Çankaya University – ECE Department – ECE 376

2013 Spring Term **April 2013**

Experiment 7 : Observing Matched Filter, Correlator Outputs, Detection, and Calculating P_e Manually.

Experiment in MATLAB is given on the course webpage with the file names MFDetector_Exp7.m and PSKMod_Exp7.

1. This experiment generates M ary 10 PSK signals, $s_m(t)$ s, then transmits the first symbol. At receiver side noise is added, correlator or matched filter demodulation is applied to the received symbol, then a decision is made upon selecting the maximum of the calculated correlation metrics values.
2. At the present settings, $M = 32$, noise spectral density is $N_0 = 0.1$ dBWatt/Hz (line 44 of the m file). Signal energy (bit, binary waveform basis) is $\varepsilon_b = \varepsilon_s / \log_2(M) = 1/\log_2(32) = 0.2$ Joule or $\varepsilon_b = -6.9897$ dB Joule. Therefore, SNR is $\text{SNR} = \overbrace{-6.9897 \text{ dB Joule}}^{\text{signal energy, } \varepsilon_s} - \overbrace{0.1 \text{ dBWatt/Hz}}^{\text{noise spectral density, } N_0} \simeq -7 \text{ dB}$. Looking at the probability of error curves of PSK given in Fig. 1 below, we see that this SNR is slightly out of range. In this figure at minimum $\text{SNR} = -4$ dB, we can read that $P_e \simeq 0.8$ and the curve of $M = 32$ is nearly asymptotic to the horizontal axis around this point, so we can assume that at $\text{SNR} = -7$ dB, we will still have roughly $P_e \simeq 0.8$. Running the m file 10 times, we approximately get this ratio.
3. Recalculate the noise spectral density (written as noise_power on line 44 of the m file) necessary to make the SNR 4 dB and insert this value on line 44 of the m file, then run the m file for $M = 2,\ 4,\ 8,\ 16,\ 32$ for sufficient number of times and calculate probability of error P_e manually (hand counting). For this you can use (6.36) of ECE376_ Dimensionality of Signals_ASK_PSK_QAM_FSK_Jan 2013_HTE. Check that these P_e numeric values conform with those read from Fig. 2.
4. Observe the time waveforms plotted in Figure 1 and Figure 2 when the code is run, comment on what these waveforms represent.

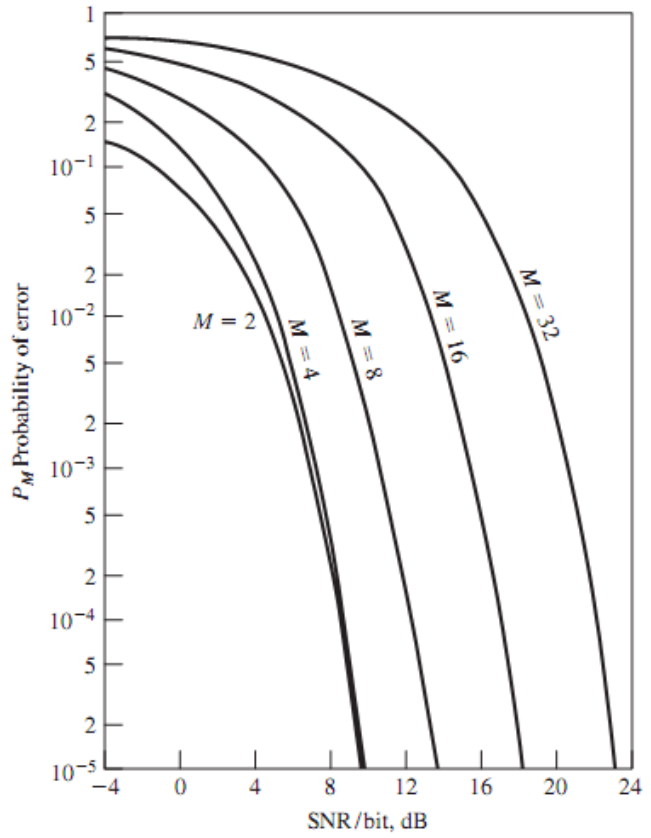

Figure 7.57 Probability of a symbol error for PSK signals.

Fig. 1 Theoretical probability of error curves for PSK at $M = 2,\ 4,\ 8,\ 16,\ 32$ (from Fig. 7.57 of Proakis 2002).

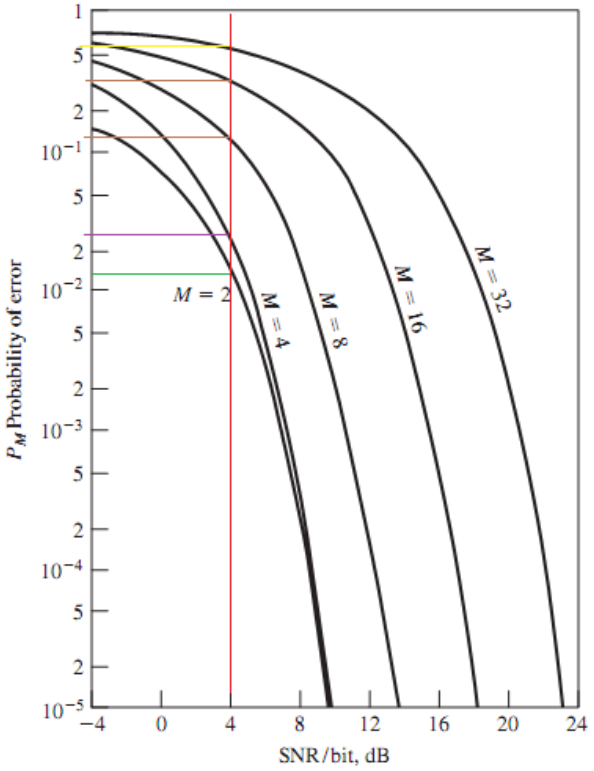

Figure 7.57 Probability of a symbol error for PSK signals.

Fig. 2 Theoretical probability of error curves for PSK at $M = 2,\ 4,\ 8,\ 16,\ 32$ (marked at SNR = 4 dB).