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The LNM Institute of Information Technology

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Experiment No. # 3
LTI system characterization

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1) **Objectives:**
   a) Linear convolution and DFT matrix Generation.
   b) Simulink based convolution.

2) **Software used:**
   a) MATLAB.

A. Pre-Lab

a) Read about LTI system characterization.
b) practice simulink.

I. CONVOLUTION AND DFT

A. *Theory*

1) J. Proakis and D. Manolakis, Digital signal processing: principles, algorithms, and applications

B. *Procedure*

1) Linear Convolution: Write a MATLAB function myLinConvMat.m that takes in the impulse response h(n) of an LTI system, the length of input sequence x(n) and provides matrix representing the convolution operator H at the output. Compute and plot the convolution results for each of the following $h_i(n)$, $i = 1, 2, 3, 4$.

$$h_1(n) = \{\bar{1}, 1\}$$

$$h_2(n) = \{\bar{1}, -1\}$$

$$h_3(n) = \frac{1}{3}\{1, \bar{1}, 1\}$$

$$h_4(n) = \frac{1}{4}\{1, 1, \bar{-4}, 1, 1\}$$

$$x_i(n) = \cos(2\pi f_i n) \quad \{where f_i = 0, \frac{1}{10}, \frac{1}{5}, \frac{1}{4}, \frac{1}{2}\}$$

Here $n = 0, 1, \cdots 99$ samples.

2) DFT: Write a MATLAB function myDft.m that takes in a finite length sequence and produces the Discrete Fourier Transform of the input.

$$X(k) = \sum_{n=0}^{N-1} x(n) e^{\frac{-j2\pi nk}{N}}$$

Where $k = 0, 1, \cdots N-1$ and $N = 8, 16, 64$ no.of points. Compare your results for $h_i(n)$'s (of Exercise1) with $8, 16, 32, 64$ point fft output. The fft is a fast way of computing DFT and is available in MATLAB. Try to see connections between $H_i(\omega)$ and the corresponding DFTs.

3) **Observation:**
   a) Generate Convolution matrix H.
   b) Perform linear convolution code and compare your results with MATLAB built in command for linear convolution.
   c) Generate DFT matrix using given expression for (8,16,64) points.
   d) Utilize the DFT matrix (8, 16)points to find DFT of any given sequence and compare the results with inbuilt fft sequence.
   e) Repeat the experiment in simulink.
4) **Conclusion:** Conclude the experiment.

II. Convolution in Simulink

1) Open simulink and create a model file with .slx extension.

2) Read input data through any random binary source.

3) Take channel coefficents $h = 1, 0.5, 0.25$.

4) Check the result of the convolution in simulink.

5) Repeat all the 'Procedure' steps and recreate the convolution of discrete signal into simulink.

Well Done
