ECE 642 - Midterm Fall 2016

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

1. (5 points) We consider a variant of DSB-AM modulation in which the quadrature carrier, and not the in-phase carrier, is used to modulate information. Specifically, assume that the analog message is $m(t) = \text{sinc}(t)$ and that the complex baseband signal is $x_z(t) = x_Q(t) = \text{sinc}(t)$.

a. Write the equation of the corresponding modulated passband signal $x_c(t)$ at a carrier frequency 100 Hz.

b. Plot $x_A(t)$ and $x_P(t)$.

c. Compute and plot the absolute value and phase of the Fourier transform of $x_c(t)$.

d. Design a passband filter such that the output of the filter is $x_c(t) = \sqrt{2}m(t)\cos(2\pi 10^2 t)$. Draw the absolute value and phase of its frequency response.

e. Derive the absolute value and phase of the frequency response of the equivalent baseband filter corresponding to the passband filter designed at the previous point.

2. (3 point) You have baseband signal $m(t)$ with Fourier transform $M(f) = 1 - |f|$ for $|f| \leq 1$ and $M(f) = 0$ otherwise.

a. Plot the Fourier transform of a DSB-AM signal that modulates $m(t)$ with $A = 1$ and $f_c = 10$ Hz.

b. Plot the Fourier transform of a filter that enables to obtain a spectral efficiency equal to 100%.

c. Plot the Fourier transform of the equivalent complex baseband signal at the output of this filter. Is this signal real or complex in the time domain?

3. (2 points) Consider the analog message $m(t) = \text{sinc}(2(t-2))$.

a. If the modulation is 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).

b. For 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.