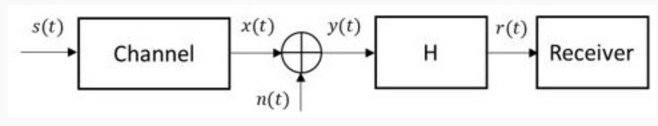
Unit 12 - Week 10

Assignment 10

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2020-04-08, 23:59 IST.

1) Consider a communication system as shown below, where the transmitted signal $s(t)$ propagates through a channel and is corrupted by noise $n(t)$. It is then acted upon by an unknown deterministic function H. *1 point*



If the probabilities of error obtained by analyzing $y(t)$ and $r(t)$ are P_{e1} and P_{e2}, respectively, then the relation between P_{e1} and P_{e2} is

- $P_{e1} > P_{e2}$
- $P_{e1} < P_{e2}$
- $P_{e1} = P_{e2}$
- dependent on H

No, the answer is incorrect.
Score: 0
Accepted Answers:
$P_{e1} = P_{e2}$

2) The transmitter in a communication system sends antipodal vectors $\vec{b}$ and $-\vec{b}$ to transmit binary symbols '0' and '1', respectively, through a channel with additive white Gaussian noise having zero mean and variance μ^2. It is given that $\vec{b} = \{\mu, -2\mu, -3\mu, 3\mu, -4\mu, 5\mu\}$ and the symbol '0' is thrice as likely as the symbol '1'. The system was operating satisfactorily with an acceptable value of bit error rate. Now, due to some attenuation in the system, the signal to noise ratio reduces to half of its previous value. Determine the total error probability in the new case. Here $Q(.)$ denotes the Q-function. *1 point*

- $\frac{1}{4}[3Q(5.75) + Q(5.56)]$
- $\frac{1}{4}[Q(5.75) + 3Q(5.56)]$
- $\frac{1}{4}[3Q(4.75) + Q(4.56)]$
- $\frac{1}{4}[Q(4.75) + 3Q(4.56)]$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{1}{4}[3Q(5.75) + Q(5.56)]$

3) The probability of error for various constellation schemes can be given as $Q\left(\sqrt{\frac{\eta_p E_b}{2N_0}}\right)$ where η_p for OOK, FSK, BPSK, and binary simplex schemes, respectively, are *1 point*

- 4, 2, 2, 4
- 4, 4, 2, 2
- 2, 2, 4, 4
- 2, 4, 4, 2

No, the answer is incorrect.
Score: 0
Accepted Answers:
2, 2, 4, 4

4) If we achieve probability of error of 10^{-8} at E_b/N_o = 15 dB for OOK scheme, then at what E_b/N_o can we achieve the same probability of error for BFSK scheme? *1 point*

- 18 dB
- 15 dB
- 12 dB
- 9 dB

No, the answer is incorrect.
Score: 0
Accepted Answers:
15 dB

5) Consider an OOK system, where the received signals for bit '1' and bit '0' are as follows *2 points*

$$y(t) = \begin{cases} s(t) + n(t), & \text{bit 1 sent} \\ n(t), & \text{bit 0 sent} \end{cases}$$

where $s(t) = tI_{[0,1]}(t) + (2 - t)I_{[1,2]}(t)$ and $n(t)$ is an additive white Gaussian noise with one-sided power spectral density of N_0. The received signal is passed through a filter with an impulse response $h_1(t) = s(-t)$ and $h_2(t) = I_{[-2,0]}(t)$ followed by a sampler at t_0. Here $I_{[A,B]}(t)$ denotes a rectangular pulse of unit amplitude spanning from t = A to t = B. If a sample at $t_0 = 0$ is used, then the BER at the output of the sampler for $h_1(t)$ and $h_2(t)$ is

