ECE 642 - Midterm Spring 2015

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

1. (4 points) Consider the baseband filter defined as

$$H_z(f) = \begin{cases} 1 - |f|/5 & \text{for } 0 \leq |f| \leq 5\text{Hz} \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

a. Evaluate the corresponding bandpass filter with carrier frequency $f_c = 20$Hz by plotting the frequency response.

b. The signal $x_c(t) = \sqrt{2}(\cos(6\pi t) + 2\cos(12\pi t))\cos(40\pi t)$ is filtered using the bandpass filter at point a. Write the equation of the output $y_c(t)$.

c. Write the equation of the complex baseband equivalent $y_z(t)$ of the output signal obtained at the previous point.

d. Calculate the powers of the signal $x_c(t)$ and of the signal $y_c(t)$.

2. (6 points) We are given the message $m(t) = \text{sinc}(t-1)$.

a. Calculate and sketch the absolute value and the phase of the Fourier transform $M(f)$.

b. Assuming PM, write the equation of the modulated signal $x_c(t)$ with $k_p = 1$, $A = 1$ and $f_c = 10$Hz (A is the amplitude of the complex baseband equivalent).

c. Assuming FM, find an approximate expression for the bandwidth B_T of the modulated signal with $k_f = 1$, $A = 1$ and $f_c = 10$Hz.

d. Assuming DSB-AM, calculate and sketch the absolute value and the phase of the Fourier transform of the modulated signal with $A = 1$ and $f_c = 10$Hz.

e. Indicate how the spectral efficiency of DSB-AM could be improved upon.

f. Calculate the correlation function of $m(t)$.