University of Pennsylvania
Department of Electrical and System Engineering
Digital Signal Processing

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HW7: GLP Systems, Windowing, and DFT   Tuesday, Mar. 29

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Due: Tuesday, Apr 5, 11:59PM

- **Homework Problems:** All problems must be turned in and are not optional for full credit

  1. Homework problems from the book: 5.39, 7.15, 7.45, 8.14

  2. Matlab problem 1: Calculation of the DFT. In this problem you will measure the execution time of a direct calculation of the DFT using three different organizations of the algorithm. The definition of the DFT is given by:

  $$X[k] = \sum_{n=0}^{N-1} x[n]W_N^{nk} \tag{1}$$

  for

  $$W_N = e^{-j2\pi/N} = cos(2\pi/N) - jsin(2\pi/N) \tag{2}$$

  and $k = 0, 1, ...N - 1$.

  (a) Two-Loop Program. Write a program (M-file) or a function in MATLAB to evaluate the DFT given above using two nested `for` loops with the inner loop summing over n and the outer loop indexing over k. Time the program for several lengths using the `clock` and `etime` commands. Compare the times of your DFT program with the built-in MATLAB command `fft` for the same lengths. Comment on the results.

  (b) One-Loop Program. Write a DFT program using one loop which steps through each value of k and executes an inner product. Time the program as was done in (a). Explain the results obtained.

  (c) No-Loop Program. Write a DFT program using a single matrix multiplication. Write your own DFT matrix rather than using the built-in `dftmtx`. Use the `exp` command with the exponent formed by an outer product of a vector of `n = 0:(N-1)` and a vector of `k = 0:(N-1)`. Time the program as you did for the previous programs.

  (d) Comment on the differences and on the comparisons of the three implementations.

  3. **Recommended Problems for Practice:** From the book: 5.38, 7.27, 7.34, 8.16