UCLA
EE230B
Digital Communication Design Project
Step 1 Report

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1 System Setup

2 Mathematical Derivations of Probability of Error

As equiprobable bits are generated and passed through an AWGN channel in this project we have used ML decision rule which states:

$\hat{m} = \text{argmin}_{1 \leq m \leq M} ||\underline{r} - \underline{s}_m||$

Thus in the following subsections the probability of error for each constellation used in the project is derived using the minimum distance rule.

2.1 BPSK

The exact probability of bit error is as follows (no interseting decision regions):

$P_e = Q(\frac{d_{min}/2}{\sqrt{N_o/2}}) = Q(\sqrt{\frac{2E_b}{N_o}})$

2.2 QPSK

The exact probability of bit error is as follows (found by subtracting the interseting decision regions from the nearest neighbour approx.):

$P_e = Q(\frac{d_{min}/2}{\sqrt{N_o/2}}) = Q(\sqrt{\frac{2E_s}{N_o}})$

2.3 16-QAM

The exact probability of bit error is as follows (found by subtracting the interseting decision regions from the nearest neighbour approx.):

$P_e = Q(\frac{d_{min}/2}{\sqrt{N_o/2}}) = 3Q(\sqrt{(\frac{4}{5}\frac{E_b}{N_o})}) - (9/4)Q(sqrt((4/5) * a))^2$

2.4 64-QAM

The exact probability of bit error is as follows (found by subtracting the interseting decision regions from the nearest neighbour approx.):

$P_e = Q(\frac{d_{min}/2}{\sqrt{N_o/2}}) = Q(\sqrt{\frac{2E_s}{N_o}})$