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: 03

Experiment name: Analog Signal quantization using MATLAB

Submission date: Feb 28th, 2024

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

ID: AB-CDEFG-H

Write a MATLAB code that can generate an approximated quantized signal for the following analog function:

$$x_1(t) = A_1 \cos\left(2\pi(CDE * 100)t\right)$$

(a) Define the amplitude $A_1 =$ GD, sampling frequency, define the time domain t for function $x_1(t)$ that gives at least 3 complete cycles.

(b) Define the number of quantization levels, step size or resolution, then find the quantized signal x_q.

(c) Obtain the absolute quantization error, $err = abs(x_1 - x_q)$

Finally, use 2x2 subplot to plot analog signal $x_1(t)$, sampling signal of $x_1(t)$, quantized signal $x_q(t)$, and quantized error signal err.

ANSWER:

(a) Define the amplitude $A_1 =$ GD, sampling frequency, define the time domain t for function $x_1(t)$ that gives at least 3 complete cycles.

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

My id:

ID = 22-47019-1
A1 = GD = 97; //Amplitude
F = CDE = 470; // Frequency

So,

$$x_1(t) = A_1 \cos\left(2\pi(CDE * 100)t\right)$$

//MATLAB code where all the parameters are defined

```
A1 = 97; % Amplitude of the analog signal,
Sampling_Frequency = 60e3; % Sampling frequency
CDE = 470; %Frequency of the analog signal
Num_Quantization_Levels = 8; % Number of quantization levels
Duration = 3; % Duration of the signal in seconds
```

```
Resolution = (2 * A1) / (2^Num_Quantization_Levels); % Step size
t=0:1/Sampling_Frequency:0.001;

% Defining the analog signal
x1 = A1 * cos(2 * pi * (CDE * 100) * t);

L=(2^Num_Quantization_Levels)-1;

delta=(max(x1)-min(x1))/L;

% Quantization
Quantized_Signal = min(x1)+(round((x1-min(x1))/delta)).*delta;
%xq


% Plotting
stem(t, Quantized_Signal, 'r')
title('Quantized Signal')
xlabel('Time (s)')
ylabel('Amplitude')
```

(b) Define the number of quantization levels, step size or resolution, then find the quantized signal x_q.

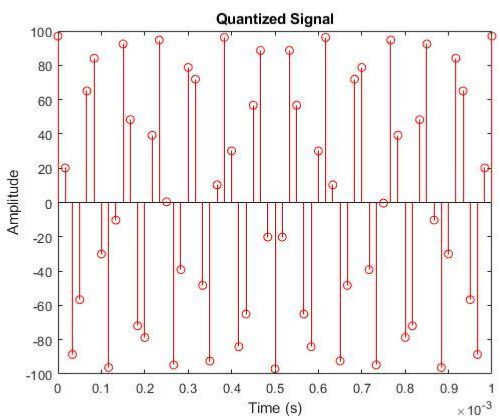
<table>
<tr><th>MATLAB Code</th><th>Output Figure</th></tr>
<tr><td>
<pre>
%{
ID: 22-47019-1 (AB-CDEFG-H);
A1 = GD = 97;
F = CDE = 470;

%}
A1 = 97; % Amplitude of the
analog signal,
Sampling_Frequency = 60e3; %
Sampling frequency
CDE = 470; %Frequency of the
analog signal
Num_Quantization_Levels = 8; %
Number of quantization levels
Duration = 3; % Duration of the
signal in seconds
Resolution = (2 * A1) /
(2^Num_Quantization_Levels); %
Step size
t=0:1/Sampling_Frequency:0.001;

% Defining the analog signal
x1 = A1 * cos(2 * pi * (CDE *
100) * t);

L=(2^Num_Quantization_Levels)-
1;

delta=(max(x1)-min(x1))/L;

% Quantization
Quantized_Signal =
min(x1)+(round((x1-
min(x1))/delta)).*delta; %xq
</pre>
</td><td>


