Analysis is done in MATLAB using this example:

1)Find the minimum sampling rate in both rad/s (Ω) and Hz (f) for the following band-limited analog signal whose CTFT is given in Fig. 1 such that it can be reconstructed from its samples. Fig. 1. CTFT of the band-limited analog signal in question 1

A graph of a function

Description automatically generated

b) The analog signal given in Fig. 1 is sampled with a sampling period T=1/150 s. Plot the discrete time Fourier transform (DTFT) of the sampled sequence by indicating all necessary information on the x- and y-axes. Determine whether the aliasing occurs or not. If aliasing occurs, specify the frequency region where aliasing occurs.

c) The analog signal given in Fig. 1 is sampled with a sampling period T=1/500 s. Determine whether the aliasing occurs or not. What is the highest frequency in the sampled signal? Let 𝛺𝑎 = 100𝜋rad/s be an analog frequency value. Which is the corresponding discrete frequency ωa in DTFT?

2) DFT is implemented using Fast Fourier Transform (FFT) algorithm in practice and MATLAB environment. In this part, exploring “fft” and “ifft” functions in MATLAB for taking DFT and inverse DFT, respectively. You can write “help fft” and “help ifft” in the Command Window of MATLAB to find out these functions.

• fft(x,N) is the N-point fft of x, padded with zeros if x has less than N points and truncated if it has more.

• ifft(x,N) is the N-point inverse fft of x.

• If N is not given, such as fft(x), the fft and ifft are implemented by taking DFT and inverse DFT size as the length of input sequence.

• You are first required to define an input sequence in MATLAB, which consists of the first 6 digits of your student ID number. For example, if your student ID is 1234567, the input of the MATLAB code is given as follows: x= [ 1 2 3 4 5 6];

• Take N=6-point fft of x and call it “y”. Plot the magnitude and phase of y using “stem” command in MATLAB. Attach these plots to your preliminary work.

• Is there some kind of symmetry in the plots? If there is a symmetry, explain the reason considering input sequence x.

• Then, take N=9-point fft of x and call it “z”. Compare z with y. Are they the same?

• Now take N=9-point ifft of z and compare the result with x.

• Take N=6-point ifft of z and compare the result with x. Why is it different than x? • Take N=4-point fft of x and call it “v”. Then, take ifft of v and compare the result with x.

MATLAB CODES:

**clear; clc; close all;**

**x = [2 1 6 7 0 5];**

**y = fft(x,6);**

**figure**

**hold on**

**subplot(211)**

**stem(abs(y))**

**ylabel('abs(y)')**

**subplot(212)**

**stem(phase(y))**

**ylabel('phase(y)')**

**sgtitle('6-point fft of x');**

**z = fft(x,9);**

**figure**

**hold on**

**subplot(211)**

**stem(abs(z))**

**ylabel('abs(z)')**

**subplot(212)**

**stem(phase(z))**

**ylabel('phase(z)')**

**sgtitle('9-point fft of x');**

**v = fft(x,4);**

**figure**

**hold on**

**subplot(211)**

**stem(abs(v))**

**ylabel('abs(v)')**

**subplot(212)**

**stem(phase(v))**

**ylabel('phase(v)')**

**sgtitle('4-point fft of x');**

**x**

**x1 = ifft(z,9)**

**x2 = ifft(z,6)**

**x3 = ifft(v,4)**

**OUTPUT WAVEFORM:A graph of a function

Description automatically generated**

**A graph of a graph

Description automatically generated**

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