

Assignment 4

CN8811 Multimedia Processing and Digital Communications
(Chap5: Probabilities, MF detection, Modulation, Multiplexing)

1. A binary source generates digits **1** and **0** randomly with probabilities $P(1) = 0.8$ and $P(0) = 0.2$.
 - (a) What is the probability that two 1's and three 0's will occur in a five-digit sequence?
 - (b) What is the probability that at least three 1's will occur in a five-digit sequence?
2. In a binary communication channel, the receiver detects binary pulses with an error probability P_e . What is the probability that out of 100 received digits, no more than three digits are in error?
3. The purpose of a *radar system* is basically to detect the presence of a target, and to extract useful information about the target. Suppose that in such a system, hypothesis H_0 is that there is no target present, so that the received signal $x(t) = w(t)$, where $w(t)$ is white Gaussian noise with power spectral density $N_0/2$. For hypothesis H_1 , a target is present, and $x(t) = w(t) + s(t)$, where $s(t)$ is an echo produced by the target. Assumed that $s(t)$ is completely known and the probability of the existence of a target is 0.5.
 - (a) Determine the structure of the optimal receiver.
 - (b) Determine the pdf of the decision variable and the optimal decision threshold.
 - (c) Evaluate the *probability of false alarm* defined as the probability that the receiver decides a target is present when it is not.
 - (d) Evaluate the *probability of detection* defined as the probability that the receiver decides a target is present when it is.
4. Twenty-four voice signals are sampled uniformly and then time-division multiplexed. The sampling operation uses flat-top samples with $1\ \mu s$ duration. The multiplexing operation includes provision for synchronization by adding an extra pulse of sufficient amplitude and also $1\ \mu s$ duration. The highest frequency component of each voice signal is 3.4 kHz.
 - (a) Assuming a sampling rate of 8 kHz, calculate the spacing between successive pulses of the multiplexed signal.
 - (b) Repeat your calculation assuming the use of Nyquist rate sampling.

Textbook: 2-18, 3.2, 3.5, 3.7, 4-1, 4-13, 4-16, 11-1.