

ELEX 3525: Data Communications
2022 Fall Term

FINAL EXAM
13:00 – 16:00
Thursday, December 8, 2022
SW01-2020

This exam has ten (10) questions on three (3) pages. The marks for each question are as indicated. There are a total of thirty-six (36) marks. Answer all questions. Write your answers and all rough work in this paper and nowhere else. Show your work. 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:

Sample Exam 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: _____

Question 1

5 marks

- (a) A message source generates two different messages with probabilities 0.125 and 0.875. What is the information rate of this source in bits per message?
- (b) If FEC were used to transmit this information over a Binary Symmetric Channel (BSC) with an error rate (p) of 0.05, would it be possible to transmit this information without errors? Why or why not?

Question 2

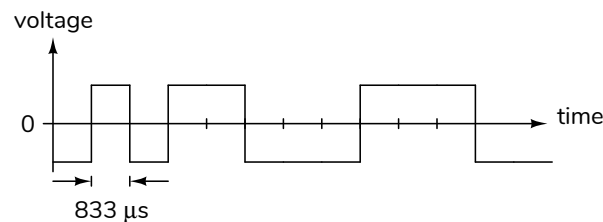
3 marks

What is the UTF-8 encoding for the Unicode glyph “Arabic-Indic digit three”, ۳, that has the Unicode code point of **U+0663**?

Question 3

5 marks

The following waveform shows the waveform received over an asynchronous serial (“RS-232”) interface configured for 8 data bits and even parity.



- (a) What is the baud rate?
- (b) What value was received? Give your answer as a hexadecimal number.
- (c) Are any errors indicated?

Question 4

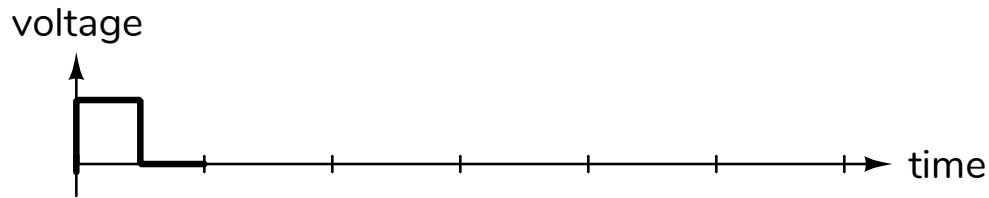
3 marks

A noise signal has Gaussian probability distribution. Its average voltage is $1 V_{DC}$ and the RMS (AC) voltage is $0.5 V_{RMS}$. What is the probability that the signal will be negative (less than 0 V)?

Question 5

2 marks

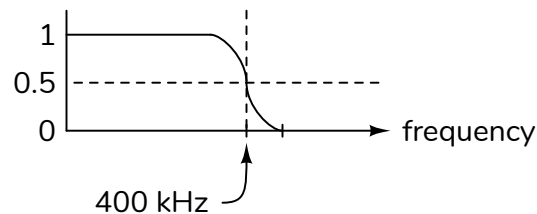
Draw the waveform that would be used to transmit the sequence of bits 1, 1, 0, 0, 1 using *differential* Manchester coding using the convention that a 1 is transmitted as a different symbol. Draw your waveform starting after the symbol drawn below. The symbol shown below is not included in the sequence of bits given above.



Question 6

3 marks

A channel has the frequency response shown below:



- What is the maximum symbol rate that can be transmitted over this channel without ISI?
- Assuming the symbol rate calculated above, how many bits per second could be transmitted if one of 4 different symbols were transmitted in each symbol interval?

Question 7

2 marks

A system uses differential data transmission over two conductors labelled D_+ and D_- . There are two possible output conditions:

- When transmitting a 1, the voltage on D_+ is 1 V (relative to ground) and the voltage on D_- is 0 V (relative to ground).
- When transmitting a 0, D_+ is 0 V (relative to ground), and D_- is 1 V (relative to ground).

- What is the common mode voltage in the two states?
- What are the differential voltages ($D_+ - D_-$) in the two states?

Question 8

5 marks

A message consisting of the bits **1001** is to be protected using a CRC with a generator polynomial of **1111**.

- What is the length of the CRC in bits?
- What is the value of the CRC computed using the simple method described in the lecture notes?
- What message would be transmitted (data plus CRC)?
- What are the values of k and n ?

Question 9

5 marks

A code has the following three codewords:

- **0000000**
- **1010101**
- **1111111**

- What is the minimum distance of this code?
- How many errors can be detected?
- How many errors can be corrected?
- If the codeword **0001111** is received, what codeword was most likely transmitted?

Question 10

3 marks

- A maximal-length PRBS sequence includes 256 ones (1's) in each period. What is the period of the PRBS in bits?
- How many *pairs* are required for a bidirectional 10-BASE-T Ethernet link to operate?
- What is the most appropriate type of ARQ for a communication system when the delay is short relative to the frame duration?

