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EXAM ID NUMBER:_____

COURSE NUMBER: EE 242

PROBLEM: 1

PhD Qualifier Exam - Summer 2015
Digital Communications

Q1.(20 marks) The discrete sequence

$$r_k = \sqrt{\mathcal{E}} c_k + n_k, \qquad k = 1, 2, \ldots, n$$

represents the output sequence of samples from a demodulator, where $c_k = \pm 1$ are elements of one of two possible code words, $\boldsymbol{c}_1 = [1\ 1\ \ldots\ 1]$ and $\boldsymbol{c}_2 = [1\ 1\ \ldots\ 1\ -1\ \ldots\ -1]$. The code word $\boldsymbol{c}_2$ has w elements that are $+1$ and $n - w$ elements that are -1, where w is some positive integer. The noise sequence $\{n_k\}$ is white Gaussian with variance σ^2.

a. What is the optimum maximum-likelihood detector for the two possible transmitted signals? (7 marks)

b. Determine the probability of error as a function of the parameters $(\sigma^2, \mathcal{E}, w)$. (7 marks)

c. What is the value of w that minimizes the error? (6 marks)

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EXAM ID NUMBER:_____

COURSE NUMBER: EE 242

PROBLEM: 2

Q2.(20 marks) Figure 1, shows the performance of several M-ary modulation schemes at a symbol rate of 10^{-5}.

a. Map the following seven schemes to the seven dots on the graph shown in Fig. 1 (6 marks)
QPSK, 8-PSK, 8-FSK, 16-PSK,
16-FSK, 64-QAM, 64-FSK

b. In the graph shown in Fig. 1, two regions are identified with boxes as **power-limited** and **bandwidth-limited**. Identify which is which? And give one example of each channel type i.e., an example for **power-limited** channel and an example for **bandwidth-limited** channel. (4 marks)

c. Find E_s/N_0 (SNR per symbol) and channel bandwidth required for transmitting 1 Mbps at a symbol error rate $= 10^{-5}$ using 16-QAM. (4 marks)

d. An engineer claims that he can design a modulation technique that is able to give 5 bits/sec/Hz with negligible probability of error at an SNR per bit of 5 dB. Do you agree with his claim? (3 marks)

e. What is the Shannon limit? What does it signify? (3 marks)

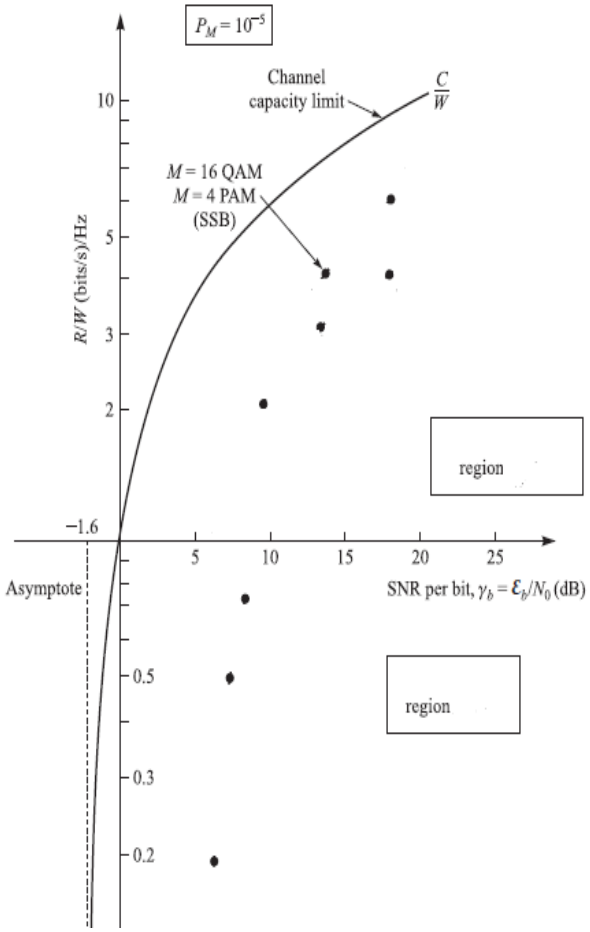

Figure 1: Graph for Q2.