ECSE 436 **McGill University**

Prof. Bajcsy **Fall 2016**

Laboratory Assignment 1 (part 1)

Due: with part 2

Problems:

Problem 1: Context of the Course

(a) Using Internet and/or library resources, describe and explain in your own words and sketches the signal processing involved in radar technology and the signal processing hardware used to implement it.

(b) In lecture, we discussed FPGA's vs. ASIC's as two hardware platforms to implement signal processing techniques in practice. Using the Internet resources and/or the library, list at least 4 advantages each technology has when compared to the other one.

Problem 2: Error Control Codes

As covered in class, large distances between codewords are important for code error-correcting ability.

(a) Show that for any binary linear block code, d_{min} = min wt(**c**), searching over all non-zero codewords.

(b) Does this result extend to non-binary linear codes? Answer and fully justify your answer.

(c) State and prove the Hamming bound on d_{min} for binary codes. Use it to show that a (24, 12, 9) binary code does not exist.

(d) Explain why an (n,k,d_{min}) binary code can ALWAYS correct up to $(d_{min}-1)$ erasures.

(e) For the (6,3, 3) binary code discussed in class, list all its codewords and verify that its $d_{min} = 3$ with and without using the result from part (a).

(f) How many codeword pairs are at a distance d_{min} for this code? Finally, sketch so called code spectrum of this code.

Problem 3: Implementing Decoding Algorithms

(a) Using Matlab, implement an encoder for the (6,3,3) code from class and a function for binary erasure channel that takes as an input a binary 0/1 vector and probability of erasure value. The output of the function is the binary vector corrupted with i.i.d. erasures represented by 1/2 values, which occurred with the given probability.

(b) Using Matlab, implement the exhaustive decoding algorithm from class for the (6,3,3) code on the erasure channel. (Hint: You can use proper distance function to "vectorize" your algorithm for speed.)

(c) Implement an erasure decoding algorithm for this (6,3,3) code using Gaussian elimination to solve out the erasure.

(d) Test performance of these algorithms using your encoder and erasure channel scripts from (a).

(e) Complexity consideration: What would the complexity of these decoders is your code is a (10000, 5000) code? Estimate how many seconds/days it would it take to decode erasures in such a codeword on a regular computer. (Use approximations as necessary.)