MATLAB code to plot $|X_c(f)|$.

4. (2 points) The baseband message $m(t) = \sin(2\pi t)$ is given.

a. Calculate the passband signal $x_c(t)$ obtained with PM modulation with $A_c = 2$, $f_c = 10$ Hz and $k_p = 1$.

b. What is (approximately) the bandwidth of the signal $x_c(t)$ of the previous point?

c. Calculate the passband signal $x_c(t)$ obtained with FM modulation with $A_c = 2$, $f_c = 10$ Hz and $k_f = 1$.

d. What is (approximately) the bandwidth of the signal $x_c(t)$ of the previous point?

5. (2 points) The passband received signal in a DSB-AM system is given as $y_c(t) = 0.1\cos(2\pi(t - 0.1))\cos(2000\pi(t - 0.1))$.

a. Calculate the baseband equivalent $y_z(t)$.

b. Propose a baseband demodulator to recover the message $m(t) = \cos(2\pi t)$ (possibly with some delay).