Mansoura University
Dept. of Electrical Communications and Electronics
Communications Theory 2
(COM9321)

Faculty of Engineering
Third year
3 hours exam
Final Exam
May. 2014

Two pages Exam

Answer the following questions
All drawing should be drawn to scale with appropriate numbers if available
Assume any missing data, and make your assumptions clear
NRZ coding is used unless other coding is stated
Please answer each question at the beginning of a new page
Don't use red colors in answering
If I can't read it I can't grade it

100 points

Q1) A signal $m(t) = \cos(wt)$ where $w=2000\pi$ is sampled using the following periodic rectangular train

Where the pulse width = 10% of the sampling period. Find and draw the sampled signal in both of the time and frequency domain for

- i- Sampling rate = 1000 Hz
- ii- Sampling rate = 2000 Hz
- iii- Sampling rate= 4000 Hz

Show how the original signal could be recovered, if possible, for the three cases (20 points)

Q2) A signal $m(t) = A\cos(wt)$ where $w=2000\pi$ is sampled at a frequency f_s, then quantized. Find the signal to quantization noise ratio in dB(at the receiver end), and the transmission bit rate for the following cases (prove any used relation)

- i- f_s=2000 Hz, 8 bits uniform quantizer.
- ii- f_s=4000 Hz, 6 bits uniform quantizer.
- iii- Linear delta modulator with f_s=40 KHz, assume no over slope error.
- iv- Linear delta modulator is used, and the sampling rate is chosen such that SNR equals to case (i) assuming no over slope error, comment on the answer (20 points)

Q3) A baseband data transmission system with a transmission bit rate f_b=1000 bits/sec that is transmitted through a band limited Nyquist channel with an overall optimum pulse spectrum.

- i- Find and draw the Nyquist channel output if the input is 1 1 -1 -1, what is signal to interference ratio when there is perfect timing at the receiver
- ii- Find a relation for the signal to interference ratio when there is exist a timing error Δt at the receiver.
- iii- What is the signal to interference ratio when detecting the last bit of the sequence 1 1 1 1 1 when the timing error equals 10% of the symbol duration.

iv- If the pulse shape of a raised cosine is given by $p(t) = \sqrt{E}\,\mathrm{sinc}(2B_0t)\left(\frac{\cos(2\pi\alpha B_0 t)}{1-16\alpha^2 B_0^2 t^2}\right)$ is used with a roll-off factor of unity. If 1 1 1 1 1 is transmitted, find and draw the received wave to scale, and indicate the best sampling times for regeneration. What is the transmission BW.

v- In (iv), what is signal to interference ratio between two adjacent symbols if the sampling error equals 10% of the symbol duration (35 points)

Q4) Assume a binary sequence of 10101010101010..... is modulated. Find and draw the modulated waveform, modulated signal spectrum, and the average transmitted energy per/symbol for the following cases . (Assume the transmission bit rate is 10000 bits /sec, the carrier frequency is 1 MHz, and the carrier amplitude is 1 volts)

i- ASK

ii- FSK, what is the condition for the frequency separation Δf

iii- PSK

iv- QAM (20 points)

Q5) A digital system that that uses a NRZ signaling with '1' transmitted as a pulse with width 1 mS, and amplitude 1 Volts and the '0' is transmitted as zero voltage. If the system suffers from additive white Gaussian noise with zero mean and single sided power spectral density $N_o=10^{-4}$ Watts/Hz. Assume equi-probable ones and zeros

i- Draw a block diagram of the optimum receiver showing the function of each block.

ii- Find and draw the probability density distribution of the signal amplitude at the receiver end showing the best decision threshold, explain?

iii- Find a relation for the optimum probability of error. And calculate its value for the given system parameters

iv- What should be the '1' amplitude to reduce the probability of error by 50%

Hint: approximate $Q(x) \cong \frac{1}{2}\exp(-x^2/2)$ (20 points)

Q6) For a (7, 4) Hamming code. Let x the input bits and c the coded bits as follows:

$c7=x1\oplus x2\oplus x4$

$c6=x2\oplus x3\oplus x4$

$c5=x1\oplus x2\oplus x3$

$c4=x4$

$c3=x3$

$c2=x2$

$c1=x1$

i- What are the possible transmitted codes

ii- If you received 0010000, is this correct sequence. If no what is the correct sequence (10 points)

Good Luck

Sherif Kishk