ECE 642 - Midterm Fall 2013

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

1. (2 points) For the signal $x(t) = 4\cos(6\pi t) + \sin(2\pi t)$:

a. Calculate the Fourier transform.

b. Calculate the Fourier series.

c. Plot the absolute value of the Fourier transform.

d. Plot the phase of the Fourier transform.

2. (4 points) For the complex envelope $x_z(t) = 5 + je^{j4\pi t}$:

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

b. Calculate and plot $X_z(f)$ (both amplitude and phase). Does it satisfy Hermitian symmetry? Why?

c. Calculate the passband signal $x_c(t)$ for carrier frequency $f_c = 30$ Hz.

d. Calculate and plot $X_c(f)$ (both amplitude and phase). Does it satisfy Hermitian symmetry? Why?

3. (1 point) Consider the signal $\text{sinc}(\frac{t-1}{4})\cos(20\pi t)$. Choose an appropriate sampling frequency.

4. (2 points) A baseband message is given as $m(t) = t$ for $0 \leq t \leq 1$ and $x(t) = 0$ elsewhere.

a. Calculate the passband signal $x_c(t)$ obtained with PM modulation with $A_c = 1$, $f_c = 20$ Hz and $k_p = 2$.

b. What is the bandwidth of the signal $x_c(t)$ of the previous point (you can approximate the bandwidth of the message with that of a rectangle of the same duration)?

c. Calculate the passband signal $x_c(t)$ obtained with FM modulation with $A_c = 1$, $f_c = 20$ Hz and $k_f = 2$.

d. What is the bandwidth of the signal $x_c(t)$ of the previous point (you can approximate the bandwidth of the message with that of a rectangle of the same duration)?

5. (1 point) A passband signal is given as $r_c(t) = \sin(2\pi(t-0.2))\cos(20\pi(t-0.2))$.

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

b. A filter with baseband equivalent $H_z(f) = 1$ for $-1/2 \leq f \leq 1/2$ and $H(f) = 0$ elsewhere is applied. Calculate the passband output of the filter.