AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)

Faculty of Science & Technology

Undergraduate Program

Course: DATA COMMUNICATION

Fall 2022-23

Section:I

Group: 3

Lab Report-05

Submitted by

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Performance Task for Lab Report: (your ID = AB-CDEFG-H)

Convert the following analog signal into digital data:

sig = a1*sin(2*pi*f1*t) + a2*cos(2*pi*f2*t) + a3*sin(2*pi*f3*t) + a4*sin(2*pi*f4*t);

[a1 = F + 1, a2 = F + 3, a3 = F + 2, a4 = F + 4, f1 = G + 5, f2 = G + 7, f3 = G + 1, f4 = G + 2]

a) Show analog signal, sampled signal, and quantized signal.

b) Show the digital data from the analog signal.

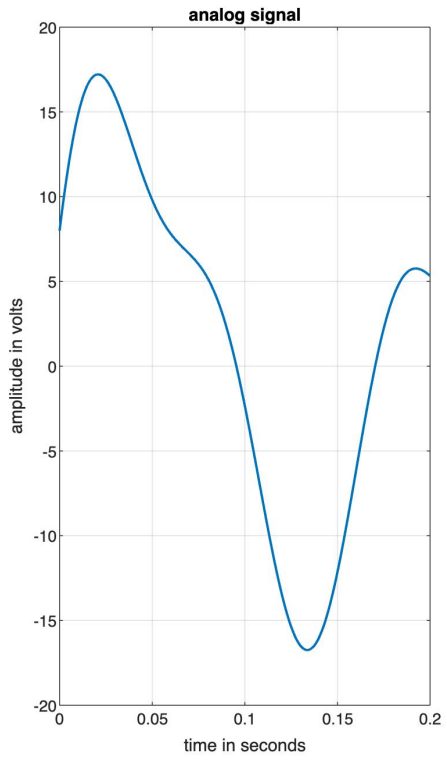
c) What are the appropriate values of sampling frequency and number of levels of quantization if

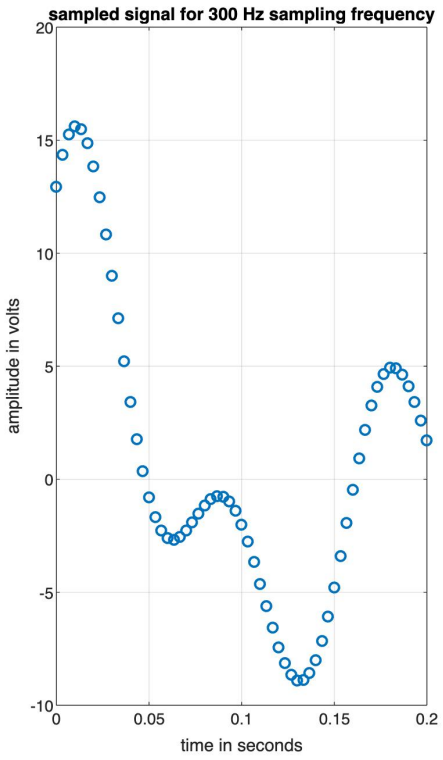
minimum required SNR and bandwidth of the channel are 25 dB and 150 Hz respectively.

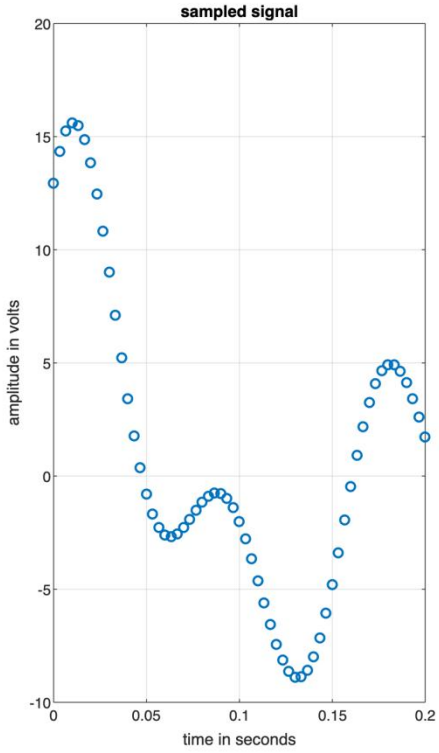
```
%20-42954-1
clc
clear all
close all
A= 2;
B= 0;
C= 4;
D= 2;
E= 9;
F= 5;
G= 4;
H= 1;

a1= F+1;
a2= F+3;
a3= F+2;
a4= F+4;

f1= G+5;
f2= G+7;
f3= G+1;
f4= G+2;

time_duration = 0.2;
%% Analog-like signal's representation
% Analog signal generation is not possible in MATLAB
a = [a1 a2 a3 a4]; % amplitude array for composite signal
f = [f1 f2 f3 f4]; % frequency array for composite signal
analog_t = 0:0.0001:time_duration;
```

