EEL316 Digital Communications Major

May 5, 2010 **Time 2 hours** **Max Marks 30**

Please note: *Answer all parts of a question at the same place. Scattered parts will not be graded. Write all assumptions and show intermediate steps.*

1. M-ary Signaling [12]

Consider the 16 point M-ary signaling system defined below:

$$s(t) = \sqrt{\frac{2E}{T}} a_i \sin(2\pi f_c t) + \sqrt{\frac{2E}{T}} b_i \cos(2\pi f_c t) \quad (1)$$

where a_i can take the values {-3, -1, 1, 3} and b_i can take the values {-3, -1, 1, 3}.

(a) **Draw** the signal-space diagram and clearly label the axes. [2]

(b) **Find** the average energy per symbol, E_{av} [3]

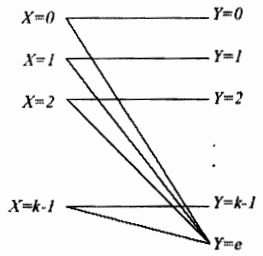
(c) For the above-mentioned **expression** for the average probability of **symbol error**, P_s, in the presence of AWGN with zero mean and power spectral density $N_0/2$ is given by [7]

$$P_e \approx \frac{3}{2} erfc\left(\sqrt{\frac{E_{av}}{10N_0}}\right) \quad (2)$$

Is the above statement mentioned in (c) **True or False** ? **Justify** mathematically [5]

2. Mutual Information [5 + 5]

(a) **Determine** the mutual information, $I(X;Y)$ for the channel shown below. Give your answer in terms of $H(X)$.



(b) Define the random variable E as follows:

$E = 1$ if $Y = e$

$= 0$ otherwise

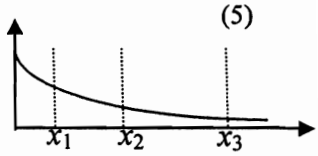
(4)

Find $H(Y, E)$.

3. Entropy [8]

The input to a quantizer is a random signal having an amplitude probability density function:

$$f_X(x) = \begin{cases} ae^{-ax} & , \ x \geq 0 \\ 0 & , \ x < 0 \end{cases} \quad (5)$$



The signal is to be quantized to four quantizing levels as shown (yes four!). **Determine** x_i, $i = 1, 2, 3$ so that the entropy at the quantizer output is maximized.

♠♠♠

-RB

Have a wonderful summer vacation