Chapter 4
MATLAB Problems

4.1 Write a program to amplitude modulate a 1000 Hz carrier using 50%, and 100% levels, and $A_c = 10$. Use a single-tone message with $f_{m1} = 100$ and $A_{m1} = 1.0$. Plot the time and frequency domain versions of your AM signal. How does the 50% version differ from the 100%?

4.2 a. Repeat 4.1 except use DSB modulation.

b. Add a 6th order Butterworth BPF to your DSB signal to suppress the lower sideband. Plot the time and frequency domain versions of your USSB signal. Note: don't forget the negative frequencies. What conclusion(s) can you draw from the results?

c. Repeat above step 4.2b, except use a 3rd order Butterworth filter. Compare the amount of sideband suppression. How does the reduced filtering affect the results?

d. Repeat above step 4.2b, except add a a second message tone with $f_{m2} = 140$ and $A_{m2} = 0.5$. Compare the results with those of Prob. 4.2a. What conclusion(s) can you draw from this experiment?

4.3 Add the necessary software to Prob. 4.1 to create an envelope detector that will demodulate the AM signal. Show that the detector output is the same as the original message. For each stage of the envelope detector (rectifier, LPF, etc.) plot the signal's time and spectra.

4.4 Repeat 4.3 except create a product detector. Plot the signals for each stage.

4.5 Repeat Prob. 4.4, except use a product detector where the local oscillator has an error of 2%. How is the detector's output affected by the error?

4.6 Show that your product detector will also demodulate the two-tone USSB signal.

4.7 Repeat 4.3 except create an envelope detector using a nonlinear device with the following input-output characteristic: $v_{out} = v_{in} + v_{in}^2$ You may use adders, scalars, but not a multiplier.

4.8 Implement a SSB system using Weavers method. Demonstrate that it works using the two tone message of Prob. 4.2d.

4.9 Show that an envelope detector is not suitable to demodulate a DSB signal. As a test case, use a DSB with $f_c = 1$ kHz and the two-tone message of Prob. 4.2d.

For comparison purposes, demodulate your DSB signal using both a product and envelope detectors. What conclusions can you draw?

4.10 Design a DSB modulator using the nonlinear device of Prob. 4.7 and any combination of adders, or filters, but not a multiplier. Show your design works by using the two-tone message of Prob. 4.2b.