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This exam paper is for:

Sample Exam 2 A01234567

Each exam is equally difficult.

Answer your own exam.

Do not start until you are told to do so.

Name: _____

BCIT ID: _____

Signature: _____

Question 1

5 marks

- (a) A message source generates two different messages with probabilities 0.125 and 0.875. What is the information rate of this source in bits per message?
- (b) If FEC were used to transmit this information over a Binary Symmetric Channel (BSC) with an error rate (p) of 0.2, would it be possible to transmit this information without errors? Why or why not?

Question 2

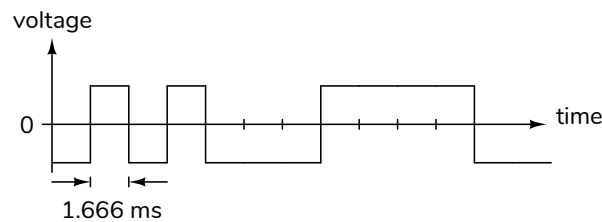
3 marks

What is the UTF-8 encoding for the Unicode glyph “Arabic-Indic digit seven”, \mathbb{V} , that has a Unicode code point of **U+0667**?

Question 3

5 marks

The following waveform shows the waveform received over an asynchronous serial (“RS-232”) interface configured for 8 data bits and even parity.



- (a) What is the baud rate?
- (b) What value was received? Give your answer as a hexadecimal number.
- (c) Are any errors indicated?

Question 4

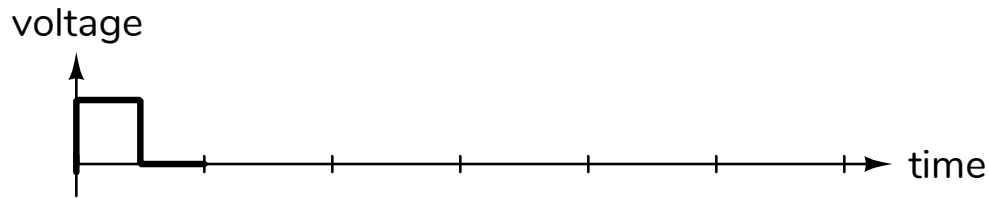
3 marks

A noise signal has Gaussian probability distribution. Its average voltage is $1 V_{DC}$ and the RMS (AC) voltage is $1 V_{RMS}$. What is the probability that the signal will be negative (less than 0 V)?

Question 5

2 marks

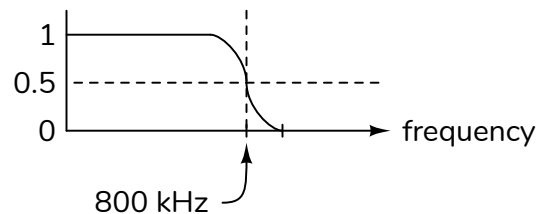
Draw the waveform that would be used to transmit the sequence of bits 1, 1, 0, 0, 1 using *differential* Manchester coding using the convention that a 1 is transmitted as a different symbol. Draw your waveform starting after the symbol drawn below. The symbol shown below is not included in the sequence of bits given above.



Question 6

3 marks

A channel has the frequency response shown below:



- What is the maximum symbol rate that can be transmitted over this channel without ISI?
- Assuming the symbol rate calculated above, how many bits per second could be transmitted if one of 8 different symbols were transmitted in each symbol interval?

Question 7

2 marks

A system uses differential data transmission over two conductors labelled D_+ and D_- . There are two possible output conditions:

- When transmitting a 1, the voltage on D_+ is 1 V (relative to ground) and the voltage on D_- is 0 V (relative to ground).
- When transmitting a 0, D_+ is 0 V (relative to ground), and D_- is 1 V (relative to ground).

- What is the common mode voltage in the two states?
- What are the differential voltages ($D_+ - D_-$) in the two states?

Question 8

5 marks

A message consisting of the bits **1010** is to be protected using a CRC with a generator polynomial of **1111**.

- What is the length of the CRC in bits?
- What is the value of the CRC computed using the simple method described in the lecture notes?
- What message would be transmitted (data plus CRC)?
- What are the values of k and n ?

Question 9

5 marks

A code has the following three codewords:

- **0000000**
- **1010101**
- **1111111**

- What is the minimum distance of this code?
- How many errors can be detected?
- How many errors can be corrected?
- If the codeword **0001111** is received, what codeword was most likely transmitted?

Question 10

3 marks

- A maximal-length PRBS sequence includes 128 ones (1's) in each period. What is the period of the PRBS in bits?
- How many *pairs* are required for a bidirectional 1000-BASE-T Ethernet link to operate?
- What is the most appropriate type of ARQ for a communication system when the delay is short relative to the frame duration?