Lab Assignment - 6
Amplitude Modulation

March 10, 2016

PROBLEM 1:

In this lab, we will implement a communication system based on amplitude modulation. The suggested reading from the text is Section 4.3. All the spectra in this assignment should display both positive and negative frequencies and not just positive ones. There should be no `for` loops in the entire solution.

Consider the following message signal:

$$x(t) = 5\left[e^{-10t} + e^{-t} + e^{-t/2}\right]\sin(4\pi t)\left[u(t) - u(t-5)\right].$$

We want to transmit $x(t)$ using a carrier of 300Hz.

(a) Write MATLAB code to compute the vector $\boldsymbol{x}$ corresponding to $x(t)$. What sampling frequency did you choose and why? Plot the signal $\boldsymbol{x}$ and its magnitude and phase spectrum.

(b) Write MATLAB code to compute the double-sideband suppressed-carrier (DSB-SC) waveform for $x(t)$ for transmission on our carrier. Do we need to change the sampling frequency of the vector $\boldsymbol{x}$ now? Why or why not?

(c) Write MATLAB code to coherently demodulate the carrier in part (b). Use the function for a low pass filter provided below. Plot the filtered sequence and its both spectra on the same figure using `subplot` command. Did you recover the message signal exactly? Plot the original message signal and the reconstructed one on the same figure, overlayed on each other using `hold on` command.

```
function y = lp_filter(x, f_cutoff, F_sampling )
%y is the filtered sequence
```

```
%x is the input sequence
%f_cutoff is the desired cutoff frequency of the low pass filter
%F_sampling is the sampling rate of the inout sequence
%f_cutoff should be less than half of sampling frequency
%  i.e. 2*f_cutoff < F_sampling

N = 100;
Rp  = 0.00057565; % Corresponds to 0.01 dB peak-to-peak ripple
Rst = 1e-4;       % Corresponds to 80 dB stopband attenuation

Wn = 2*f_cutoff/F_sampling;
b = firceqrip(N,Wn,[Rp Rst],'passedge'); % NUM = vector of coeffs
y=filter(b,1,x);
y = [y(N/2+1:end); zeros(N/2,1)];
end
```

(d) Write MATLAB code to transmit $x(t)$ using DSB-C or AM. How much DC component did you add to $x(t)$ before feeding it to the DSB-SC modulator?

(e) Write MATLAB code to demodulate the carrier in part (d). Did you recover the signal exactly?

(f) Draw sytem-level block diagrams from antenna to speakers that will implement both of your modulators and demodulators using Xilinx Spartan 3 boards you used in EE-372 digital systems design course. You can add antenna, analog to digial and digital to analog converters in your block diagram. Draw block diagrams of digital hardware that you will implement inside the Xilinx FPGA.

Deliverable

You are required to bring a hand-written report of the assignment to the lab. You don't need to print plots and only need to write the code corresponding to different plots. The first page of your report should answer the short questions in different parts of the assignment.