7.20 In this chapter we showed that an optimal demodulator can be realized as:

- A correlation-type demodulator
- A matched-filter type demodulator

where in both cases $\psi_j(t)$, $1 \leq j \leq N$, were used for correlating $r(t)$, or designing the matched filters. Show that an optimal demodulator for a general M-ary communication system can also be designed based on correlating $r(t)$ with $s_i(t)$, $1 \leq i \leq M$, or designing filters that are matched to $s_i(t)$'s, $1 \leq i \leq M$. Precisely describe the structure of such demodulators by giving their block diagram and all relevant design parameters, and compare their complexity with the complexity of the demodulators obtained in the text.

7.21 In a binary antipodal signalling scheme the signals are given by

$$s_1(t) = -s_2(t) = \begin{cases} \frac{2At}{T} & 0 \leq t \leq \frac{T}{2} \\ 2A\left(1 - \frac{t}{T}\right) & \frac{T}{2} \leq t \leq T \\ 0, & \text{otherwise} \end{cases}$$

The channel is AWGN and $S_n(f) = \frac{N_0}{2}$. The two signals have prior probabilities p_1 and $p_2 = 1 - p_1$.

1. Determine the structure of the optimal receiver.
2. Determine an expression for the error probability.
3. Plot error probability as a function of p_1 for $0 \leq p_1 \leq 1$.

7.22 In an additive white Gaussian noise channel with noise power-spectral density of $\frac{N_0}{2}$, two equiprobable messages are transmitted by

$$s_1(t) = \begin{cases} \frac{At}{T}, & 0 \leq t \leq T \\ 0, & \text{otherwise} \end{cases}$$

$$s_2(t) = \begin{cases} A\left(1 - \frac{t}{T}\right) & 0 \leq t \leq T \\ 0, & \text{otherwise} \end{cases}$$

1. Determine the structure of the optimal receiver.
2. Determine the probability of error.

7.23 Consider a signal detector with an input

$$r = \pm A + n$$

where $+A$ and $-A$ occur with equal probability and the noise variable n is characterized by the (Laplacian) pdf shown in Figure P-7.23.

1. Determine the probability of error as a function of the parameters A and σ.
2. Determine the "SNR" required to achieve an error probability of 10^{-5}. How

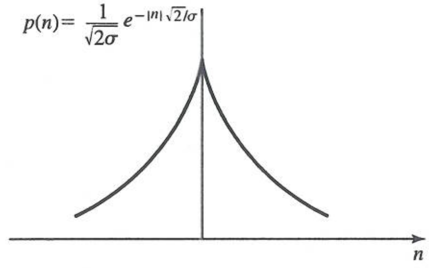

Figure P-7.23

7.24 A Manchester encoder maps an information 1 into 10 and a 0 into 01. The signal waveforms corresponding to the Manchester code are shown in Figure P-7.24. Determine the probability of error if the two signals are equally probable.

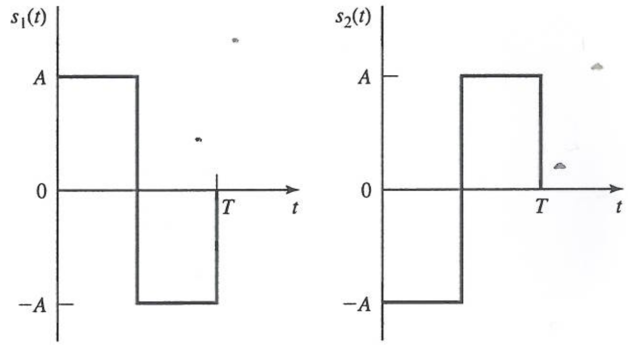

Figure P-7.24

7.25 A three-level PAM system is used to transmit the output of a memoryless ternary source whose rate is 2000 symbols/sec. The signal constellation is shown in Figure P-7.25. Determine the input to the detector, the optimum threshold that minimizes the average probability of error, and the average probability of error.

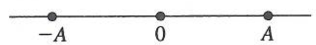

Figure P-7.25

7.26 Consider a biorthogonal signal set with $M = 8$ signal points. Determine a union