ECE503 Homework Assignment Number 9

Due by 8:50pm on Monday 09-Apr-2012

IMPORTANT: Please place your ECE mailbox number on all homework assignments. Your ECE mailbox number can be found on the course web page.

Make sure your reasoning and work are clear to receive full credit for each problem. Points will be deducted for a disorderly presentation of your solution. Please also refer to the course academic honesty policies regarding collaboration on homework assignments.

1. 3 points. Mitra 11.12. If we measure "operations" as real multiplications, what is the asymptotic complexity of the DFT? What if we measure "operations" as real additions?

2. 4 points. Mitra 11.27.

3. 3 points. Mitra 11.32.

4. 7 points total. Suppose you have a causal IIR digital filter with transfer function

$$H(z) = \frac{1 + 0.5z^{-1}}{1 - 1.4z^{-1} + 0.98z^{-2}}$$

   (a) 1 point. Use Matlab to plot the magnitude response of this filter. Is this filter stable?

   (b) 3 points. Now suppose the filter coefficients are quantized to 8-bit signed fixed-point data-types with 4 fractional bits. Compute the quantized coefficients and write them in base-10 and binary representations, showing the binary decimal point explicitly. Re-plot the magnitude response of your filter with these quantized coefficients, comparing the results with the unquantized filter. Is the quantized filter stable?

   (c) 3 points. Given your filter coefficients must be quantized to 8-bit signed fixed-point data-types, what is the optimum number of fractional bits to use here? Can you improve the frequency response of your quantized-coefficient filter by using less/more fractional bits?

5. 4 points. Represent $x[n] = n(-\pi)^n$ in an 8-bit signed fixed-point data type with two fractional bits for $n = 0, \ldots, 3$ in both saturation overflow and wrapped overflow. Write your results in base-10 and binary and show your binary decimal point explicitly. Also compute the quantization error.

6. 4 points. Mitra 11.49. This problem assumes wrapped overflow. Also compute the final result assuming saturation overflow.