Digital Signal Processing
MATLAB HW2 - q1

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Professor: Dr. Sheikhzadeh Author: Maryam Barazande - 9723016 E-mail: maryambarazande7@gmail.com University: Amirkabir University of Technology

Clear recent data

```
clear; close all; clc;
```

RECONSTRUCTION

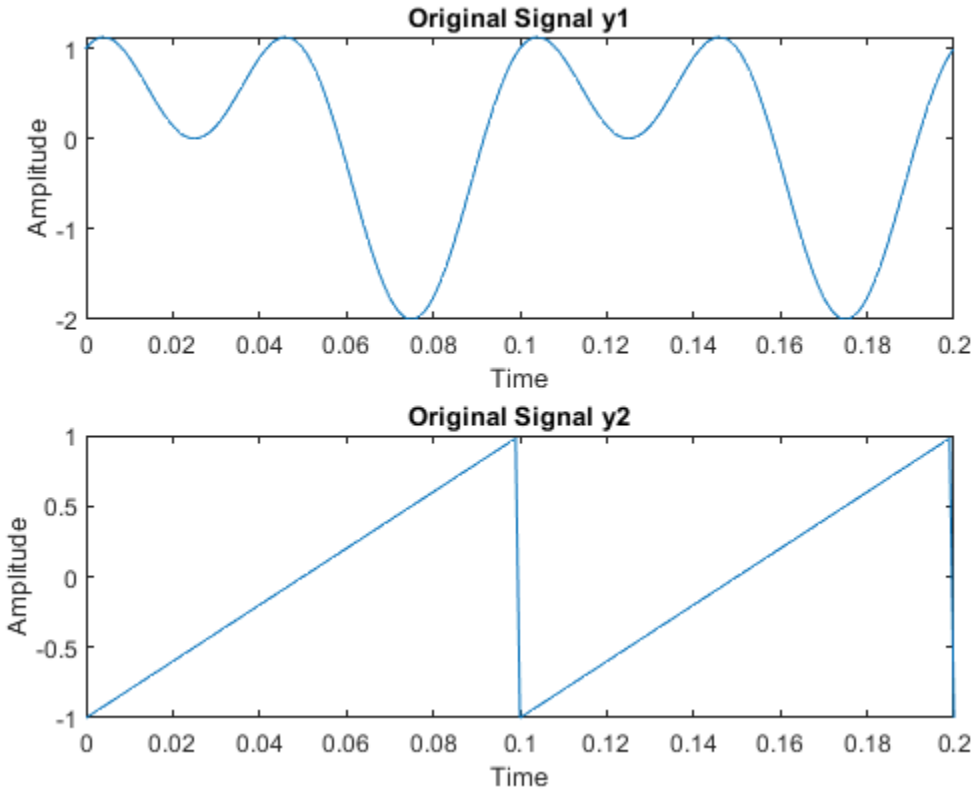
A. Sampling

PART 1

define parameters

```
f = 10;
t = 0:0.001:0.2 ;

% compute signals
y1 = sin(2*pi*f*t) + cos(4*pi*f*t);
y2 = sawtooth(2*pi*f*t);

% plot signals
figure(1);
subplot(2,1,1);
plot(t,y1);
title("Original Signal y1");
xlabel('Time');
ylabel('Amplitude');
subplot(2,1,2);
plot(t,y2);
```

```
title("Original Signal y2");
xlabel('Time');
ylabel('Amplitude');
```

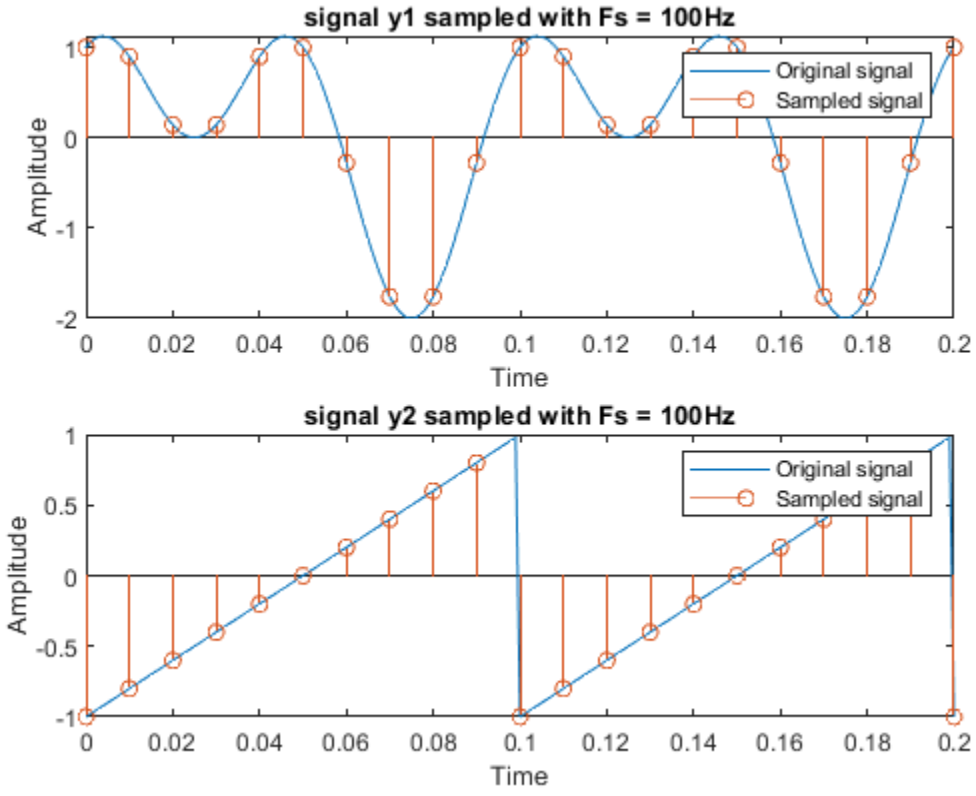


PART 2

define parameters

```
fs = 100;
ts = 0: 1/fs:0.2 ;

% sampling signals
ys1 = sin(2*pi*f*ts) + cos(4*pi*f*ts);
ys2 = sawtooth(2*pi*f*ts);

% plot signals
figure(2);
subplot(2,1,1);
plot(t,y1);
hold on;
stem(ts,ys1);
title("signal y1 sampled with Fs = 100Hz");
xlabel('Time');
ylabel('Amplitude');
legend('Original signal', 'Sampled signal');
subplot(2,1,2);
```

```
plot(t,y2);
hold on;
stem(ts,ys2);
title("signal y2 sampled with Fs = 100Hz");
xlabel('Time');
ylabel('Amplitude');
legend('Original signal', 'Sampled signal');
```

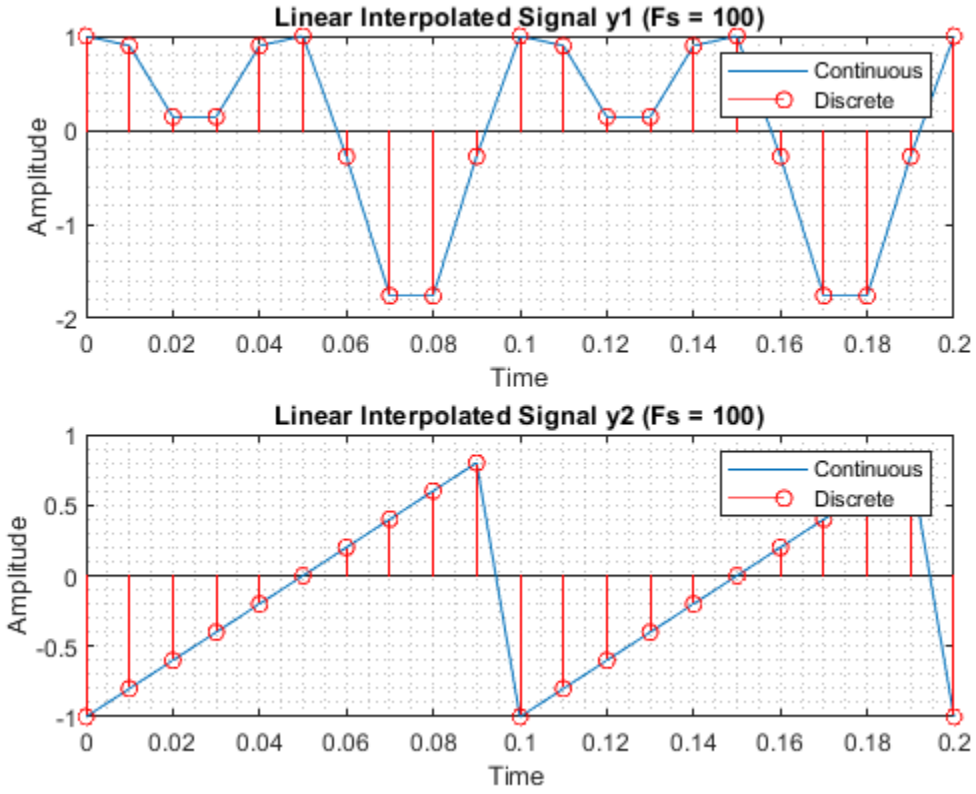


B. Interpolation

PART 1. Linear Interpolation

```
fs_interp1 = 100;
ts_interp1 = 0:1/fs_interp1:0.2;
ys1_interp1 = interp1(t,y1,ts_interp1,"linear");

% plot signals
figure(3);
subplot(2,1,1);
plot(ts_interp1,ys1_interp1);
hold on;
stem(ts_interp1,ys1_interp1,'r');
grid minor;
title("Linear Interpolated Signal y1 (Fs = 100)");
xlabel('Time');
```

```
ylabel('Amplitude');
legend('Continuous', 'Discrete');

ys2_interp1 = interp1(t,y2,ts_interp1,"linear");
subplot(2,1,2);
plot(ts_interp1,ys2_interp1);
hold on;
stem(ts_interp1,ys2_interp1,'r');
grid minor;
title("Linear Interpolated Signal y2 (Fs = 100)");
xlabel('Time ');
ylabel('Amplitude');
legend('Continuous', 'Discrete');
```



