Shiv Nadar University

Department of Electrical Engineering-(SoE)

EED305: Digital Signal Processing **Lab-6** **Instructor:** Prof. Vijay Kumar Chakka

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Topic: Discrete Fourier Transform

1. Construct a Fourier transformation matrix D of size $N \times N$ in MATLAB, by using the sequence $s_k[n] = e^{\frac{j2\pi}{N}kn}, 0 \le n \le N-1, 0 \le k \le N-1$. Where first column of the matrix is $s_0[n], 0 \le n \le N-1$, second column is $s_1[n], 0 \le n \le N-1$, similarly N^{th} column is $s_{N-1}[n], 0 \le n \le N-1$.

2. For a given length $N = 4$, verify that these sequences $s_0[n], s_1[n], s_2[n], s_3[n]$ are orthogonal to each other. I.e.,
$$\sum_{n=0}^{N-1} s_i^*[n] s_j[n] = \begin{cases} 0 & for\ i \neq j \\ N & for\ i = j \end{cases}$$

3. Verify the condition that $DD^H = NI$, where I is an Identity matrix. By using the condition $D^{-1} = D^H$.

4. Consider a $N = 4$ length input sequence. Compute the (DFT) transformation coefficients $X[K]$ using $X[K] = D^H x[n]$. Compute the inverse transformation (IDFT), using $x[n] = \frac{1}{N} DX[K]$.

5. Consider the input sequence of system $x(n) = \{1,2,3,4\}$ having an impulse response $h(n) = \{0,1,0,0\}$. Perform the following analysis:
   a. Compute the output response of the system $y(n)$.
   b. Compute its respective 4-DFT's ($X[K]$ and $H[K]$) and calculate the 4-IDFT $y(n)$ of the sequence $Y[K] = X[K]H[K]$.
   c. Write your observation about the sequence $y(n)$ obtained in (a) and (b).

6. Compute the 50 point (DFT) transformation coefficients $X[K]$ for a given input data sequence $x[n]$ ($'inputData.mat'$) and impulse responses ($'h1.mat', 'h2.mat'$) .Then from obtained coefficients compute $Y_1[K] = X[k]H_1[k]$ and $Y_2[K] = X[K]H_2[K]$. Find the 50-point inverse transformation $y_1(n)$ and $y_2(n)$. Plot the signal x(n), y_1(n),y_2(n). write your observations