

EE521 Analog and Digital Communications

Quiz 2 Rules

Please work alone

Please work alone, although you may ask me questions by email. I will reply when appropriate by email to all so that everyone has the same clarifications (and to avoid redundant questions by clarifying just once when needed).

Open Book, Open Notes, Computer Allowed

Use of the text, *Digital Communications*, Second Edition, by Bernard Sklar, and the examples and course handouts, including updates posted on <http://temple.jkbeard.com>, is encouraged as references while working this quiz. Also, use of notes taken by yourself during class and while studying, and your homework and other notes by yourself are OK to use while working this quiz. *You are encouraged to use Excel or another computer program to work this quiz.* If you do so, please print out your code and output and include the source code, preferably as a soft copy (i.e., a computer file) with your quiz.

Turning In the Quiz

The quiz is due at 6:00 PM on Wednesday, April 5, 2006. You may

- Send a file by email to jkbeard@temple.edu or jkbeard@comcast.net (preferred)
- FAX it to (609) 654-8751.
- Turn it in to Dr. Beard at the beginning of EE521 class.

Format of your Work

Your work must be legible and your reasoning must be clear. Use complete sentences in any explanations when you write out an answer or explanation. References to Sklar must include page numbers, heading numbers, and, if relevant, equation numbers. References to the class handouts must include the date, page number, and equation or figure number as applicable. Additional information such as “third paragraph” and a quote of a word or two such as “that begins with ‘For the random variable $z(T)$...’” will help me to locate your reference.

If you use handwriting, please scan to a GIF, TIFF, JPG, or PDF file (**PDF preferred**) and e-mail me that file, or use FAX to the number I gave above.

Percentage Credit

The SystemView assignment due today is 25% of your Quiz 1 grade. There are three additional problems in today’s take-home, each with 25% credit. Each has two or three parts. Credit for each part is given on the problem.

Problem 1

This problem was assigned last week and is due today. It is included here for your reference and to put all the quiz questions in one document.

Using SystemView, generate a test signal over the speech band, add some noise to it, sample it to 8 bits and convert it to a serial bit stream, then convert it back to PAM and scale to the original scale. Before you begin, block out your system and decide what the SystemView sample rate must be, and set it. Increase the number of samples using the power-of-two spin button until the end time is 1 second or more.

- Use a frequency sweep signal, from 30 Hz to 3000 Hz..
- Add noise, initially at 17 dB SNR.
- Digitize to a serial bit stream with these tokens:
 - Quantize to 8 bits, using the quantizer from the function library. Make sure that the input voltage range accommodates the voltage of the input, plus noise.
 - Use the sampling operator to sample at the engineering Nyquist rate for the signal chosen.
 - Use a custom algebraic function to turn the sampled, quantized output into a Symbol. This will require that the signal be shifted in level and scaled to become an unsigned integer.
 - Use the symbol-to-bit converter from the Comms library to convert the symbol to a bit stream.
- Convert the bit stream back to a symbol using the bit-to-symbol converter from the comms library.
- Use a custom function to re-scale the symbol to the original scale of the signal plus noise.
- Display the output in a system sink.

You will send me your files by e-mail or have them ready for me to load on my laptop when class starts. I will have a USB flash drive and a CD-ROM drive to accomplish this. I don't have a floppy drive, so if you can't bring your laptop with the file on it, or you can't burn a CD-ROM, send the file by e-mail.

You will write a one or two sentence description of each token. This description will tell me

- What the token is -- which token is used from which library.
- What the token does -- an algebraic equation or one or two words..
- What the data format is on the input.

- What the data format is on the output.

Data format parameters for token inputs and outputs will include

- Signal type -- analog, digital 0-1, digital (-1)-(+1), symbol unsigned integer, etc.
- Voltage range (-1v to +1v, 0 to 255 v, etc.) .
- Sample rate (SystemView sample rate, 6600 Hz, etc.) .

Problem 2

Part A (20%)

- For coherent detection of BPSK in an AWGN channel, what is the BER for E_b/N_0 of 5 dB?
- Repeat for E_b/N_0 of 10 dB.
- Repeat for E_b/N_0 of 15 dB.

Part B (40%)

Using the results from Part A, calculate the probability of message error for an uncoded 12-bit word in an AWGN channel with a E_b/N_0 of 5 dB.

Part C (40%)

Using the results from Part A, calculate the probability of message error for a (24,12) linear block code implemented to correct bit errors in one and two bits, e.g. $t=2$, in an AWGN channel with an E_b/N_0 of 5 dB.

Problem 3

This problem will be concerned with the (8,4) linear block code determined by the generator matrix G :

0	1	1	1	1	0	0	0
1	0	1	1	0	1	0	0
1	1	0	1	0	0	1	0
1	1	1	0	0	0	0	1

Part A (60%)

- Is this a systematic code? Why?
- Use Excel or other aid and compile a codeword list.
- What is d_{min} ?
- What is the maximum number of correctable errors t ?

Part B (40%)

- Draw the parity portion of the generator matrix.
- Draw the transpose of the parity check matrix, H^T .
- Compute the syndrome for the received codeword (1, 0, 0, 1, 1, 0, 1, 0)

Problem 4

Here we will be concerned with a (15,5) systematic cyclic code. The generator polynomial is

$$g(x) = 1 + x + x^2 + x^5 + x^8 + x^{10}$$

We have a message polynomial

$$m(x) = 1 + x^2 + x^3$$

For this systematic cyclic code, the parity bits are the lower order portion of the polynomial.

Part A (20%)

Write an equation for the code polynomial that places the parity polynomial $p(x)$ in the lower orders of the code polynomial, and places the message polynomial in the higher orders of the code polynomial.

Part B (50%)

Find the parity polynomial.

Part C (30%)

Write the codeword polynomial