AMERICAN INTERNATIONAL UNIVERSITY–BANGLADESH (AIUB)

FACULTY OF ENGINEERING

Course name: Data Communication

Course code: COE 3201

Section: H

Semester: Spring 2023-24

Name: MD. ABU TOWSIF

ID: 22-47019-1

Instructor name: Dr. Muhammad Morshed Alam

Experiment no: 04

Experiment name: Study of Nyquist bit rate and Shannon capacity using MATLAB

Submission date: March 03rd, 2024

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

ID: AB-CDEFG-H

Performance Task for Lab Report 04: (your ID = AB-CDEFG-H)

**Generate a composite signal using two simple signals as,

$x = A1 \sin(2\pi(C*100)t) + A2 \cos(2\pi(G*100)t) + s*randn(size(t));$

(a) Select the value of the amplitudes as follows: let A1 = AB, A2 = AF and s=AH

(b) Calculate the SNR value of the composite signal.

(c) Find the bandwidth of the signal and calculate the maximum capacity of the channel.

(d) What will be the signal level to achieve the data rate?

ANSWER:

(a) Select the value of the amplitudes as follows: let A1 = AB, A2 = AF and s=AH

A	B	-	C	D	E	F	G	-	H
2	2	-	4	7	0	1	9	-	1

My id:

ID = 22-47019-1
C = 4;
G = 9;
A1 = AB = 22;
A2 = AF = 21;
s = AH = 21;

So,

$x = A1 \sin(2\pi(C*100)t) + A2 \cos(2\pi(G*100)t) + s*randn(size(t));$

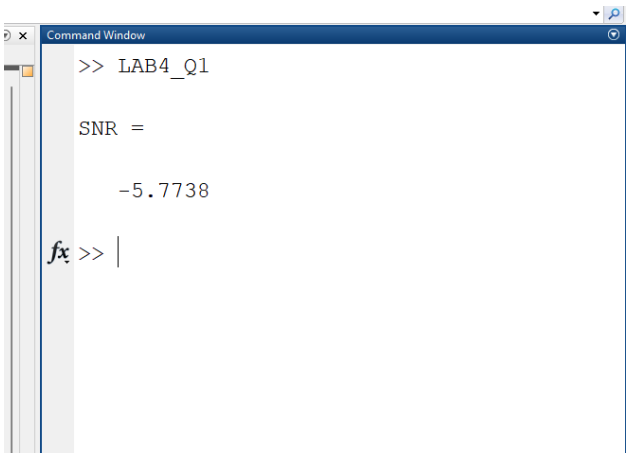
//MATLAB code where all the parameters are defined

```
%{
 ID: 22-47019-1 (AB-CDEFG-H)
SO, C = 4;
    G = 9;
    A1 = AB = 22;
```

```
    A2 = AF = 21;
    s = AH = 21;
%}
C = 4;
G = 9;
A1 = 22;
A2 = 21;
s = 21;
fs = 4000; % Sampling frequency
t = 0:1/fs:1-1/fs; % Time duration
x = A1*sin(2 * pi * (C*100) * t ) + A2*cos(2*pi*(G*100) * t) +
s*randn(size(t)); %composite signal
```

(b) Calculate the SNR value of the composite signal.

MATLAB Code	Output Figure

`%{`
` ID: 22-47019-1 (AB-CDEFG-H)`
`SO, C = 4;`
`  G = 9;`
`  A1 = AB = 22;`
`  A2 = AF = 21;`
`  s = AH = 21;`
`%}`
`C = 4;`
`G = 9;`
`A1 = 22;`
`A2 = 21;`
`s = 21;`
`fs = 4000; % Sampling frequency`
`t = 0:1/fs:1-1/fs; % Time duration`
`x = A1*sin(2 * pi * (C*100) * t ) + A2*cos(2*pi*(G*100) * t) + s*randn(size(t)); %composite signal`
 	
`powfund = A1^2/2 + A2^2/2;`
`varnoise = s^2;`
`%noise`
`noise = s*randn(size(x));`
 	
`%noisy signal`
`noisySignal = x  + noise;`
	
	Command window screenshot.

```
SNR = snr(noisySignal)
%Calculation of SNR using snr
function
```

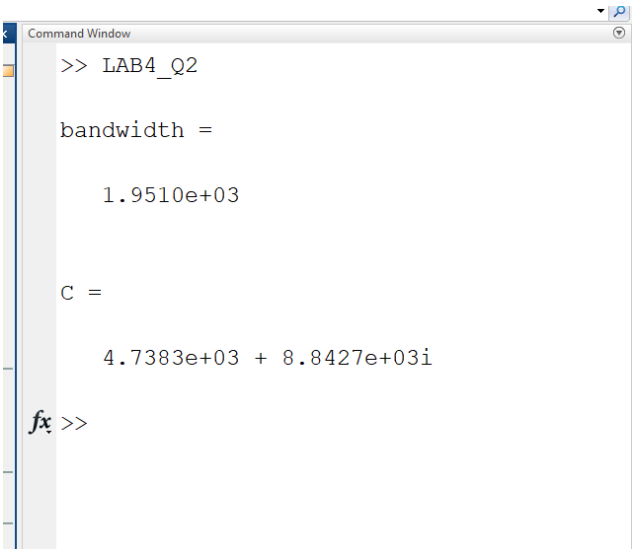
(c) Find the bandwidth of the signal and calculate the maximum capacity of the channel.

MATLAB Code	Output Figure

```
 %{
 ID: 22-47019-1 (AB-CDEFG-H)
SO, C = 4;
    G = 9;
    A1 = AB = 22;
    A2 = AF = 21;
    s = AH = 21;
%}
C = 4;
G = 9;
A1 = 22;
A2 = 21;
s = 21;
fs = 4000; % Sampling
frequency
t = 0:1/fs:1-1/fs; % Time
duration
x = A1*sin(2 * pi * (C*100) *
t ) + A2*cos(2*pi*(G*100) *
t) + s*randn(size(t));
%composite signal

powfund = A1^2/2 + A2^2/2;
varnoise = s^2;
%noise
noise = s*randn(size(x));

%noisy signal
noisySignal = x  + noise;
SNR = snr(noisySignal);
%calculating the SNR using
the snr function
```



`bandwidth = obw(x,fs) % Bandwidth of the signal` `C = bandwidth * log2(1+SNR) % Capacity of the channel`	

(d) What will be the signal level to achieve the data rate?

MATLAB Code	Output Figure

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SO, C = 4;
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A1 = AB = 22;
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C = 4;
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A1 = 22;
A2 = 21;
s = 21;
fs = 4000; % Sampling frequency
t = 0:1/fs:1-1/fs; % Time duration
x = A1*sin(2 * pi * (C*100) * t)
+ A2*cos(2*pi*(G*100) * t) +
s*randn(size(t)); %composite
signal
 	
bandwidth = obw(x,fs); % Bandwidth
of the signal
L=2; % Level of the signal
BitRate = 2*bandwidth*log2(L)
L = 2.^(BitRate/(2*bandwidth))
%Signal level to achieve data rate