SS EXPERIMENT LAB 10

TITLE: Sampling theorem

NAME: Yash Gupta

ROLL NO: S20200010234

OBSERVATION: In this lab, I learned the Sampling theorem

1. Consider an analog signal $x(t) = \cos(20\pi t), 0 \leq t \leq 1$. Supposed the signal is sampled at $T = 0.01, 0.07$ *and* 0.1 to obtain the discrete-time signal $x(n)$. Write a MATLAB program to perform the following operations:

I. Plot the signal $x(n)$ for each value of T

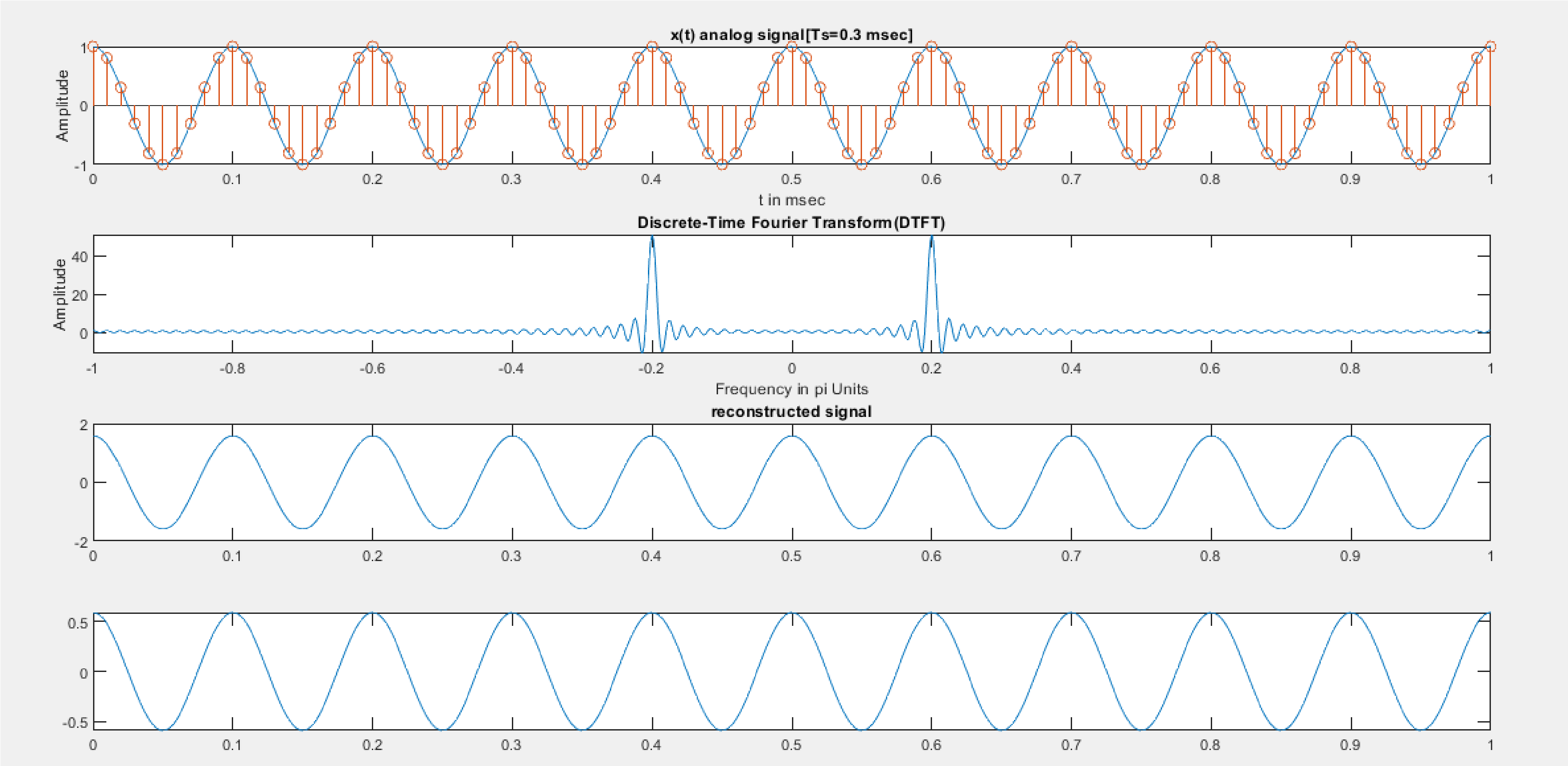
II. Reconstruct the analog signal $x_r(t)$ from the samples $x(n)$ for each T case with ideal interpolation and plot them.

