Department of Electrical and Computer Engineering

Modern Communication Systems, ENEE3306

Midterm Exam

ate: Sunday, 29/3/2015

ame: Qusay Hawari

Time:70 mins

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1. Sampling, Quantization and Encoding (Criterion c) **[40 points]**

The waveform s(t) shown in Figure 1.1 is a segment of a voice signal that has a maximum frequency component at 4KHz and maximum amplitude of 2mV (M_{max}=-M_{min}). Assume the signal is processed as described in the block diagram shown in Figure 1.2, answer the following:

a) Determine the sampled signal values; $m_s(nT)$,

b) Determine the quantized signal values; $m_q(nT)$,

c) Determine the binary signal values; m_b,

d) Determine the output bit rate; R_b,

e) Calculate the Quantization Noise Power, Nq_{-2},

f) If 3-bit Quantizer is used,

  f-1) Calculate the new Quantization Noise Power; Nq_{-3},

  f-2) Compare your Nq_{-3} with the answer of part e,

g) If the input waveform s(t) has a maximum frequency component of 1KHz, determine the new quantized values of $m_s(nT)$,

h) Why do we use anti-aliasing filter?

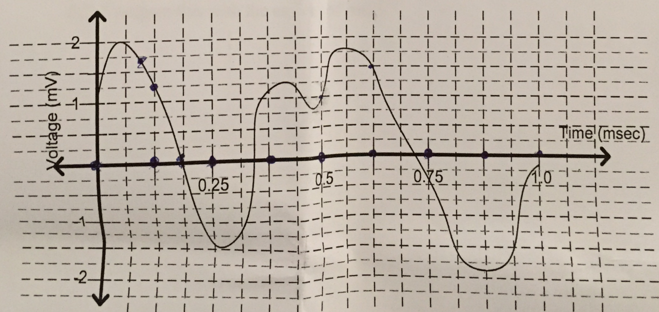

Figure 1.1: s(t) waveform

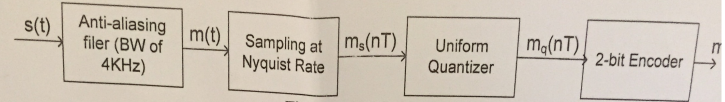

Figure 1.2: PCM system

Q2. Signal Sampling in the frequency domain ***[10 point]***

The signal s(t) given below is ideally sampled at a rate 4000 Hz and then passed through a LPF,

$$s(t) = \cos(2\pi \times 1000 \times t) + \cos(2\pi \times 2000 \times t + \pi)$$

a) Plot the amplitude spectrum of the sampled signal,

b) What is the output signal if the filter bandwidth is 1000 Hz?

Q3. Decision Region and Optimal Receiver Design **[30 point]**

A discrete memory-less source output the information bits “0” and “1” with equal probability. Assume the information bit “0” is modulated by symbol “S_1” and information bit “1” is modulated by symbol “S_2” as shown in Figure 2. Assume the noise power density $\frac{N_o}{2} = 4 \times 10^{-9}\, V^2/Hz$ answer the following:

a) Determine the optimal receiver decision criteria,

b) Sketch the decision regions for both symbols,

c) Calculate the probability of error at receiver (symbol error),

d) Draw the block diagram of the correlate optimum receiver *[clearly label each block]*,

e) Draw the block diagram of the match filter optimum receiver *[clearly label each block]*,

f) Assume probability of transmitting bits “0” is 10 times the probability of transmitting bit “1” ($P("0") = 10P("1")$)

  f-1) Determine the optimal receiver decision criteria.

  f-2) Compare this with the answer of part a.

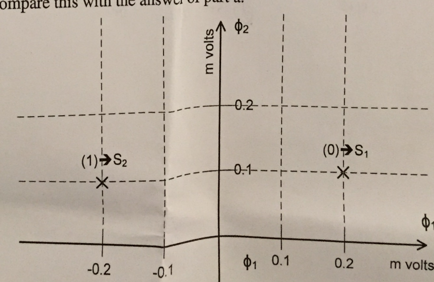

Figure 2

Good Luck