UNIVERSITY OF MANITOBA

Department of Electrical and Computer Engineering

ECE 4830 Signal Processing II. **Laboratory 3**

Problem 1

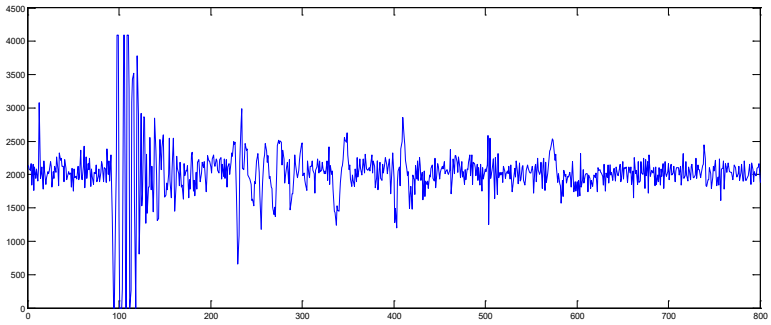
You are given two short audio sounds (50001 samples per sound) sampled at 44100 Hz corresponding to sounds from two different sets of mechanical gears.

a) Develop a technique that will use the Fourier Transform to classify each sound as Gear1 and Gear2. Make it flexible so that the audio volume of the recordings can change without incurring in a misclassification. Consider that N_w is the 50001 samples, that is, you only have two examples.

b) Can you reduce the sampling rate and not use Fs = 40000 Hz? If so, what is your suggested sampling frequency and what changes do you need to do in order to use the solution you developed in part (a).

Problem 2

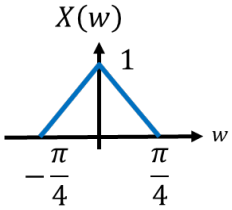
You will be given a matlab file containing 16 ultrasound scans at the same position such as the one shown next:



The first peak as indicated by the first arrow corresponds to the equipment and is always there but has no meaning. The strongest response around time bin 100 is caused by multiple reflections as explained in class. What type of filtering can be used to eliminate any further response from the extra pulses sent caused by this bouncing back and forth at the beginning of the ultrasound pulse trajectory? Please design the filter, decide for LPF, HPF or BPF and its frequency support.

Problem 3

Find the inverse DTFT of $X(w)$ shown using the derivative property $nx(n) \leftrightarrow j\frac{dX(w)}{dw}$ ***only once***. Do not use it twice as that is the way we solved it in class. Verify you have the same answer we obtained in class.



Problem 4

Find the convolution of the everlasting signals: $x_1(n) = \frac{A}{16}\ sinc\left(\frac{\pi}{16}n\right)$ and $x_2(n) = B\ Cos\left(\frac{3\pi}{4}n\right)$

Problem 5

A discrete time system with input *x*(*n*) and output *y*(*n*) is described in frequency by:

$$Y(w) = e^{-j2\pi w}X(w) + \frac{dX(w)}{dw}$$

(a) Compute the response of the system to the input *x*(*n*) = *δ*(*n*).

(b) What is the difference equation in time of the system.

(c) Check if the system is stable and time-invariant