ECE 642 - Midterm Spring 2014

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 signal $x(t) = \sum_{n=-\infty}^{\infty} s(t - 2n)$, where $s(t)$ is a rectangle of unit height spanning the interval $[-1/2, 1/2]$.

a. Plot $x(t)$.

b. Calculate and plot the Fourier transform $X(f)$.

c. Consider a bandpass filter $H_c(f)$ with unit gain, central frequency equal to 3/2 Hz and bandwidth equal to 1 Hz. Calculate the output $y(t)$ (in the time domain) of this filter when the input is $x(t)$.

d. Evaluate the frequency response of the equivalent baseband filter $H_z(f)$.

2. (5 points) We are given the complex baseband signal $x_z(t) = \text{sinc}(t-1) + j2\text{sinc}(t)$.

a. Calculate the real part and the imaginary parts of the Fourier transform $X_z(f)$ (to express the transforms, please use the function $\text{rect}(t)$, which is defined as a rectangle of unit height and spanning the interval $[-1/2, 1/2]$).

b. Plot the real and imaginary parts of $X_z(f)$. Comment on the symmetry or lack thereof of these plots.

c. Plot the real part of the Fourier transform of the bandpass signal obtained by upconverting $x_z(t)$ to the carrier frequency 10 Hz.

d. Plot the imaginary part of the Fourier transform of the bandpass signal of the previous point.

e. Choose a sampling frequency for the bandpass signal at the previous points.

3. (2 points) Consider the baseband message $m(t) = \text{rect}(t)$ (the function $\text{rect}(t)$ is defined at the previous problem). The message is modulated using DSB-AM with $A = 1$ and is received through a channel with phase $\phi_P = \pi$.

a. Draw the baseband equivalent block diagram of the DSB-AM system including the explicit equations for all the involved signal ($x_z(t)$, $r_z(t)$, etc.).

b. Assume that the baseband demodulator uses the wrong phase $\theta_P = \pi/2$, instead of $\phi_P = \pi$. What is the demodulated message $\hat{M}(t)$ (you can neglect the noise)?