Unit 11 - Week 9

Assignment 9

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

Due on 2020-04-01, 23:59 IST.

The following eleven questions are of multiple choice type out of which only one is correct. Please choose only the correct option as zero mark will be awarded if no option or wrong option is chosen.

1) The minimum frequency separation in a non-coherent FSK system is equal to its symbol rate. *1 point*
When this system is transformed into a simplex system (note that a simplex system uses coherent receiver), then the spectral efficiency improves by a factor of α.

The number of bits encoded in each symbol is

- $\log_2\left(\frac{\alpha-1}{\alpha}\right)$
- $\log_2\left(\frac{\alpha}{\alpha-1}\right)$
- $\log_2\left(\frac{\alpha-2}{\alpha}\right)$
- $\log_2\left(\frac{\alpha}{\alpha-2}\right)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\log_2\left(\frac{\alpha}{\alpha-2}\right)$

2) Differential modulation schemes are usually based on phase modulation schemes because *1 point*

- phase modulation schemes are bandwidth efficient schemes
- information can be easily encoded in the difference of phases of consecutive symbols
- phase is least affected by noise
- all of these

No, the answer is incorrect.
Score: 0
Accepted Answers:
information can be easily encoded in the difference of phases of consecutive symbols

3) A biorthogonal signal set is generated from a PPM signal set. If $\Delta\rho > 0$ represents the difference in spectral efficiencies of the two schemes then the number of bits encoded in each symbol is *1 point*

- $1 + \log_2(\Delta\rho)$
- $2 + \log_2(\Delta\rho)$
- $1 - \log_2(\Delta\rho)$
- $2 - \log_2(\Delta\rho)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$1 - \log_2(\Delta\rho)$

4) A differential QPSK scheme maps the symbols 00, 01, 10 and 11 to phase differences of 0°,−90°,90° and 180°, respectively. *1 point*
The information bit sequence $b[n]$ = 1001110001 has to be sent using this mapping.
Assuming an initial phase of 135°, determine the phases (in radians) of the symbols present in the resultant set.

- $\frac{-3\pi}{4},\frac{3\pi}{4},\frac{-3\pi}{4},\frac{\pi}{4},\frac{\pi}{4}$
- $\frac{\pi}{4},\frac{3\pi}{4},\frac{3\pi}{4},\frac{-3\pi}{4},\frac{\pi}{4}$
- $\frac{\pi}{4},\frac{\pi}{4},\frac{-3\pi}{4},\frac{-\pi}{4},\frac{-3\pi}{4}$
- $\frac{-3\pi}{4},\frac{3\pi}{4},\frac{-\pi}{4},\frac{-\pi}{4},\frac{-3\pi}{4}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{-3\pi}{4},\frac{3\pi}{4},\frac{-\pi}{4},\frac{-\pi}{4},\frac{-3\pi}{4}$

5) Match the types of channels given in Column-I with the most preferred modulation schemes given in Column-II. *1 point*

Column-I (Types of Channels)	Column-II (Modulation Scheme)
i. Power Constrained Channel	a) PAM
ii. Bandwidth Constrained Channel	b) QAM
iii. Linear Time-Varying Channel	c) MSK
iv. Non-Linear Channel	d) PPM
	e) DQPSK
	f) Offset-QPSK

- i) a, b ; ii) c, d ; iii) e ; iv) f
- i) c, d ; ii) a, b ; iii) e ; iv) c, f
- i) c, d ; ii) a, b ; iii) f ; iv) e
- i) a, b ; ii) c, d ; iii) e ; iv) c, f

No, the answer is incorrect.
Score: 0
Accepted Answers:
i) c, d ; ii) a, b ; iii) e ; iv) c, f

6) Consider the following systems: *2 points*

S_1 : a biorthogonal system of 512 symbols
S_2 : a QAM passband system whose I and Q channels are independently modulated by PPM with 9 bits per symbol
S_3 : a non-coherent CDMA system using Walsh codes generated by a Hadamard matrix $\mathbf{H}_6$
S_4 : a 64-PPM system converted to the passband using DSB modulation
S_5 : a coherent 8-ary FSK system whose symbol rate is two times of the minimum frequency separation

All these systems have the same data rate of 900 Mbps. Match the systems given in Column-I with their bandwidth requirement given in Column-II.

