**ELEX 7860 : Wireless System Design**
**2021 Winter Term**

# Midterm Exam 2
## 12:30 − 14:20
## Thursday, March 11, 2021

This exam has five (5) questions on six (6) pages. The marks for each question are as indicated. There are a total of nineteen (19) marks.

Download this exam and write your answers in the space provided. You may print the exam and write the answers by hand, mark up this document using a tablet, or edit the file with a word processor.

You may access books, notes or electronic documents created before this exam. You may not communicate in any other way during the exam.

Please sign the following declaration to confirm your understanding of this:

> *This work is solely my own effort and I understand the consequences of plagiarism and other offences described in* BCIT Policy 5104.

Signed: _____

Answer all questions. *Show your work.* Draw a box around your final answer. Numerical answers must include units.

When you are done, export your document to a **PDF** file. Submit the PDF file to the Midterm Exam 2 Assignment folder on the course web site before the submission deadline, 14:20 PM . If you submit multiple times only the most recent submission will be marked.

**Only PDF files will be marked.**

Name: _____

BCIT ID: _____

| Question | Mark | Max. |
|----------|------|------|
| 1 | | 3 |
| 2 | | 3 |
| 3 | | 4 |
| 4 | | 4 |
| 5 | | 5 |
| Total | | 19 |

A company is claiming that they have a modulation and FEC technique that will allow nearly error-free data transmission at a rate of 80 Mb/s over a 20 MHz channel that has an SNR of 5 dB with white, Gaussian noise.

Give a brief explanation of why this is, or is not, credible. Show your calculations.

The generator matrix for a code is:

$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 \end{bmatrix}$$

(a) What are $n$ and $k$?

(b) What is the transmitted codeword when the data word is $[1\ 0\ 1]$?

(c) What is the parity check matrix for this code?

A code uses the following parity check matrix:

$$H = \begin{bmatrix} 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 \end{bmatrix}$$

What is the minimum distance of the code? Show your work.

A communication system uses a rate-3/4 FEC code to achieve an error rate of $1 \times 10^{-5}$ at an SNR of 10 dB. An SNR of 16 dB is required to achieve this error rate if FEC is not used. In both cases the channel bandwidth is 500 kHz and the transmitted data rate, including any FEC, is 1 Mb/s.

What is the coding gain as defined by the reduction in $E_b/N_0$ required to obtain an error rate of $1 \times 10^{-5}$?

An OFDM system uses 1024 subcarriers and a sampling rate of 10 MHz. It operates over a channel with a delay spread of 10 microseconds. The guard time duration is twice the channel delay spread. Only 612 of the 1024 the subcarriers are transmitted and each of these is modulated using QPSK modulation (2 bits per subcarrier).

(a) What is the total duration of each OFDM symbol, including the guard time?

(b) How many bits are transmitted per second?

(c) What is the approximate bandwidth of the signal?

(d) What is the spectral efficiency of this system in bits per second per Hz?