ELEX 3525: Data Communications
2023 Fall Term

Final Exam
13:00
Thursday, December 14, 2023
SW01-2020

This exam has ten (10) questions on two (2) pages. The marks for each question are as indicated. There are a total of twenty-nine (29) marks. Answer all questions. Write your answers and all rough work in this paper and nowhere else. Show your work. Underline or draw a │box│ around your final answer. Numerical answers must include units. Books and notes are allowed. No electronic devices other than calculators are allowed. **Show your work.**

This exam paper is for:

Questions Version 1   A00123456

Each exam is equally difficult.

Answer your own exam.

Do not start until you are told to do so.

Name: _____

BCIT ID: _____

Signature: _____

0

Question 1   3 marks

(a) A data source outputs one of eight equally-likely messages every millisecond. What is the *information* rate of this source in units of bits per second?

(a) Could this information be transmitted with an arbitrarily low error rate over an AWGN channel that has a 350 Hz bandwidth if the signal power is 1 W and the noise power is 1 mW? Why or why not?

Question 2   2 marks

You use a "true RMS" DMM to measure a noise source whose probability distribution is Gaussian. On the DC setting you read 1 V and on the AC setting you read 0.666 V. What is the probability that the voltage will be negative (less than 0)?

Question 3   3 marks

What is the Unicode code point of the character whose UTF-8 encoding is the three bytes **E3 94 A5**? Give your answer as a hexadecimal value.

Question 4   4 marks

Draw the waveform used to transmit the 8-bit value **0x3e** over an asynchronous serial interface at 1200 bps with odd parity. Label the vertical axis with voltage levels that would be correct for a transmitter. Show the duration of one bit on the horizontal axis.

Question 5   2 marks

The waveform below was encoded with an MLT-3 line code. What data was transmitted? Assume the first bit transmitted was a zero. Give your answer as a sequence of eight 1's or 0's. Tic marks indicate the bit boundaries.
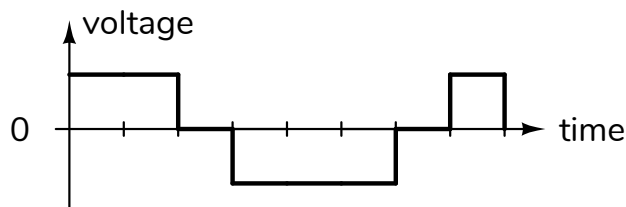
Question 6   2 marks

A PRBS has a period of 1023 bits. What is the longest run of zeros in the sequence?

Question 7   5 marks

A message consisting of the bits **1101** is to be protected using a CRC with a generator polynomial of $x^3 + x^2 + x + 1$.

(a) What is the length of the CRC in units of bits?

(b) What is the value of a CRC computed using the simple method described in the lecture notes?

(c) What message would be transmitted (data plus CRC)?

(d) What are the values of k and n?

Question 8   4 marks

A code has the following three six-bit codewords:

- **000000**

- **111000**

- **111111**

(a) What is the minimum distance of this code?

(b) What is the maximum number of errors that are guaranteed to be detected?

(c) What is the maximum number of errors that are guaranteed to be corrected?

(d) If the codeword **000011** is received, what codeword was most likely transmitted?

Question 9   2 marks

A differential signal has a common-mode voltage of $50\,\mathrm{mV}$ and a differential voltage of $-100\,\mathrm{mV}$. What are the voltages on the two conductors relative to ground? You may use any variable names for these two voltages.

Question 10   2 marks

Of the ARQ protocol(s) studied in this course, which one(s) would have high throughput over a channel with a long delay relative to the packet duration and a very low error rate?

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This exam paper is for:

Questions Version 2   A00123456

Each exam is equally difficult.

Answer your own exam.

Do not start until you are told to do so.

Name: _____

BCIT ID: _____

Signature: _____

255

Question 1   3 marks

   (a) A data source outputs one of eight equally-likely messages every millisecond. What is the *information* rate of this source in units of bits per second?

   (a) Could this information be transmitted with an arbitrarily low error rate over an AWGN channel that has a 250 Hz bandwidth if the signal power is 1 W and the noise power is 1 mW? Why or why not?

Question 2   2 marks

You use a "true RMS" DMM to measure a noise source whose probability distribution is Gaussian. On the DC setting you read 1 V and on the AC setting you read 0.75 V. What is the probability that the voltage will be negative (less than 0)?

Question 3   3 marks

What is the Unicode code point of the character whose UTF-8 encoding is the three bytes **E3 94 A5**? Give your answer as a hexadecimal value.

## Question 4   4 marks

Draw the waveform used to transmit the 8-bit value **0xd5** over an asynchronous serial interface at 9600 bps with odd parity. Label the vertical axis with voltage levels that would be correct for a transmitter. Show the duration of one bit on the horizontal axis.

Question 5   2 marks

The waveform below was encoded with an MLT-3 line code. What data was transmitted? Assume the first bit transmitted was a zero. Give your answer as a sequence of eight 1's or 0's. Tic marks indicate the bit boundaries.

voltage

0

time
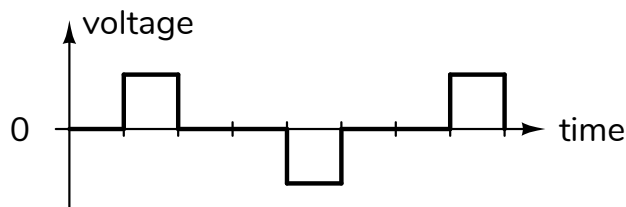
Question 6   2 marks

A PRBS has a period of 32767 bits. What is the longest run of zeros in the sequence?

Question 7   5 marks

A message consisting of the bits **1101** is to be protected using a CRC with a generator polynomial of $x^3 + x^2 + x + 1$.

(a) What is the length of the CRC in units of bits?

(b) What is the value of a CRC computed using the simple method described in the lecture notes?

(c) What message would be transmitted (data plus CRC)?

(d) What are the values of k and n?

Question 8   4 marks

A code has the following three six-bit codewords:

- **000000**

- **111000**

- **111111**

(a) What is the minimum distance of this code?

(b) What is the maximum number of errors that are guaranteed to be detected?

(c) What is the maximum number of errors that are guaranteed to be corrected?

(d) If the codeword **000011** is received, what codeword was most likely transmitted?

Question 9   2 marks

A differential signal has a common-mode voltage of 100 mVand a differential voltage of -200 mV. What are the voltages on the two conductors relative to ground? You may use any variable names for these two voltages.

Question 10   2 marks

Of the ARQ protocol(s) studied in this course, which one(s) would have high throughput over a channel with a long delay relative to the packet duration and a very low error rate?