III. Determine the reconstruction error i.e. $x(t) - x_r(t)$ for each T cases and plot them.

IV. Plot the DTFT of $x(n)$ *signal* for each value of T

```
clear;
clc;
close all;
figure;
Dt = 0.002;
t = 0:Dt:1;
xa = cos(20*pi*t);
Ts = 0.01;
n = 0:1:100;
x = cos(20*pi*n*Ts);
K = 500;
Xw=[];
k=1;
w_indx=[];
Xph=[];
for w= -pi:pi/K:pi
    tmp = sum(x .* exp(-j*n*w));
    Xw(k) = real(tmp);
    w_indx(k) =w;
    k=k+1;
end
subplot(4,1,1);
plot(t,xa);
xlabel('t in msec');
ylabel('Amplitude');
title('Discrete Signal- x(n)');
hold on
stem(n*Ts,x);
title('x(t) analog signal[Ts=0.3 msec]');
hold off
subplot(4,1,2);
plot(w_indx/pi,Xw);
```

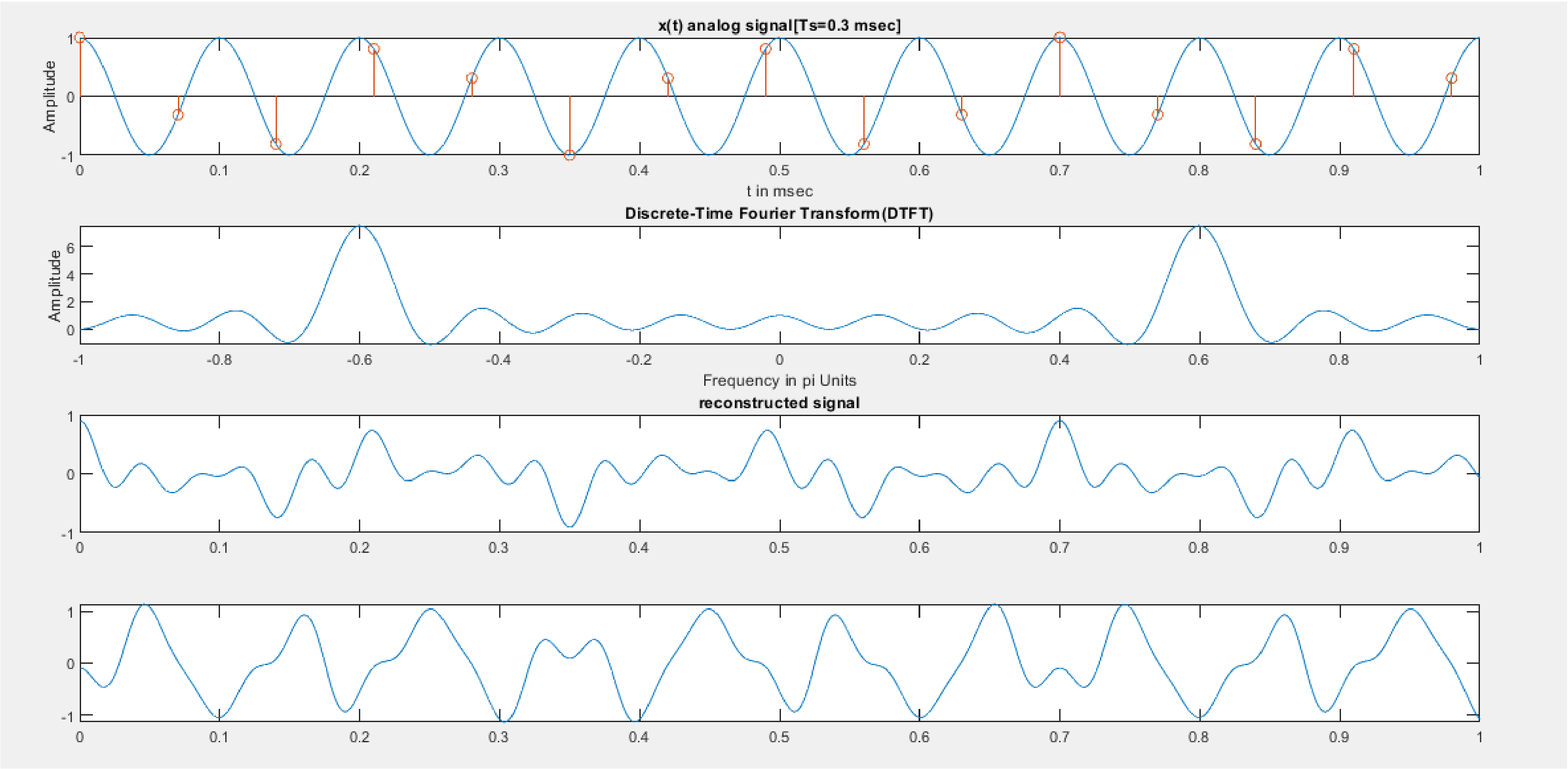
```
xlabel('Frequency in pi Units');
ylabel('Amplitude');
title('Discrete-Time Fourier Transform(DTFT)');
i=1;
y=zeros(1,501,'double');
for t1=0:Dt:1
    for n1=-10000:10000
        y(i)=y(i)+cos(20*pi*n1*Ts)*sinc(pi*20*(t1-(n1*Ts)));
    end
    i=i+1;
end
subplot(4,1,3);
plot(t,y);
title('reconstructed signal');
subplot(4,1,4);
plot(t,y-xa);
```



x(t) analog signal[Ts=0.3 msec]
Amplitude
t in msec
Discrete-Time Fourier Transform(DTFT)
Amplitude
Frequency in pi Units
reconstructed signal

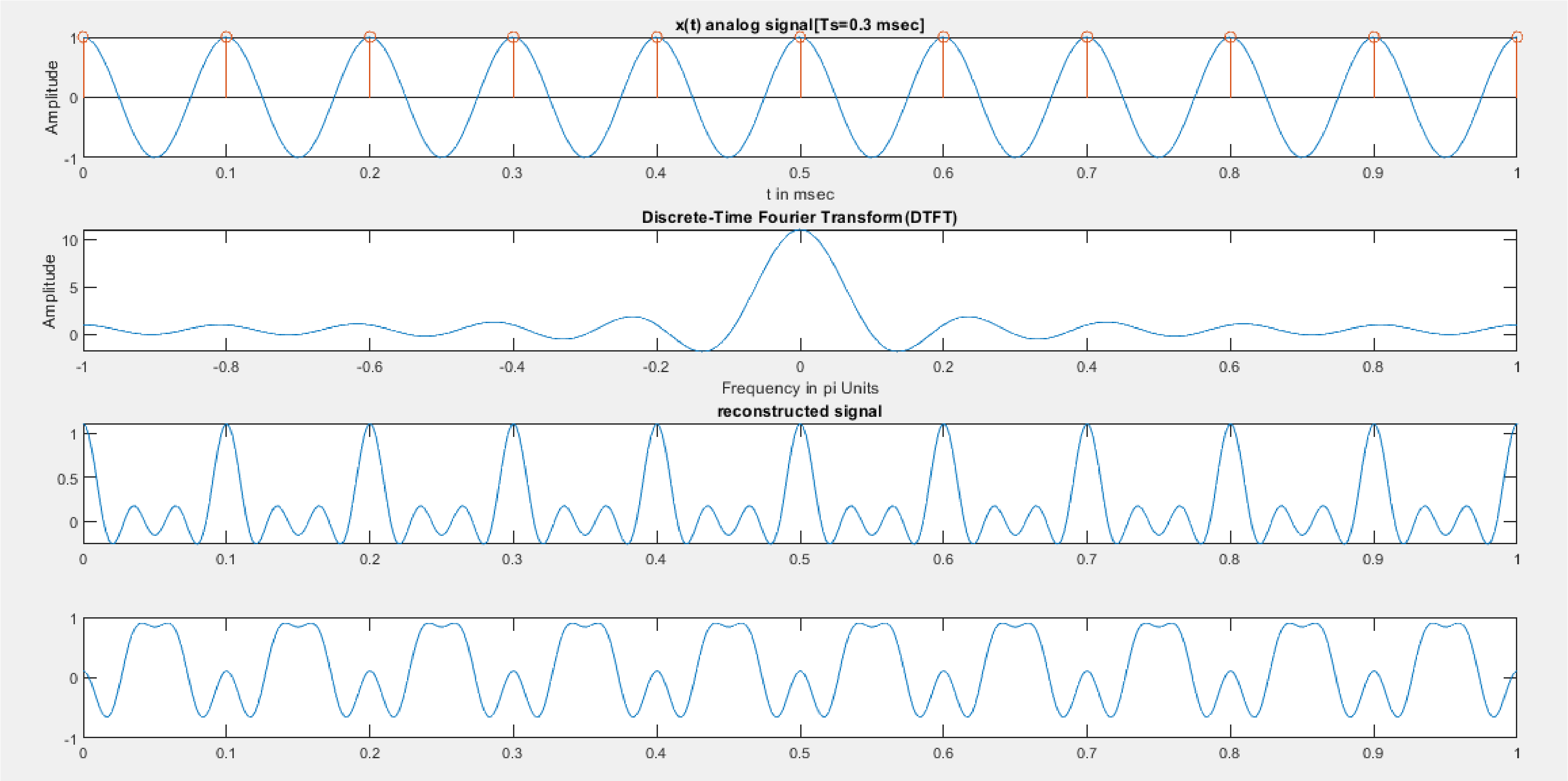
```
clear;
clc;
close all;
figure;
Dt = 0.002;
t = 0:Dt:1;
xa = cos(20*pi*t);
Ts = 0.07;
n = 0:1:14;
x = cos(20*pi*n*Ts);
K = 500;
Xw=[];
k=1;
w_indx=[];
Xph=[];
for w= -pi:pi/K:pi
    tmp = sum(x .* exp(-j*n*w));
    Xw(k) = real(tmp);
    w_indx(k) =w;
    k=k+1;
end
subplot(4,1,1);
plot(t,xa);
xlabel('t in msec');
ylabel('Amplitude');
title('Discrete Signal- x(n)');
hold on
stem(n*Ts,x);
title('x(t) analog signal[Ts=0.3 msec]');
hold off
subplot(4,1,2);
plot(w_indx/pi,Xw);
```

```
xlabel('Frequency in pi Units');
ylabel('Amplitude');
title('Discrete-Time Fourier Transform(DTFT)');
i=1;
y=zeros(1,501,'double');
for t1=0:Dt:1
    for n1=-10000:10000
        y(i)=y(i)+cos(20*pi*n1*Ts)*sinc(pi*20*(t1-(n1*Ts)));
    end
    i=i+1;
end
subplot(4,1,3);
plot(t,y);
title('reconstructed signal');
subplot(4,1,4);
plot(t,y-xa);
```


