Chapter 7
MATLAB PROBLEMS

7.1. Develop the Matlab code to simulate an AM broadcast superhet receiver for the specifications of Table 7.1-1. Evaluate its performance with respect to image rejection. To improve computation speed, reduce all frequencies by a factor of 1000. Thus $f_{IF} = 455$ kHz $\rightarrow 455$ Hz, $540 < f_c < 1700$ Hz, and $995 < f_{LO} < 2155$ Hz, etc. Use a 1st order BPF for the IF strip with $B = 10$ Hz. Have the input signal consist of a carrier with amplitude $A_c = 1$. Set the receiver local oscillator frequency such that $f_{LO} = 1075$ Hz and therefore the nominal value of $f_c = 620$ kHz. Let's initially assume there is no filtering at the receiver's front end.

a. Sweep the AM signal's carrier frequency from 500 to 3000 Hz and determine the receiver response versus input frequency.

b. Add a 3rd order butterworth filter at the receiver's front end with cutoff frequency $f_0 = f_{LO}$ Hz. and then repeat the above step. How does the front end LPF affect image response?

7.2 Repeat Prob 7.1 except for $f_{IF} = 2000$ kHz . This means $f_{LO} = 2620$ for $f_c = 620$ kHz. (a) Have a 1st order butterworth filter at the receiver's front end with $f_0 = f_{LO}$, (b) Repeat part (a) with a 3rd order butterworth filter at the front end. Compare and discuss your results of this problem and the results obtained from Prob. 7.1. What other function is this receiver system performing?

7.3 Simulate the system of Fig. 7.2-6 to show that you can transmit two messages over a single channel without interference if you use two orthogonal carrier signals. For test purposes, use DSB signals at the same carrier frequency equal to $f_c = 620$ Hz, single tone message and the following parameters: $A_{c1} = A_{c2} = 1$, $A_{m1} = 1$, $A_{m2} = 0.5$, $f_{m1} = 10$ Hz, and $f_{m2} = 7.5$ Hz.

7.4 Repeat Prob. 7.3 except to show the effects of a 45 degree phase error in the quadrature component. Comment on your results.

7.5 Simulate the DC receivers of Figs. 7.1-3 and 4 to show how each receiver processes LSSB and USSB signals transmitted at the same carrier frequency. Input two signals to the receiver, one a LSSB with a 10 Hz message at $f_c = 1$ kHz, and the second a USSB with a 20 Hz message at $f_c = 1$ kHz. Show that the receiver in Fig. 7.1-4 rejects the LSSB signal whereas the receiver in Fig. 7.1-3 will allow the two signals to interfere with each other.

7.6 Implement and simulate an PLL FM detector using the basic blocks shown in Fig. 7.3-2. Use the FM signal of MATLAB Prob. 5.1 to test your detector. Plot several cycles of the message to indicate the how quickly the PLL achieves lock.