

*Topic covered in this homework is: Fast Fourier Transform. Homework will be graded for (1) completion and (2) Three randomly picked problems will be graded. Submissions will be using gradescope. Please solve problems on your own in order to maximally benefit from this homework.*

**Problem 1:**

Calculate the DFT of the length-4 sequence  $x[n] = [1, -2, 3, -4]$  explicitly “by hand” using the decimation-in-time FFT algorithm.

**Problem 2:**

A flowgraph illustrating the decimation-in-time FFT algorithm is shown below. Complete the connections in the output stage, clearly identifying the connection weights. Also determine the values of the indices  $a, b, \dots, h$ .

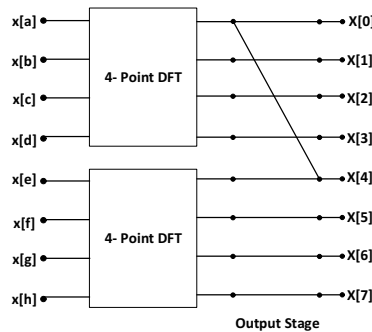


Figure 1: An 8-point decimation-in-time FFT algorithm.

**Problem 3:**

Assume that a real multiply-add takes one nanosecond and that the amount of time to compute a DFT is determined by the amount of time it takes to perform all of the multiply-adds sequentially, i.e., you have access to only one multiply-add unit.

1. How much time does it take to compute a 1024-point DFT directly?
2. How much time is required if an FFT is used?
3. Repeat the above two parts for a 16384-point DFT.

**Problem 4:**

Two complex sequences of lengths  $L = 8192$  and  $M = 512$  respectively are to be linearly convolved. Compute the number of complex multiply-adds required if:

1. The convolution is performed directly in the sequence-domain.
2. Using radix-2 FFTs.