

Name _____

EE-3221 - Dr. Durant - Quiz 8
Winter 2020-'21, Week 10

This is an *open*-book quiz. Open notes. You may use a calculator.

1. (6 points) Use the FFT algorithm from class (radix-2 decimation-in-time FFT) to calculate the 4-point DFT of $x(n) = 1 + \cos\left(\frac{\pi}{2}n\right) = [2 \ 1 \ 0 \ 1]$

(turn over for 2nd problem)

2. (4 points) $x(n)$ has length 1536 ($2^{11} - 2^9$) and $h(n)$ has length 512 (2^9). By the width property, the convolution has length 2047 ($2^{11}-1$). Calculating the convolution directly would require $1536 \times 512 = 786,432$ multiplies.
- List the 4 steps to calculate the convolution result using radix-2 (thus $N = 2^k$) FFTs and IFFTs (inverse FFTs). Hint: Convolution property of DTFT: $Y(e^{j\Omega}) = H(e^{j\Omega})X(e^{j\Omega})$
 - Calculate the number of (complex) multiplies needed by each step. Recall that a radix-2 FFT has N inputs and k layers, therefore it requires kN multiplies. You do not need to treat real multiplies differently or account for trivial multiplies (by 1, j , etc.).
 - Add up the multiplies needed and calculate how much the required computing power due to multiplies has been reduced by using the FFT method.