COM 5120 Communication Theory

Homework #3

Due: 11/23/2020 (Monday)

1. (10%) Consider the set of three (M=3) finite-energy signaling waveforms in :

The channel is AWGN with PSD of *.* Find the conditional error probability , assuming that was sent.

Ans:

1. (15%) Consider a digital communication system that transmits information via QAM over a voice-band telephone channel at a rate of 2400 symbols/s. The additive noise is assumed to be white and Gaussian.
2. (5%) Determine the required to achieve an error probability of at 2400 bits/s.

Ans:

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1. (5%) Repeat part 1 for a rate of 4800 bits/s.

Ans:

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1. (5%) Repeat part 1 for a rate of 9,600 bits/s.

Ans:

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1. (20%) Consider a communication system where three equiprobable messages are transmitted. Let be encoded by signals respectively given by

where the signal duration is and each signal is zero outside this interval. Assume that the signals are transmitted over an additive white Gaussian noise channel.

1. (5%) Find a set of orthonormal basis function to represent the set of signals, and then draw the corresponding signal constellation.

Ans:

1. (5%) Determine the optimum decision regions.

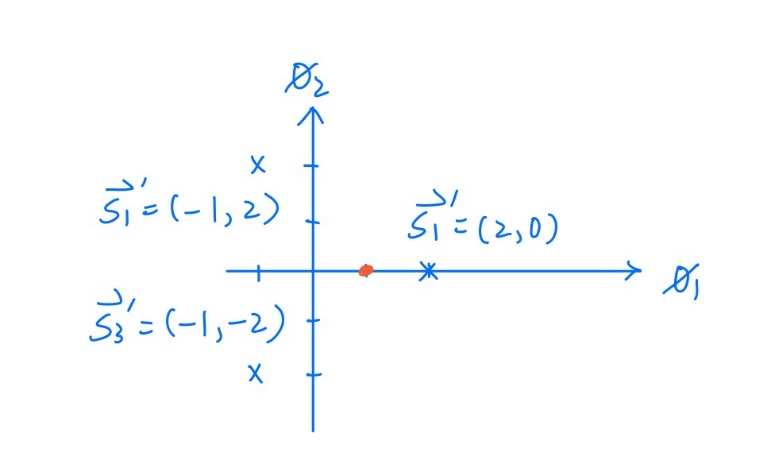
Ans:

一張含有 文字, 地圖, 雪, 滑雪 的圖片

自動產生的描述

1. (10%) Determine an equivalent minimum-energy signal set that would yield the same probability of error as the signal set described above. Draw the corresponding signal constellation and optimum decision regions.

Ans:



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1. (25%) Consider a one-dimensional discrete communication model shown below.

The transmitted symbol where a>0 is a deterministic and known value. The noise is dependent on . Specifically, given , is Gaussian distributed with zero mean and variance , and given , is Gaussian distributed with zero mean and variance , where and are known. Assume that Prob and Prob.

1. (10%) Derive a maximum posteriori probability (MAP) receiver for detecting .

Ans:

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1. (10%) Suppose , , , . Find the decision regions for and .

Ans:

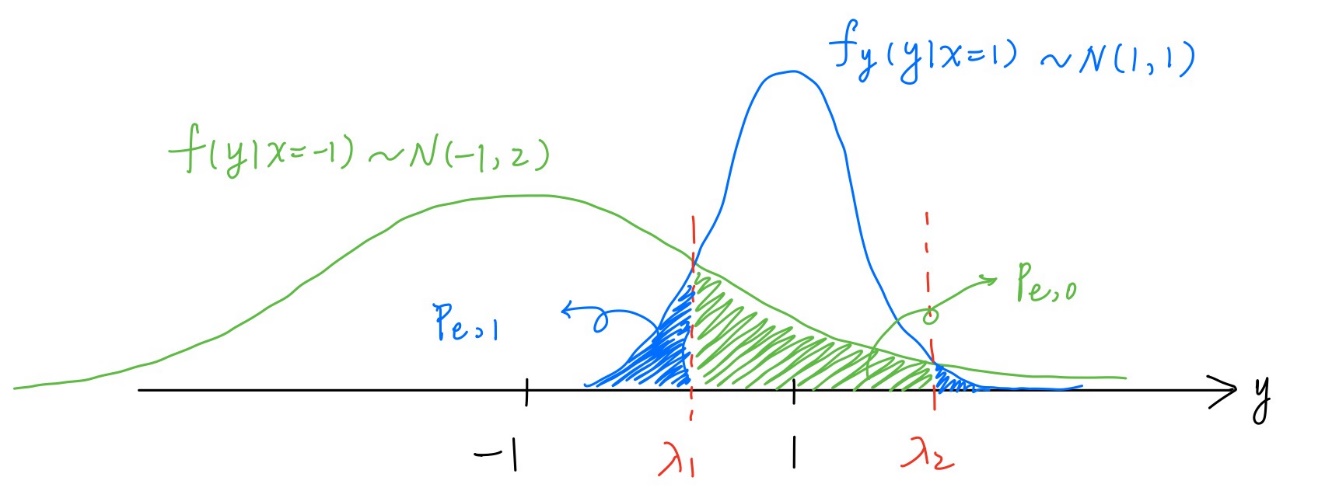
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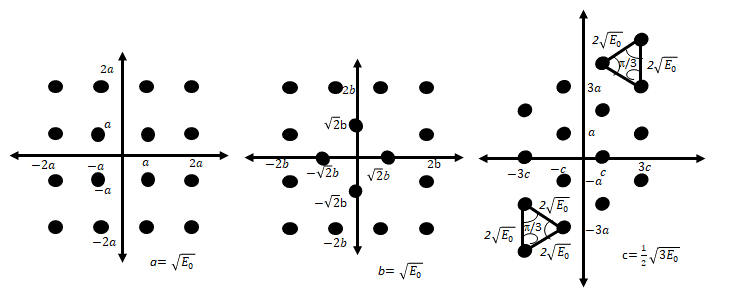
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1. (5%) Find the probability of error for the values specified in (b)

Ans:



1. (20%) Consider three -ary QAMs (A), (B) and (C), where as shown in the following figure with the symbol period of .



1. (B) (C)
2. (6%) Please find the average energy per symbol of the these QAM schemes.

Ans:

for (A) :

for (B) :

for (C) :

1. (6%) Please compare the CFM (Constellation Figure of Merits) of these QAM schemes.

Ans:

CFM = …the larger the better

for (A) :

for (B) :

for (C) :

1. (8%) Find the average probability of symbol error of these QAM over additive white Gaussian noise (AWGN) channel with PSD of in case optimal detection is used.

Ans:

for (A) :

for (B) :

for (C) :

(p.s only consider minimum distance.)

1. (10%) A M-ary PSK signal set is given that . , where . *;*

Please derive the probability of error for M-ary PSK.

Ans: