

**Independent University Bangladesh**

Department of Electrical and Electronics Engineering

**Lab Report** **07**

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Course code: EEE 321L

Couse name: Digital Signal Processing Lab

Lab no: 07

Lab title: Study on sampling, signal reconstruction and aliasing

Date: 30/12/2020

1. Sampling and discrete time Fourier Transform (DTFT)

Code:

% analog signal

dt = 0.00005;

t = -0.005:dt:0.005;

x\_a = exp(-1000\*abs(t));

% sampling

Fs = 5000;

Ts = 1/Fs;

n = -25:25;

x = exp(-1000\*abs(n\*Ts));

% DTFT

K = 500;

k = 0:K;

w = pi\*k/K;

X = x\*exp(-j\*n'\*w); % n' for complex multiplication

X = real(X);

w = [-fliplr(w) w(2:K+1)];

X = [fliplr(X) X(2:K+1)];

% Plotting

subplot(2,1,1);

plot(t\*1000, x\_a);

xlabel('time in ms');

ylabel('x(n)', 'fontsize', 15);

title('Discrete-time Signal', 'fontsize', 15);

hold on;

stem(n\*Ts\*1000, x);

gtext('Ts=0.2ms', 'fontsize', 12);

hold off;

subplot(2,1,2); plot(w/pi, X);

xlabel('frequency in pi units'); ylabel('X(w)', 'fontsize', 15);

title('Discrete-time Time Fourier Transform', 'fontsize', 15);

gtext('Ts=0.2ms', 'fontsize', 12);

Output: 

1. Signal reconstruction of xa(t) = e-1000|t|

Code:

% original analog signal

t = -0.005:0.00005:0.005;

x\_a = exp(-1000\*abs(t));

% discrete time signal

Fs = 5000;

Ts = 1/Fs;

n = -25:25;

nTs = n\*Ts;

x\_n = exp(-1000\*abs(nTs));

% analog signal reconstruction

y\_a = x\_n\*sinc(Fs\*(ones(length(n),1)\*t-nTs'\*ones(1,length(t))));

% error

error = max(abs(x\_a-y\_a))

% plotting

subplot(2,1,1); plot(t\*1000,x\_a);

ylabel('x(n)', 'fontsize', 15);

title('Discrete Time Signal', 'fontsize', 15);

hold on;

stem(n\*Ts\*1000, x\_n);

hold off;

subplot(2,1,2); plot(t\*1000,y\_a, 'r');

xlabel('time in ms'); ylabel('x\_a(t) and y\_a(t)', 'fontsize', 15);

title('Original and Reconstructed Signal', 'fontsize', 15);

hold on;

plot(t\*1000, x\_a)

Output: *Error* = 0.0363



1. Signal reconstruction of xa(t) = cos(20πt + Θ)

Code:

% original analog signal

t = -0.2:0.00001:0.2;

x\_a = cos(20\*pi\*t);

Ts = 0.005;

Fs = 1/Ts;

n = -40:40;

nTs = n\*Ts;

x\_n = cos(20\*pi\*nTs);

% analog signal reconstruction

y\_a = x\_n\*sinc(Fs\*(ones(length(n),1)\*t-nTs'\*ones(1,length(t))));

% error

error = max(abs(x\_a-y\_a))

% plotting

subplot(2,1,1); plot(t, x\_a);

ylabel('x(n)', 'fontsize', 15);

title('Discrete Time Signal', 'fontsize', 15);

axis([-0.2 0.2 -1.5 1.5]);

hold on;

stem(nTs, x\_n); grid;

hold off;

subplot(2,1,2); plot(t,y\_a, 'r');

xlabel('x\_a(t) and y\_a(t)', 'fontsize', 15);

title('Original and Reconstructed Signal', 'fontsize', 15);

hold on;

plot(t, x\_a); grid

Output: *Error* = 0.1374



1. Assignment:
   1. Function definition

% function to plot sampled and reconstruction signals of sinusoids

function [error] = reconstruct(f, Fs)

% original analog signal

t = -(20/Fs):0.00001:(20/Fs);

x\_a = sin(2\*pi\*f\*t);

% discrtete signal

Ts = 1/Fs;

n = -20:20;

nTs = n\*Ts;

x\_n = sin(2\*pi\*f\*nTs);

% analog signal reconstruction

y\_a = x\_n\*sinc(Fs\*(ones(length(n),1)\*t-nTs'\*ones(1,length(t))));

% error

error = max(abs(y\_a-x\_a));

%plotting

subplot (2,1,1)

plot(t\*1000, x\_a);

hold on

stem(nTs\*1000, x\_n);

title('Discrete-time signal','fontsize',15);

ylabel('x(n)','fontsize',13);

xlabel('time in ms','fontsize',13);

grid;

hold off

subplot(2,1,2);

plot(t, y\_a, 'r');

hold on

plot(t, x\_a, 'b');

title('Original and Reconstructed signal','fontsize',15);

xlabel('time in ms','fontsize',13);

ylabel('x\_a(t) and y\_a(t)','fontsize',13);

grid;

end

* 1. Call and outputs:

Code:

% generate sampled, reconstructed signal plots and error

error = reconstruct(100, 1000)

Outputs:



