Assignment 5

Digital Communication System-I

May 2023

Please answer the following questions:

Consider a cascaded binary symmetric channel (BSC) in Figure 1 to answer Q1-Q2.

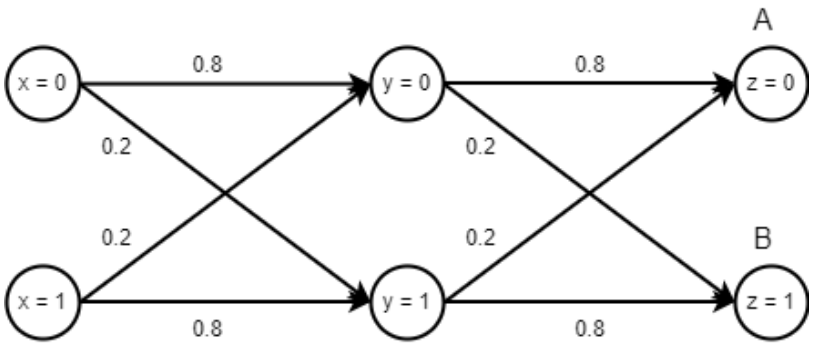

Figure 1: Cascaded BSC

Q 1: Find out the probability $Pr(z = 1)$ and $Pr(z = 0)$ at node A and B, respectively, if a priori probability is given as $Pr(x = 0) = 0.3$ and $Pr(x = 1) = 0.7$.

(a) 0.572,0.428

(b) 0.428,0.572

(c) 0.56,0.44

(d) 0.44,0.56

Q 2: MAP decision rule is same as the ML decision rule if $Pr(y = 0|x = 1) = Pr(y = 1|x = 0) = 0.5$.

(a) True

(b) False

Q 3: Why do we need optimum detection rule in communication system?

(a) Minimize the energy consumption

(b) Effective use of channel bandwidth

(c) Minimize the probability of error

(d) To detect and correct the error

Q 4: If the bit error probability for BPSK modulated signal with coherent detection over an AWGN channel with the power spectral density of the channel noise is $N_0/2$ is 0.1587 then find out the SNR (in dB) in the AWGN channel. The two signals $s_1(t)$ and $s_2(t)$ are assumed to be equi-probable with bit energy E_b?

(a) 10 dB

(b) 5

(c) -3 dB

(d) 2 dB

Q 5: The vector representations of the binary equiprobable orthogonal signal set is given as $S_1 = (\sqrt{2E_b}, 0)$ and $S_1 = (0, \sqrt{2E_b})$. What is their error probability over the AWGN channel?

(a) $Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$

(b) $Q\left(\sqrt{\frac{4E_b}{N_0}}\right)$

(c) $Q\left(\sqrt{\frac{E_b}{N_0}}\right)$

(d) $Q\left(\sqrt{\frac{E_b}{2N_0}}\right)$

Q 6: Probability of error depends on which of the following factor(s)?

(a) Euclidean distances among signal vectors in signal space diagram

(b) Positions of signal vectors in signal space diagram

(c) Both (a) and (b)

(d) None of these

Q 7: Assume a binary antipodal signalling scheme $s_1(t) = \sqrt{E_b}$ and $s_2(t) = -\sqrt{E_b}$, with a priori probability of $s_1(t) = 0.2$ and of $s_2(t) = 0.8$ over an AWGN channel with the power spectral density of the channel noise is $N_0/2$. Find out the threshold (r_{th}) for the decision region

(a) $r_{th} = \frac{0.1N_0}{\sqrt{E_b}}$

(b) $r_{th} = \frac{0.4N_0}{\sqrt{E_b}}$

(c) $r_{th} = \frac{0.69N_0}{\sqrt{E_b}}$

(d) $r_{th} = \frac{0.38N_0}{\sqrt{E_b}}$

Q 8: Which of the following statement about the Q function is correct?

(a) Q function is an even function

(b) $Q(x)$ is a decreasing function for $x > 0$

(c) Both (a) and (b)

(d) None of the above

Q 9: Which of the following expressions represent(s) the ML decision rule for AWGN vector channel?

(a) $\hat{m} = \arg\min_{1 \le m \le M} \|r - s_m\|^2$

(b) $\hat{m} = \arg\max_{1 \le m \le M} \left(\int_0^T r(t)s_m(t)dt + \frac{1}{2}\int_0^T |s_m(t)|^2 dt\right)$

(c) $\hat{m} = \arg\max_{1 \le m \le M} \|r - s_m\|^2$

(d) None of the above

Q 10: Consider the following signal

$$s(t) = \begin{cases} \frac{A}{T}\sin(2\pi f_c t), & \text{if } 0 \le t \le T \\ 0, & \text{otherwise} \end{cases}$$

What is the output of the matched filter at t = T?

(a) $\frac{A^2}{2T^2}\sin(4\pi f_c T)$

(b) $\frac{A^2}{2T}\cos(2\pi f_c T)$

(c) $\frac{A^2}{2T} - \frac{A^2}{2T}\sin(4\pi f_c T)$

(d) $\frac{A^2}{2T} - \frac{A^2}{8\pi f_c T^2}\sin(4\pi f_c T)$