###### University of Dhaka

#### Department of Electrical and Electronic Engineering

EEE-3204: Digital Signal Processing Laboratory

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| Section | : | B |
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**Lab-1: Analog-to-Digital conversion and reconstruction of analog signal.**

**Theory:**

**Read and Run the code to observe what happens**

% Analog to Digital Conversion

clc; close all; clear all;

% Analog signal

b=3; % number of bits/sample;

A=10; % Amplitude of analog signal

f = 10; %% Frequency of the analog signal

T = 1/f; %% Period of the analog signal

tmin = 0; tmax = 2\*T; %% The signal is for 2 period

dt = T/100; %%

t = tmin:dt:tmax;

xt = A\*sin(2\*pi\*f\*t);

% Sampling

Fs = 200;

dts = 1/Fs;

ts = tmin:dts:tmax;

xs = A\*sin(2\*pi\*f\*ts);

n=0:1:(length(ts)-1);

%Quantixation of xs

del=2\*A/(2^b-1); % quantization step

xL=(xs/del); %% Laveling according to quantization level

L=2^b-1; %% No. of quantization level

xq=round(xL-min(xL)); %% Leveling & quantization

e=xq-xL; % Quantization error

% Coding for digital signal

xd=dec2bin(xq,b);

% Reconstruction of xt (basic)

xtr=(bin2dec(xd)-L/2)\*del;

figure;

subplot(2,2,1)

plot(t,xt,'-b');

hold on

stem(ts,xs,'rs');

title('Sampling of x(t)')

xlabel('t')

ylabel('x(t)')

grid on

subplot(2,2,2)

stem(n,xs,'rs')

xlabel('n')

ylabel('x(n)')

title('Sampled signal, x(n)')

grid on

subplot(2,2,3)

stem(n,xL,'r')

xlabel('n')

ylabel('x(n)')

title('Leveling of x(n)')

grid on

subplot(2,2,4)

stem(n,xL+L/2,':bo')

hold on

stem(n,xq,':rs')

hold on

stem(n,e,':gd')

xlabel('n')

ylabel('x(n) & xq(n)')

title('Quantization of x(n)')

legend('x(n)','xq(n)','e(n)')

grid on

figure;

plot(ts,xtr,'-b')

xlabel('t')

ylabel('x(t)')

title('Reconstructed x(t)')

grid on

**Exercise**

**Exercise-1:**

Construct an analog signal y with A = 5, f = 20 Hz, T=1/f sec, t=0:T/50:2T using the function y=A\*sin(2\*pi\*f\*t). Write Matlab code for 10 bit analog-to-digital conversion and reconstruction of analog signal using sampling rate of (a) Fs = 40 samples/second, (b) Fs = 50 samples/second (c) Fs = 100 samples/second (d) Fs = 200 samples/second

**Exercise-2**

Construct an analog signal y with A = 5, f = 20 Hz, T=1/f sec, t=0:T/50:2T using the function y=A\*cos(2\*pi\*f\*t). Write Matlab code for analog-to-digital conversion and reconstruction of analog signal using sampling rate of 400 samples/second for different quantization level of (a) 8, (b) 16, (c) 32 and (d) 1024.

**Exercise-3**

Construct an analog signal y with A = 5, f = 5 Hz, T=1/f sec, t=0:T/100:5T using the function y=A\*sin(2\*pi\*f\*t). Write Matlab code for analog-to-digital conversion and determine SQNR for using different bits/sample of b=1 to 16. Also draw a plot to show the graph of b vs SQNR. You should use *for* loop to compute SQNR

**References**

[1] S.K. Mitra, Digital Signal Processing, 3rd Edition, McGraw-Hill Education (Asia), 2009.

[2] J.G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, 4th Edition, Pearson International Edition, 2007.

[3] Emmanuel C. Ifeachor and Barrie W. Jervis, Digital Signal Processing: A Practical Approach, 2nd Edition, Pearson International Edition, 2005.

[4] *Using Matlab*, The Math Works Inc.