Chapter 10
MATLAB Problems

10.1 Simulate the transmission of a single tone message in the presence of additive white gaussian noise (AWGN) to show the effects on low pass and band pass filtering on the signal's power spectral density plot.

(a) Transmitt a single tone baseband signal with parameters of

(i) $A_m = 1,$ and $f_m = 200,$
(ii) 3rd order LPF with $W = 500$ Hz,
(iii) $(S/N)_D \approx 100 - 200$ dB.

Plot both the power spectral density of the noisy signal. You may have to expand the amplitude scale to see the noise component. Calculate a precise value of signal-to-noise ratio.

(b) Repeat part (a) except simulate an AM signal containing the message in Part (a). Use the parameters of

(i) $A_c = 1,$ and $f_c = 1500,$ μ=1, $A_m = 1,$ $f_m = 200$
(ii) 3rd order BPF with center frequency =1500 Hz, and $B_T = 1000$ Hz
(iii) Enough additive noise to see it in a power spectral density plot.

Plot the power spectral density of the modulated signal with and without band pass filtering. Again, you may have to expand the amplitude scale to see the noise component.

10.2 Write a program to simulate the performance of envelope and product detectors to demodulate a 100 % modulated AM signal with a single tone message. Use the following parameters for your transmitter and receiver:
$f_c = 2000$ Hz, $f_m = 200$ Hz, $A_c = 1,$ $A_m = 1,$ $\mu = 1,$ 3rd order LPF, and W=500 Hz.
Try a various (S/N) levels. Once you get a specific level of (S/N) to where the product detector's output is somewhat clear as compared to the envelope detector's, then do 20 runs of your simulation to average out the signal waveforms. Plot the detectors' outputs. State any observations or conclusions of your results.

10.3. Using the message and filter parameters in Prob. 10.2, compare the $(S/N)_D$ performance of AM versus DSB using product detection. Make the necessary plots of your signals.

10.4 Repeat Prob. 10.3 except have the product detector demodulate a DSB signal and the envelope detector demodulate an AM signal. Consider averaging the detector outputs.

10.5 Simulate an AM system using various values of γ to show threshold effects and verify Eq. (15b) of Sect. 10.2 for (a) an envelope detector, (b) verify the statement on page 453 that there is no threshold effect with the product detector.

10.6 Implement and simulate an FM system with a slope detector, single tone message and a received signal that has been corrupted by AWGN. Consider the following:

(a) Test your system to see the threshold effect and signal quality.
(b) Determine the degree in which Eq. (19) of Sect. 10.3 establishes the threshold point at which further increases in D no longer improve the signal quality.

Output the appropriate plots and make any appropriate observations and conclusions.