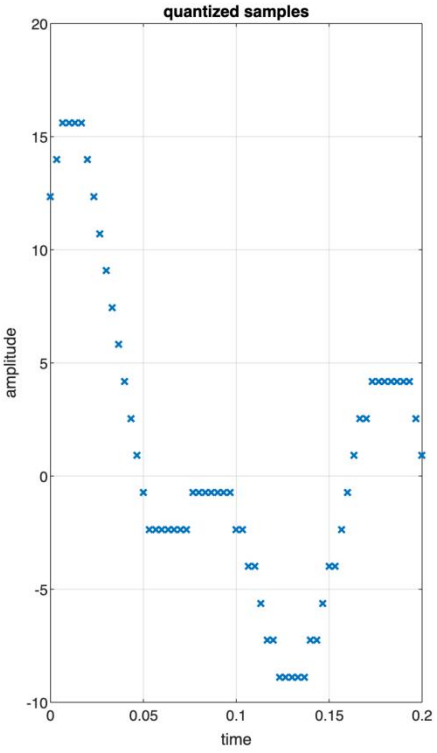
```
analog_sig = a(1)*sin(2*pi*f(1)*analog_t) + a(2)*cos(2*pi*f(2)*analog_t)
+ a(3)*sin(2*pi*f(3)*analog_t)+ a(4)*sin(2*pi*f(4)*analog_t);
figure
subplot(1,2,1)
plot(analog_t, analog_sig,'linewidth',1.5)
grid on
xlabel('time in seconds')
ylabel('amplitude in volts')
title('analog signal')

%% Sampling Frequency
fs = 300;
ts = 1/fs;

%% Sampling
samp_t = 0:1/fs:time_duration;
samp_sig = a(1)*sin(2*pi*f(1)*samp_t) + a(2)*cos(2*pi*f(2)*samp_t) +
a(3)*sin(2*pi*f(3)*samp_t + pi/4);
subplot(1,2,2)
plot(samp_t, samp_sig,'o','linewidth',1.5)
grid on
xlabel('time in seconds')
ylabel('amplitude in volts')
title(['sampled signal for ',num2str(fs),' Hz sampling frequency'])

%% Levels for Quantization
L = 16;
%% Quantizing
delta = (max(samp_sig) - min(samp_sig))/(L-1); % step size
quant_sig = min(samp_sig) +
round((samp_sig-min(samp_sig))/delta)*delta; % quantized signal
figure
subplot(1,2,1)
plot(samp_t, samp_sig,'o','linewidth',1.5)
grid on
xlabel('time in seconds')
ylabel('amplitude in volts')
title('sampled signal')
subplot(1,2,2)
plot(samp_t, quant_sig,'x','linewidth',1.5);
grid on
xlabel('time')
ylabel('amplitude')
title('quantized samples')
```

```
%% Number of Bits/Sample
nb = log2(L)
bandwidth=150;
data_rate=fs*nb
SNR_thy=6.02*nb+1.76
SNR=10^(SNR_thy/10)
max_cap=bandwidth*log2(1+SNR)

i = round((quant_sig-min(quant_sig))/delta);% index for encoding
dig_data_matrix = de2bi(i,nb); % encoded binary bits are as a
matrix here
dig_data = reshape(dig_data_matrix',1,[]); % encoded binary bits
are as an array here
disp(['The index values for encoding from quantization of the sampled
signal are: ',num2str(i)])
disp(['The converted bits from the input analog signal
are:',num2str(dig_data)])
```









```
nb =

     4

data_rate =

        1200

SNR_thy =

   25.8400

SNR =

  383.7072

max_cap =

   1.2881e+03
```