- $Q\left(\sqrt{\frac{E_b}{2N_0}}\right), Q\left(\sqrt{\frac{3E_b}{2N_0}}\right)$
- $Q\left(\sqrt{\frac{E_b}{N_0}}\right), \left(\sqrt{\frac{3E_b}{2N_0}}\right)$
- $Q\left(\sqrt{\frac{E_b}{2N_0}}\right), Q\left(\sqrt{\frac{3E_b}{4N_0}}\right)$
- $Q\left(\sqrt{\frac{E_b}{N_0}}\right), Q\left(\sqrt{\frac{3E_b}{4N_0}}\right)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$Q\left(\sqrt{\frac{E_b}{N_0}}\right), Q\left(\sqrt{\frac{3E_b}{4N_0}}\right)$

GROUP-A

A PAM signaling scheme transmits values 'a_1' and 'a_0' for symbols '1' and '0', respectively, through a channel with additive white Gaussian noise having zero mean and variance $2a$, such that $a_0 + a_1 = -2$ and $a = a_0 - m$ where m is the mean of a_1 and a_0. The prior of symbol '1' is $P_H(1)$ and that of symbol '0' is $P_H(0)$. These are related as $P_H(1) = \eta P_H(0)$ where H denotes the hypothesis and η is a constant. The following two transmitters are available: T_1 which provides $\eta = 1$ and T_2 which provides $\eta = \sum_{n=0}^{\infty}(1/n!)$. If the received random variable is $\boldsymbol{X}$ (having numerical values x), then answer the following questions.

6) What is the decision rule for detection if T_1 is used? *2 points*

- $x \underset{H=1}{\overset{H=0}{\gtrless}} 0$
- $x \underset{H=1}{\overset{H=0}{\gtrless}} -1$
- $x \underset{H=1}{\overset{H=0}{\gtrless}} 1$
- $x \underset{H=1}{\overset{H=0}{\lessgtr}} 0$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$x \underset{H=1}{\overset{H=0}{\gtrless}} -1$

7) What is the decision rule for detection if T_2 is used? *1 point*

- $x \underset{H=1}{\overset{H=0}{\gtrless}} 0$
- $x \underset{H=1}{\overset{H=0}{\gtrless}} -1$
- $x \underset{H=1}{\overset{H=0}{\gtrless}} 1$
- $x \underset{H=1}{\overset{H=0}{\lessgtr}} 0$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$x \underset{H=1}{\overset{H=0}{\gtrless}} 0$

8) Given a = 2, what is the total probability of error if T_1 is used? *1 point*

- $Q(0.25)$
- $Q(0.5)$
- $Q(1)$
- $Q(1.5)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$Q(1)$

9) Given a = 2, what is the total probability of error if T_2 is used? *1 point*

- $0.5[Q(1) + Q(0.5)]$
- $0.5[Q(0.5) + Q(1.5)]$
- $0.27 \times Q(1) + 0.73 \times Q(0.5)$
- $0.27 \times Q(0.5) + 0.73 \times Q(1.5)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$0.27 \times Q(0.5) + 0.73 \times Q(1.5)$

GROUP-B

A repetition coder which repeats 3 bits is used with binary on-off keying scheme. We assume $a^2/2N_0$ is 15 in dB scale, where a is the amplitude of each bit. Answer the following questions

10) The symbol error rate if hard decision is used per bit with majority decoding is approximately *2 points*

- 3×10^{-12}
- 3×10^{-16}
- 3×10^{-8}
- 3×10^{-11}

No, the answer is incorrect.
Score: 0
Accepted Answers:
3×10^{-16}

11) The symbol error rate if ML detection is used for 3 bits together is approximately *1 point*

- 1×10^{-22}
- 9.2×10^{-85}
- 1×10^{-85}
- 9.2×10^{-22}

No, the answer is incorrect.
Score: 0
Accepted Answers:
1×10^{-22}

12) The symbol error rate if ML detection is used for n bits together is *1 point*

- $Q\left(\sqrt{\frac{nE_b}{2N_0}}\right)$
- $Q\left(\sqrt{\frac{2nE_b}{N_0}}\right)$
- $Q\left(\sqrt{\frac{nE_b}{4N_0}}\right)$
- $Q\left(\sqrt{\frac{E_b}{N_0}}\right)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$Q\left(\sqrt{\frac{E_b}{N_0}}\right)$