ECE 642 - Midterm Fall 2014

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

1. (3 points) Consider a digital information signal that encodes the message 01001. The signal is such that "0" is encoded with a rectangle of height 1 and duration 1 ms, while a "1" is encoded with a rectangle of height -1 and the same duration

a. Plot $x(t)$.

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

c. Evaluate the absolute value and phase of the Fourier transform at frequency 1 kHz.

2. (4 points) We are given the passband signal $x_c(t) = \sqrt{2}\text{sinc}(t)\cos(2\pi 100t + 2\pi t)$.

a. Calculate in-phase and quadrature components, namely $x_I(t)$ and $x_Q(t)$.

b. Calculate the amplitude $x_A(t)$.

c. Calculate the real part of the Fourier transform of the complex envelope $x_z(t)$.

d. Calculate the real part of the Fourier transform of the passband signal $x_c(t)$.

3. (2 points) The signal $x_c(t) = (\sin(20\pi t) + \cos(40\pi t))\cos(2\pi 1000t)$ is given.

a. Provide a passband filter that produces at the output a tone at frequency 1010 Hz.

b. Represent the filter in the baseband domain.

4. (1 point) You have available a bandwidth of 20 MHz around the carrier frequency 2.4 GHz.

a. What is the largest bandwidth W of an analog information signal that can be transmitted using AM?

b. Respond to the same question for FM assuming $K_f = 1$ and that the maximum value of the message is $3W$.