AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH

Faculty of Science and Technology

Course Title: Data Communication

Lab Report-4

Exp. Title: Study of Nyquist bit rate and Shannon capacity using MATLAB

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Class Task:

Suppose our composite signal is,
signal = 1.5*sin(2*pi*2*t)+0.9*cos(2*pi*10*t)+1.1*sin(2*pi*20*t) + 0.13*randn(size(t));
*****Calculate the SNR value of the signal**

MATLAB Code:

```
close all;
clc;

fs = 8000; % Sampling frequency
t = 0:1/fs:1-1/fs; %time array
signal =
1.5*sin(2*pi*2*t)+0.9*cos(2*pi*10*t)+1.1*sin(2*pi*20*t) ;
%signal
noise = 0.13*randn(size(t)); %noise
noisy_signal = signal+noise;% noisy signal
%power of any array = average of squared value of each
element of the array
power_signal = sum(signal.^2)/length(signal); %signal power
power_noise = sum(noise.^2)/length(noise); %noise power

SNR = snr(signal,noise); %Calculation of SNR for composite
signal using snr function (in dB)
defSNR = 10*log10(power_signal/power_noise); %Calculation
of SNR manually (in dB)
regularSNR = 10^(SNR/10); % calculation of regular SNR
```

Output

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datacom_labtask4_1.m | datacom_labtask4_2.m

```
 8 -    clc;
 9
10 -    fs = 8000; % Sampling frequency
11 -    t = 0:1/fs:1-1/fs; %time array
12 -    signal = 1.5*sin(2*pi*2*t)+0.9*cos(2*pi*10*t)+1.1*sin(2*pi*20*t) ; %signal
13 -    noise = 0.13*randn(size(t)); %noise
```

Command Window

```
>> SNR

SNR =

   20.9933

>> defSNR

defSNR =

   20.9933

>> regularSNR

regularSNR =

  125.6979

fx >>
```

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

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

$x = A_1 \sin(2\pi((C+D+H)*100)t) + A_2 \cos(2\pi((D+E+H)*100)t) + s*randn(size(t));$

(a) Select the value of the amplitudes as follows: let A_1 = (A+B+H), A_2 = (B+C+H) and s = (C+D+H)/30

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

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

MATLAB Code:

```
close all;
clc;
%ID= 20-42451-1
A=2;
B=0;
C=4;
D=2;
E=4;
F=5;
G=1;
H=1;

%(a)
A1=A+B+H;
A2=B+C+H;
s=(C+D+H)/30;


fs= 5000;% sampling freqency
t= 0:1/fs:1-1/fs;%time array

signal = A1*sin(2*pi*((C+D+H)*100)*t ) +
A2*cos(2*pi*((D+E+H)*100)*t) ;
noise = s*randn(size(t));
x = signal+noise;
%(b)
power_signal = sum(signal.^2)/length(signal); %signal power
power_noise = sum(noise.^2)/length(noise); %noise power
%power_signal2= A1^2/2 + A2^2/2;
%power_noise12=s^2;
SNR_dB= snr(signal,noise); % SNR in dB using snr() function
regularSNR= power_signal/power_noise; %regular SNR using
defination
```

```
%regularSNR2= power_signal2/power_noise2;
regularSNR2=10^(SNR_dB/10);% regular snr from SNR_dB
%(c)
bandwith=obw(signal ,fs); % bandwith calculation.
ssumption: Channel BW = Signal BW
max_capacity = bandwith*log2(1 + regularSNR); % max
capacity in bps
%(d)
level = floor(2^(1/2*log2(1 + regularSNR))); % highest
number of usable voltage levels
```

Output:

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Command Window

```
>> SNR_dB

SNR_dB =

   24.8464

>> regularSNR

regularSNR =

  305.2404

>> regularSNR2

regularSNR2 =

  305.2404

>> bandwith

bandwith =

    0.9900
```

```
>> max_capacity

max_capacity =

    8.1759

>> level

level =

    17

>>
```