Chapter 3
MATLAB Problems

3.1 Write a program to determine the order of a Butterworth LPF needed to insure that the bandwidth of an audio signal is -60 db down from its maximum at a frequency of 20 kHz and has a half power frequency of 15 kHz. Assume that the input signal is flat over 20 kHz.

3.2 Write a program to show how multipath causes fading with signals received on a mobile receiver. Limit yourself to fading due to signal cancellation as modeled in Fig. 3.2-9. Thus you may neglect path losses due to spherical dispersion, absorption by the media, etc.. Assume the following: (a) the frequency is 1900 MHz, (b) the transmitter's antenna is 100 feet high and radiates omni directionally, (c) the receiver is 5 feet off the ground, (c) the linear distance between the tower base and the receiver will vary between 1 to 5 kilometers, and (c) the signal reflects halfway between the transmitter and receiver, thus the angle between ground and tower and ground and receiver will vary as the receiver moves away from the tower. Plot signal strength versus distance from the transmitter. Hint: before writing code, make a sketch of your system and specify how the multipath distances and time delays are affected was he receiver moves away from the transmitter.

3.3 Given a single order RC LPF whose half power frequency is 20 kHz. At what input frequency does the amplitude and phase distortion exceed 1%?

3.4 Write the code for a correlator that will recognize a single period 50 Hz sine wave sampled at 500 Hz, and reject other sinusoidal waves. Plot the maximum value of correlator output for inputs of 1 to 100 Hz.

3.5 Using adaptive cancellation, write a program that will eliminate 60 Hz interference that has corrupted a 1000 Hz sine wave. As a benchmark, compare your results if you used a single order band reject filter.

3.6 Determine the degree of adjacent channel rejection for a single order BPF used on an AM broadcast radio. Assume the BPF's center frequency is 990 kHz and the interfering signals are occurring at 1000 and 1010 kHz and that all signals have equal power. What would be the level of interference rejection if a third order BPF were used.

3.7 Dynamic range. Consider a system with an input/output relationship of $y = T[x] = \tan^{-1}(x)$ and an input of $x(t) = A_1 \cos 2\pi 100t + A_2 \cos 2\pi 400t$ with with $A_1 > A_2$. Determine the values of A_1 and A_2 whereby the system is 90% linear. Plot output versus input for your values of A_1 and A_2 alongside a linear plot to show where the output values deviate from the linear line. There may be more than one solution.