

Figure P-7.6

and are equally correlated, with correlation coefficient

$$\gamma_{mn} = \frac{1}{\mathcal{E}} \int_0^T s'_m(t) s'_n(t) dt = -\frac{1}{M-1}$$

7.8 Suppose that two signal waveforms $s_1(t)$ and $s_2(t)$ are orthogonal over the interval $(0, T)$. A sample function $n(t)$ of a zero-mean, white noise process is crosscorrelated with $s_1(t)$, and $s_2(t)$, to yield

$$n_1 = \int_0^T s_1(t) n(t) dt$$

$$n_2 = \int_0^T s_2(t) n(t) dt$$

Prove that $E(n_1 n_2) = 0$.

7.9 A binary digital communication system employs the signals

$$s_0(t) = 0, \quad 0 \leq t \leq T$$

$$s_1(t) = A, \quad 0 \leq t \leq T$$

for transmitting the information. This is called *on-off signaling*. The demodulator crosscorrelates the received signal $r(t)$ with $s_1(t)$ and samples the output of the correlator at $t = T$.

1. Determine the optimum detector for an AWGN channel and the optimum threshold, assuming that the signals are equally probable.
2. Determine the probability of error as a function of the SNR. How does on-off signaling compare with antipodal signaling?

7.10 A binary PAM communication system employs rectangular pulses of duration T_b and amplitudes $\pm A$ to transmit digital information at a rate $R_b = 10^5$ bps. If the power-spectral density of the additive Gaussian noise is $N_0/2$, where $N_0 = 10^{-2}$ W/Hz, determine the value of A that is required to achieve a probability of error $P_b = 10^{-6}$.

7.11 In a binary PAM system for which the two signals occur with unequal probabilities (p and $1 - p$), the optimum detector is specified by Equation (7.5.54).

1. Determine the average probability of error as a function of (\mathcal{E}_b/N_0) and p .
2. Evaluate the probability of error for $p = 0.3$ and $p = 0.5$, with $\mathcal{E}_b/N_0 = 10$.

7.12 A binary PAM communication system is used to transmit data over an AWGN channel. The prior probabilities for the bits are $P(a_m = 1) = 1/3$ and $P(a_m = -1) = 2/3$.

1. Determine the optimum threshold at the detector.
2. Determine the average probability of error.

7.13 Binary antipodal signals are used to transmit information over an AWGN channel. The prior probabilities for the two input symbols (bits) are $1/3$ and $2/3$.

1. Determine the optimum maximum-likelihood decision rule for the detector.
2. Determine the average probability of error as a function of \mathcal{E}_b/N_0 .

7.14 The received signal in a binary communication system that employs antipodal signals is

$$r(t) = s(t) + n(t)$$

where $s(t)$ is shown in Figure P-7.14 and $n(t)$ is AWGN with power-spectral density $N_0/2$ W/Hz.

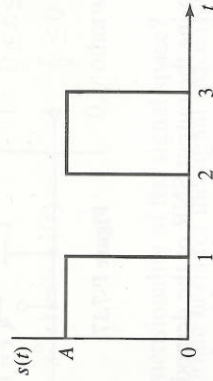


Figure P-7.14

1. Sketch the impulse response of the filter matched to $s(t)$.
2. Sketch the output of the matched filter to the input $s(t)$.