</td></tr>
</table>

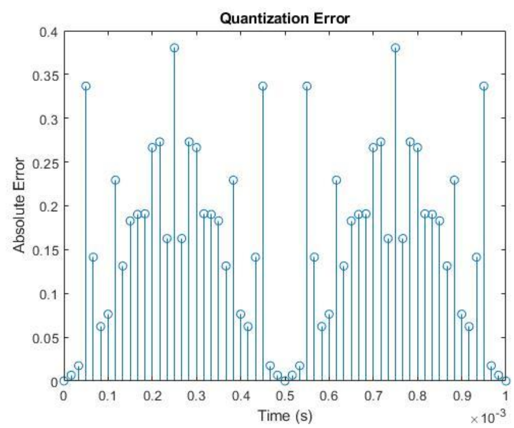
<pre>% Plotting
stem(t, Quantized_Signal, 'r')
title('Quantized Signal')
xlabel('Time (s)')
ylabel('Amplitude')</pre>	

(C) Obtain the absolute quantization error, $err = abs(x_1 - x_q)$

<table>
<tr><th>MATLAB Code</th><th>Output Figure</th></tr>
<tr><td>

```
%{
ID: 22-47019-1 (AB-CDEFG-H);
A1 = GD = 97;
F = CDE = 470;


%}
A1 = 97; % Amplitude of the
analog signal,
Sampling_Frequency = 60e3; %
Sampling frequency
CDE = 470; %Frequency of the
analog signal
Num_Quantization_Levels = 8; %
Number of quantization levels
Duration = 3; % Duration of the
signal in seconds
Resolution = (2 * A1) /
(2^Num_Quantization_Levels); %
Step size
t=0:1/Sampling_Frequency:0.001;%

% Defining the analog signal
x1 = A1 * cos(2 * pi * (CDE *
100) * t);


L=(2^Num_Quantization_Levels)-1;

delta=(max(x1)-min(x1))/L;

% Quantization
Quantized_Signal =
min(x1)+(round((x1-
min(x1))/delta)).*delta; %xq

% Calculating quantization error
err = abs(x1 -
Quantized_Signal);

stem(t, err)
```

</td><td>



</td></tr>
</table>

title('Quantization Error') xlabel('Time (s)') ylabel('Absolute Error')	

(d) Finally, use 2x2 subplot to plot analog signal $x_1(t)$, sampling signal of $x_1(t)$, quantized signal $x_q(t)$, and quantized error signal err.

<table>
<tr><th>MATLAB Code</th><th>Output Figure</th></tr>
<tr><td>
%{
ID: 22-47019-1 (AB-CDEFG-H);
A1 = GD = 79;
F = CDE = 470;

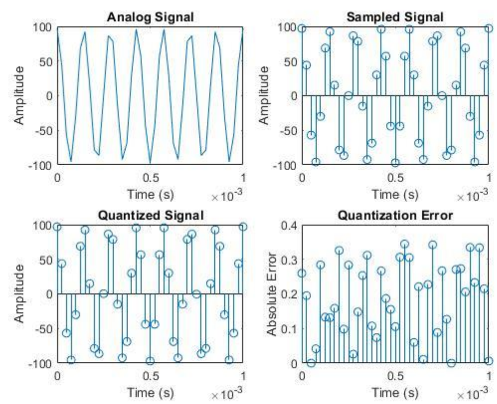
%}
A1 = 97; % Amplitude of the
analog signal,
Sampling_Frequency = 40e3; %
Sampling frequency
CDE = 470; %Frequency of the
analog signal
Num_Quantization_Levels = 8; %
Number of quantization levels
Duration = 3; % Duration of the
signal in seconds
Resolution = (2 * A1) /
(2^Num_Quantization_Levels); %
Step size
t=0:1/Sampling_Frequency:0.001;%

% Defining the analog signal
x1 = A1 * cos(2 * pi * (CDE *
100) * t);

L=(2^Num_Quantization_Levels)-1;

delta=(max(x1)-min(x1))/L;

% Quantization
Quantized_Signal =
min(x1)+(round((x1-
min(x1))/delta)).*delta;

subplot(2,2,1)
plot(t, x1)
title('Analog Signal')
xlabel('Time (s)')
</td><td>


</td></tr>
</table>

ylabel('Amplitude') subplot(2,2,2) stem(t, x1) title('Sampled Signal') xlabel('Time (s)') ylabel('Amplitude') subplot(2,2,3) stem(t, Quantized_Signal) title('Quantized Signal') xlabel('Time (s)') ylabel('Amplitude') subplot(2,2,4) stem(t, Quantization_Error) title('Quantization Error') xlabel('Time (s)') ylabel('Absolute Error')	