University of Massachusetts Dartmouth
Department of Electrical and Computer Engineering

ECE 320 DISCRETE-TIME LINEAR SYSTEMS

Spring 2008

MATLAB **Project 3**

Sampling

Issued: Monday, November 25, 2013 **Due:** Monday, December 9, 2013

The ground rules for this project are the same as Project 1 and Project 2.

Use the solutions distributed for Projects 1 & 2 as a model for your report for this project. Please make sure you include detailed minutes of which group members met when, and what they did at the meeting. Also, make sure that any analytic solutions are included in the report, not as handwritten appendices.

Remember that non-participating group members may be fired from the group after one warning as discussed in the course information handout distributed at the first class meeting. Students fired from a group must either convince another group to hire them, or complete the entire project on their own.

Part 1: Buck, Daniel, & Singer, Project 7.1, all parts (a)–(j). **Note:** Use $\beta = 2\pi(2000)$ for (g)-(j), not $\beta = 2000$ as in the book.
Part 2: New project below.

You are secret agent Melbourne Wrist-toe, a member of the top-secret SD-320 organization. Your friends all believe your cover story – that you are a UMassD ECE student. Working with your partner Mason, you acquired one of the coveted Ravioli manuscripts drawn by the 15th century genius and architect Manicotti Ravioli. This particular manuscript includes a diagram for a speech scrambling system, shown below in Figure 1, which was used to encode a secret message from Ravioli. Some of the important parts of the diagram in the Ravioli manuscript were damaged when you recovered it from your rival organization, $e^{j\omega}$-Directorate. Working with the SD-320 technology guru Fender, you need to use the diagram from the manuscript to write a Matlab program that will unscramble the speech and recover the secret message.

(a) Download the scrambled speech `.wav` file for your group from the course web site under Matlab Projects. You are looking for a Matlab file named `groupx.wav`, where `x` is your group number. This file contains the output of the speech scrambler sampled at 10 kHz. Listen to the file to confirm that it is truly scrambled.

(b) Using what you learned on Project 5.1, plot the magnitude spectrum $|X(e^{j\omega})|$ for the scrambled data file you loaded from the web site. You'll need to use the `wavread` command to read your file into Matlab. Which parts of the spectrum look like speech? Instead of labeling your plot in DT frequencies (radians), work out the correct x-axis to label it in Hz (or kHz).

(c) As a first start towards unscrambling the speech, work through graphically what the output of the system will be when the input is

$$x_c(t) = \left(\frac{\sin\left(2\pi(1000)t\right)}{\pi t} \right)^2 .$$

Compare your results with the scrambled speech spectrum in part (b) to make your best guess at what the missing values are in the diagram. State clearly any assumptions you make in this process. Hand in sketches of the spectrum you get for each step in the process with all important frequencies labeled clearly.

(d) Based on your work in part (c), design a DT descrambling system. You will need to be careful to convert all of the important frequencies into DT frequencies. Demonstrate that your system would correctly unscramble the test waveform in part (c) if it were sampled at 10 kHz to obtain $x[n]$.

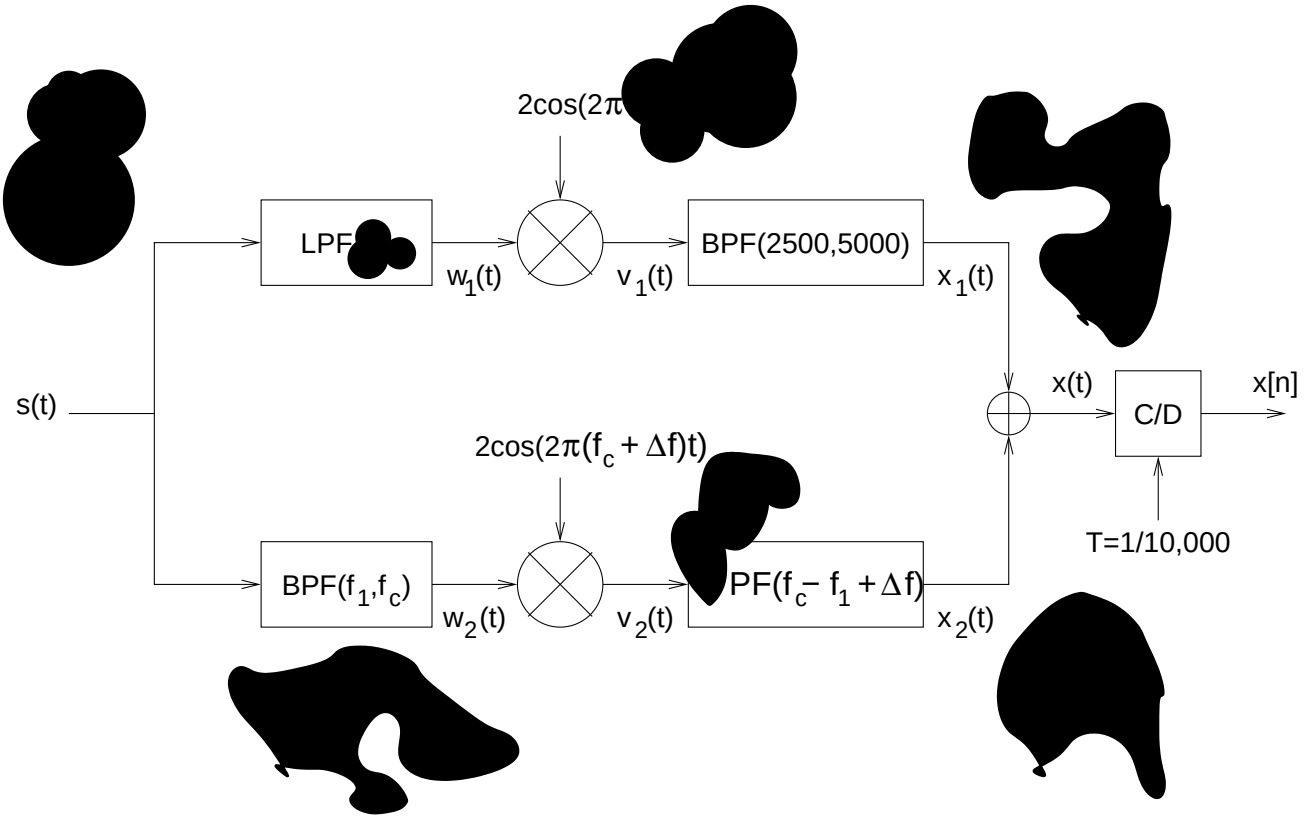

Figure 1: Secret speech scrambler from the Ravioli manuscript

(e) Implement your unscrambling system in Matlab and decode the secret message. Use FIR filters designed with `fir1` to approximate the ideal filters in your design in part (d). Make sure all of the FIR filters you use in your system have the same length. Agent Wrist-toe, what is the secret message?