

ECE-486 Test 2
May 1, 2003 — Computer Portion (1 hr)
Open Book, Computers and Calculators Allowed

Do your own work. Do not send output to the printer. Printed output will not be accepted or graded. Submit your filter designs electronically.

Make sure you are able to electronically submit designs before you begin working on this test.

Designs submitted after 9:00 PM will not be accepted or graded.

1. A discrete-time system utilizing a sample rate of 100 ksp/s is to implement a bandpass filter which meets the following specifications:

$$\begin{aligned} \text{Passband: } & 7 \text{ kHz} \leq F \leq 12 \text{ kHz} \\ \text{Passband Gain: } & 6 \pm 0.2 \text{ dB} \end{aligned}$$

$$\begin{aligned} \text{Stopbands: } & F \leq 5 \text{ kHz, and} \\ & F \geq 15 \text{ kHz} \\ \text{Stopband Gain: } & \leq -90 \text{ dB} \end{aligned}$$

- (a) Use the window method to design a linear phase filter which meets the above specification. Submit your design for grading using the MATLAB command

`ece486_submit('lastname_test2_1a',h);`

where “h” is the name of the vector containing your filter coefficients.

- (b) Now redesign the above filter using the Remez algorithm. Submit your design for grading using the MATLAB command

`ece486_submit('lastname_test2_1b',h);`

where “h” is the name of the vector containing your filter coefficients.

- (c) In the space below, give list the number of filter coefficients and the filter order for each of the above designs. Evaluate the computational complexity of each design by indicating the number of multiplications per second required for each filter. Assume a filter structure which minimizes the number of multiplications required.

2. The course www site provides a link to a data file containing 256 samples of a humpback whale call, sampled at 22.05 ksps. Assume that the data provided is in units of volts.

The link to the data file is:

<http://www.eece.maine.edu/~hummels/classes/ece486/hmpback.dat>

- (a) Identify the three dominant harmonic tones present in the whale call by listing the frequencies of these tones below. Give your answer in units of Hz.

- (b) Give the amplitude (in volts) of the largest harmonic tone present in the whale call.

- (c) Use the FFT to approximate the derivative of the whale call. Submit your derivative estimate for grading using the MATLAB command

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ece486_submit('lastname_test2_2c',y);
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where “y” is the name of the (real!) vector containing your derivative estimate. What are the units associated with your submitted derivative estimate?

- (d) Now use the window method to design a 20-coefficient linear phase FIR filter for which the filter output approximates the derivative of the input signal for frequencies below 15 kHz. Describe below how you designed your filter, and submit your design for grading using the MATLAB command

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ece486_submit('lastname_test2_2d',h);
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where “h” is the name of the vector containing your filter coefficients.

3. When I used the FFT to estimate the derivative of a signal, I obtained the results shown below. The top plot shows my input test signal, and the bottom plot shows my estimated derivative. Explain the large transient signal shown at the beginning and end of the estimated derivative. (I used a sample rate of 22.05 ksp/s, and calculated the results using 256 samples).

