

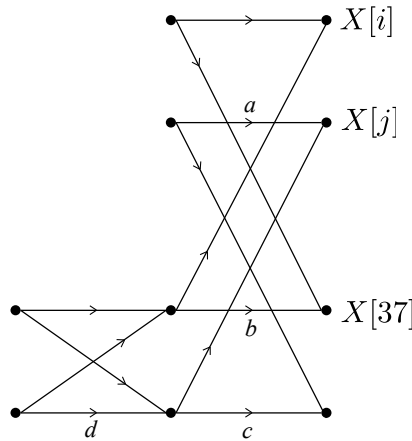
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN
 Department of Electrical and Computer Engineering
 ECE 310 DIGITAL SIGNAL PROCESSING – SPRING 2026
Homework 10 (Part 1)

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Due: Friday, April 17, 11:59pm on Gradescope

Note: More problems will be added to this Homework based on the material of the lecture of 4/13.

1. Using the recursive DFT formulas and FFT algorithm derived in the class, draw the complete flow graph of the 4-point decimation-in-time FFT. Compute the output of this FFT flow graph for the test input signal $x = \{2, 0, 1, -1\}$, and compare the FFT output with the output using the standard DFT formula.
2. Below is part of the flow diagram for a radix-2 64-point decimation-in-time FFT. Determine the values of the indices i and j and of the complex coefficients a, b, c, d (which you can express in terms of W_{64} or in terms of a complex exponential).



3. Consider the two finite-length sequences:

$$\{x[n]\}_{n=0}^4 = \{1, 2, 3, 2, 1\}, \{h[n]\}_{n=0}^2 = \{-1, 0, 1\}$$

- (a) Compute the linear convolution $x[n] * h[n]$.
 - (b) Compute the circular convolution $x[n] \otimes_5 h_{zp}[n]$ where $\{h_{zp}[n]\}_{n=0}^4 = \{h[0], h[1], h[2], 0, 0\}$.
 - (c) What is the smallest value of N so that N -point circular convolution is equal to the linear convolution?
4. Given two sequences $\{x[n]\}_{n=0}^{93}$ and $\{h[n]\}_{n=0}^{52}$, you are asked to compute their linear convolution $y[n] = x[n] * h[n]$. You decide to use the DFT for this purpose.
 - (a) What is the length of the sequence $y[n]$?
 - (b) To speed computation, you decide to use a radix-2 FFT to compute the DFT. How should the sequences be zero-padded so that their linear convolution can be computed using the smallest possible radix-2 FFT?