FINAL EXAM
13:00 – 16:00
Thursday, December 9, 2021

This exam has fourteen (14) questions on five (5) pages. The marks for each question are as indicated. There are a total of forty (40) 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   A00000000

Each exam is equally difficult.

Answer your own exam.

Do not start until you are told to do so.

Name: _____

BCIT ID: _____

Signature: _____

Question	Mark	Max.
1		3
2		3
3		3
4		3
5		4
6		2
7		2
8		3
9		4
10		4
11		2
12		2
13		3
14		2
Total		40

Question 1   3 marks

A communication system transmits three different messages with the following probabilities:

message	probability
A	50%
B	x %
C	6.25%

(a) What is the probability of message B?

(b) How much information, in bits, is communicated by each message?

(c) What is entropy of this source in bits per message?

Question 2   3 marks

The Arabic letter Hah (ح) has the Unicode code point U+062D.

(a) How many bytes would be required to transmit this character using the UTF-8 encoding?

(b) What are the values of those bytes? Give your answer in hexadecimal.

Question 3   3 marks

A communication system transmits data using MLT-3 with levels of $+1$, 0 and -1 volts. The decision threshold are at ± 0.5 V. The channel adds Gaussian noise with an RMS voltage of 0.16 V to the signal. If a signal level of 0 V is transmitted, what is the probability that it will not be received correctly (i.e. that the receiver will decide that either a $+1$ or a -1 was transmitted instead)?

Question 4 — 3 marks

A differential transmitter uses two conductors (D+ and D−) to transmit data.

- When a '1' is being transmitted D+ is at 5V relative to ground and D− is at 0V (also relative to ground).
- When a '0' is being transmitted D− is at 5V relative to ground and D+ is at 0V (also relative to ground).

Assume the differential voltage is positive when D+ is more positive than D−.

(a) What are the common-mode and differential voltages when a '1' is being transmited?

(b) What are the common-mode and differential voltages when a '0' is being transmited?

(c) If the channel adds an offset voltage of 5 V to both conductors is the differential voltage affected? Is the common-mode voltage affected?

Question 5 — 4 marks

The following waveform transmits a single value (a "character") over an asynchronous serial interface:
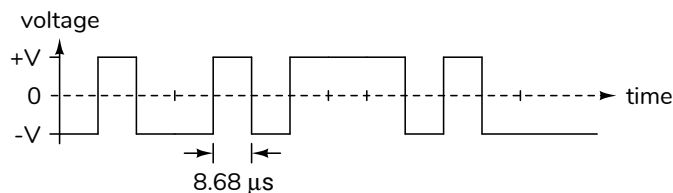
(a) What was the baud rate?

(b) Was parity used? If so, was it even or odd parity?

(c) What is the value of the character that was transmitted. Give your answer as a hexadecimal value.

Question 6 2 marks

Question 6 — **2 marks**

The following waveform shows data that has been encoded using a differential NRZ line code using the convention that a change is a '1' and no change is a '0':
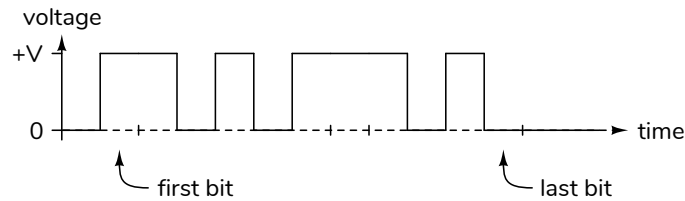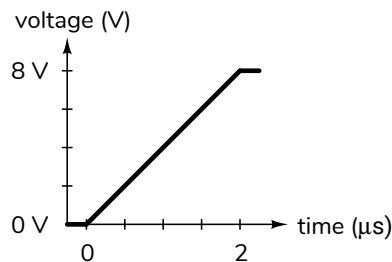

What sequence of bits was transmitted between the indicated bits? Give your answer as a sequence of 1's and 0's in the order the bits were transmitted.

Question 7 — **2 marks**

You measure the following transition between two levels on a communication system waveform:

(a) What is the slew rate?

(b) If the decision threshold is half-way between the two levels, what is the noise margin?

Question 8 — **3 marks**

The following sequence of bits includes an HDLC frame:

```
1 0 1 1 0 1 1 1 1 1 1 0 1 0 1 1 1 1 1 0 1 1 0 1 1 1 1 1 1 0 0 1 0
```

What are the values of the data bits within the HDLC frame? Give your answer a sequence of 0's and 1's in the order they appear in the frame.

Question 9   4 marks

A communication system uses the generator polynomial $G(x) = x^4 + x + 1$ to protect a message consisting of the bits **10110**.

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

   (b) Use the simple CRC algorithm described in the lectures to compute the CRC that would be appended to this message. Give your answer as a binary number.

Question 10   4 marks

A code has four valid codewords:

- **0000000**
- **1110000**
- **0001111**
- **1000011**

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

   (b) How many errors can it correct?

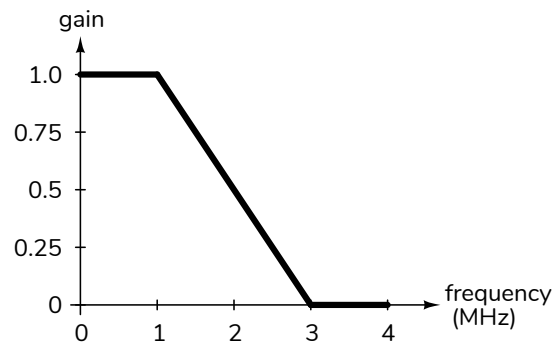   (c) How many errors can it detect?

   (d) If the codeword **1111111** was received, was there an error?

   (e) What codeword was most likely transmitted?

Question 11   2 marks

A channel has the following frequency response:

Is it possible to transmit data over this channel without ISI? If so, what is the maximum symbol rate for which this is possible?

Question 12   2 marks

What is the minimum bandwidth required for any communication system to be able to achieve a very low error rate while transmitting 1 Mb/s of information over an AWGN channel that has an SNR of 0 dB?

Question 13   3 marks

The following bytes (in hexadecimal) follow the preamble in an Ethernet frame:

```
00 e0 4c 6b e4 9b 50 3e aa 0c 77 7e 08 00 50 3e aa 0c 77 7e
```

(a) What is the destination address?

(b) What is the value of the type field?

(c) What is the value of the first byte in the (Ethernet frame's) payload?

Question 14   2 marks

1. Would TDMA, FDMA or CSMA be most appropriate for a communication system primarily used by customers viewing web pages? *Briefly* explain.

2. Would (i) stop-and-wait ARQ, (ii) go-back-N ARQ or (iii) selective repeat ARQ be most appropriate for use on a link between North America and Asia operating at 10 Gb/s with very low error rates (e.g. one frame error per month)? *Briefly* explain.