x(t) analog signal[Ts=0.3 msec]
Amplitude
t in msec
Discrete-Time Fourier Transform(DTFT)
Amplitude
Frequency in pi Units
reconstructed signal

```
clear;
clc;
close all;
figure;
% Analog signal
Dt = 0.002;
t = 0:Dt:1;
xa = cos(20*pi*t);
% Discrete-time signal
Ts = 0.1;
n = 0:1:10;
x = cos(20*pi*n*Ts);
% DTFT
K = 500;
% number of points
Xw=[];
k=1;
w_indx=[];
Xph=[];
for w= -pi:pi/K:pi
    tmp = sum(x .* exp(-j*n*w));
    Xw(k) = real(tmp);
    w_indx(k) =w;
    k=k+1;
end
subplot(4,1,1);
plot(t,xa);
xlabel('t in msec');
ylabel('Amplitude');
title('Discrete Signal- x(n)');
hold on
stem(n*Ts,x);
```

```
title('x(t) analog signal[Ts=0.3 msec]');
hold off
subplot(4,1,2);
plot(w_indx/pi,Xw);
xlabel('Frequency in pi Units');
ylabel('Amplitude');
title('Discrete-Time Fourier Transform(DTFT)');
i=1;
y=zeros(1,501,'double');
for t1=0:Dt:1
    for n1=-10000:10000
        y(i)=y(i)+cos(20*pi*n1*Ts)*sinc(pi*20*(t1-(n1*Ts)));
    end
    i=i+1;
end
subplot(4,1,3);
plot(t,y);
title('reconstructed signal');
subplot(4,1,4);
plot(t,y-xa);
```


x(t) analog signal[Ts=0.3 msec]
Amplitude
t in msec
Discrete-Time Fourier Transform(DTFT)
Amplitude
Frequency in pi Units
reconstructed signal