Column-I (Systems)	Column-II (BW requirement in GHz)
i) S_1	a) 1.2
ii) S_2	b) 4.8
iii) S_3	c) 9.6
iv) S_4	d) 12.8
v) S_5	e) 25.6

- i – d, ii – e, iii – c, iv – c, v – a
- i – d, ii – e, iii – b, iv – c, v – a
- i – d, ii – e, iii – b, iv – a, v – c
- i – d, ii – e, iii – c, iv – a, v – b

No, the answer is incorrect.
Score: 0
Accepted Answers:
i – d, ii – e, iii – c, iv – c, v – a

GROUP-A

A communication system employs a binary hypothesis testing detector which receives random variables $\mathbf{Y}$. The conditional probability density function (pdf), given hypothesis X_0, is uniformly distributed over [-1,3] while the conditional pdf, given hypothesis X_1, is Gaussian distributed with unity mean and unity variance.

7) At what values of y, are the likelihoods equal? *1 point*

- $y = \pm 0.033$
- $y = \pm 1.967$
- $y = 0.033, 1.967$
- $y = -0.033, -1.967$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$y = 0.033, 1.967$

8) If the hypothesis X_1 is twice as likely as the hypothesis X_0 and ∪ denotes the union of sets, then the decision regions would be *2 points*

- X_1: $y \in (-\infty,-1] \cup [-0.523, 2.523] \cup [3,\infty)$
  X_0: $y \in (-1,-0.523) \cup (2.523,3)$
- X_1: $y \in (-1,-0.523) \cup (2.523,3)$
  X_0: $y \in (-\infty,-1] \cup [-0.523,2.523] \cup [3,\infty)$
- X_1: $y \in (-0.523,2.523)$
  X_0: $y \in (-\infty,-0.523] \cup [2.523,\infty)$
- X_1: $y \in (-\infty,-0.523] \cup [2.523,\infty)$
  X_0: $y \in (-0.523,2.523)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
X_1: $y \in (-\infty,-1] \cup [-0.523,2.523] \cup [3,\infty)$
X_0: $y \in (-1,-0.523) \cup (2.523,3)$

GROUP-B

Consider an optical on-off keying system, where the received signals for bit '1' and bit '0' are as follows

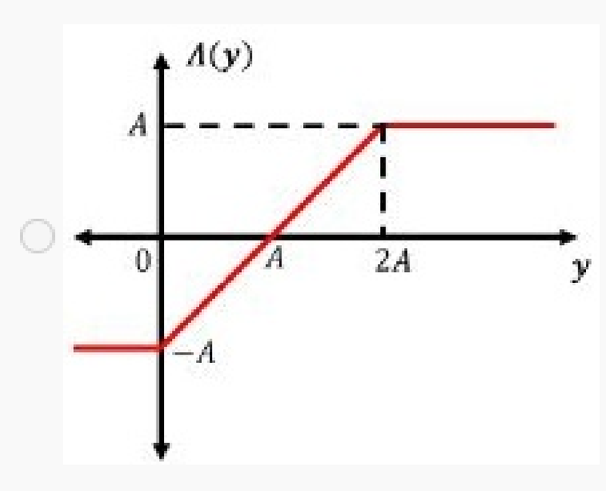
$$\mathbf{Y} = \begin{cases} A + \mathbf{N}, & \text{if bit 1 sent} \\ \mathbf{N}, & \text{if bit 0 sent} \end{cases}$$

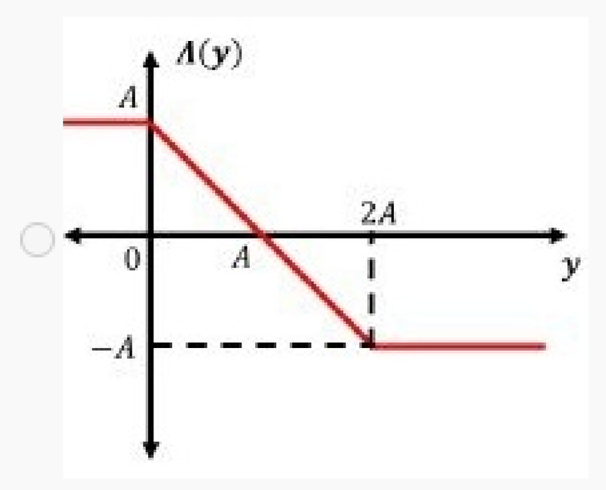
Here $A > 0$ and $\mathbf{N}$ has a Laplacian probability density defined as $f_{\mathbf{N}}(n) = \alpha e^{-|n|}$, where α is a constant and e is the base of natural logarithm. The log-likelihood ratio is defined as

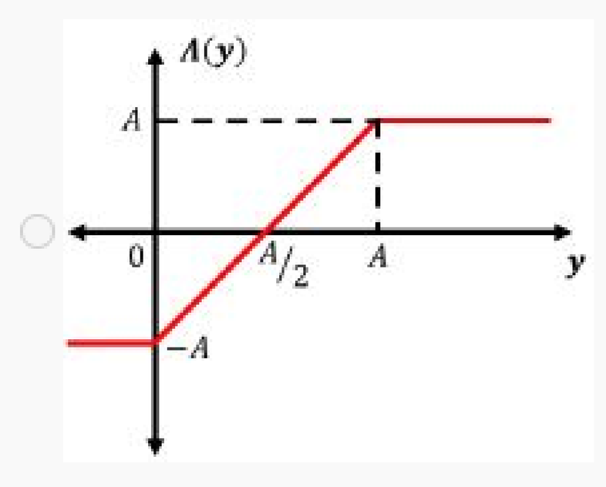
$$\Lambda(y) = \ln\left[\frac{f_{\mathbf{Y}}(y|1)}{f_{\mathbf{Y}}(y|0)}\right]$$

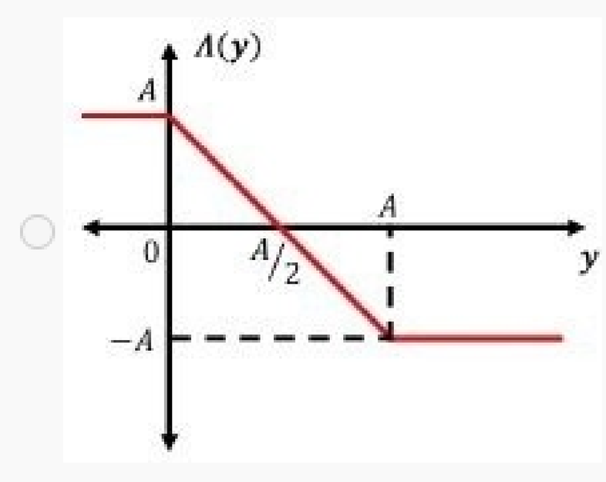
where $f_{\mathbf{Y}}(y|i)$ denotes the conditional probability that bit $i \in \{0,1\}$ is sent.

9) Which of the following depicts the correct plot of $\Lambda(y)$? *2 points*

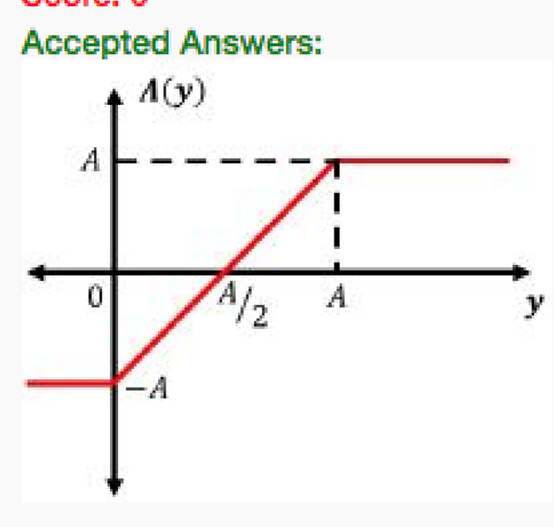








No, the answer is incorrect.
Score: 0
Accepted Answers:



10) If the hypotheses are equally likely, then the decision rule is *1 point*

- $y \underset{H=0}{\overset{H=1}{\gtrless}} A$
- $y \underset{H=0}{\overset{H=1}{\gtrless}} A/2$
- $y \underset{H=0}{\overset{H=1}{\gtrless}} 2A$
- $y \underset{H=0}{\overset{H=1}{\gtrless}} -A$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$y \underset{H=0}{\overset{H=1}{\gtrless}} A/2$

11) If $A = 2$ and the hypotheses are not equally likely, then the decision rule changes to *2 points*

$$y \underset{H=0}{\overset{H=1}{\gtrless}} 3/2$$

Determine the values of the priors, $P(0)$ and $P(1)$.

- $P(0) = 0.73,\ P(1) = 0.27$
- $P(0) = 0.27,\ P(1) = 0.73$
- $P(0) = 0.33,\ P(1) = 0.67$
- $P(0) = 0.67,\ P(1) = 0.33$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$P(0) = 0.73,\ P(1) = 0.27$