PART2. Sinc Interpolation

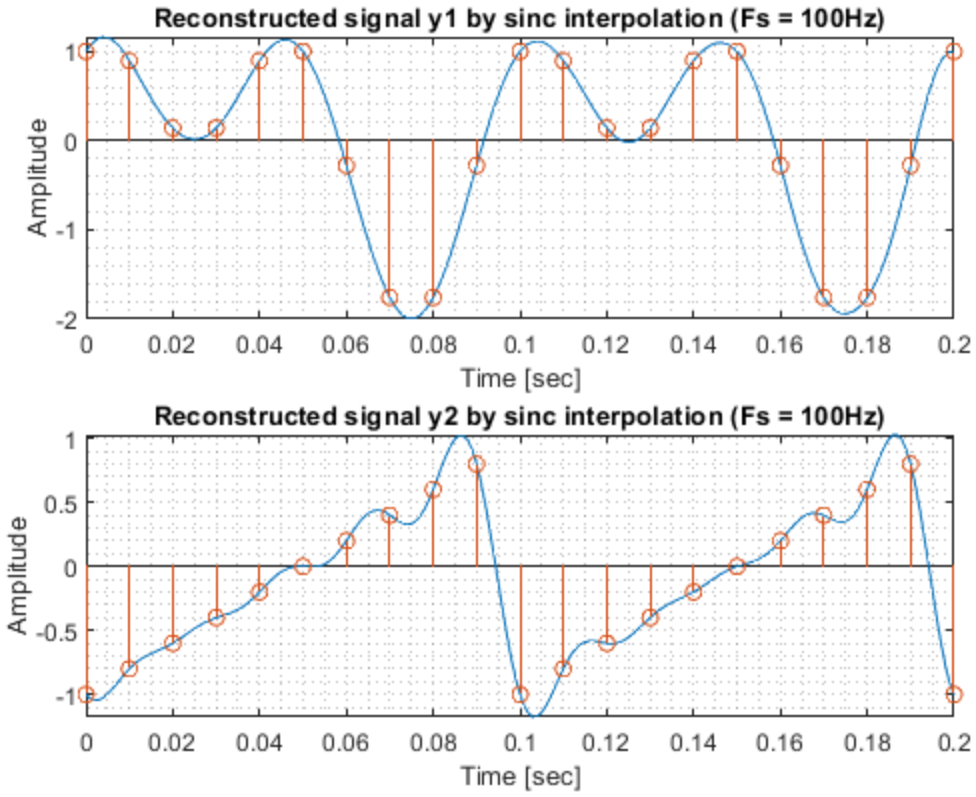
```
%%%%%%%%%%%%%%%%%%%%%%%%%%%% 1 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
yr1 = zeros(size(t));
yr2 = zeros(size(t));
% reconstructing signals by sinc interpolation
for i = 1 : length(t)
 for n = 0 : length(ts) - 1
 yr1(i) = yr1(i) + ys1(n + 1) * sinc((t(i) - n * (1/fs)) *fs);
 yr2(i) = yr2(i) + ys2(n + 1) * sinc((t(i) - n * (1/fs)) *fs);
 end
```

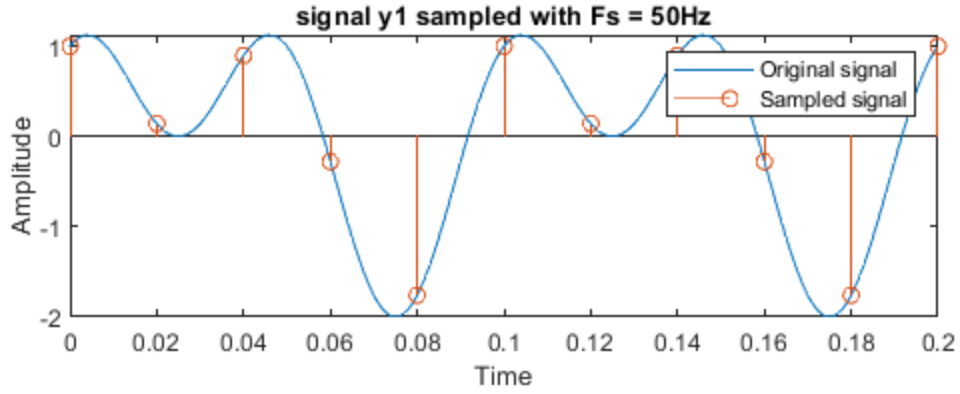
```
end
% plot signals
figure(4);
subplot(2, 1, 1);
plot(t, yr1);
hold on;
stem(ts, ys1);
grid minor;
title('Reconstructed signal y1 by sinc interpolation (Fs = 100Hz)');
xlabel('Time [sec]');
ylabel('Amplitude');

subplot(2, 1, 2);
plot(t, yr2);
hold on;
stem(ts, ys2);
grid minor;
title('Reconstructed signal y2 by sinc interpolation (Fs = 100Hz)');
xlabel('Time [sec]');
ylabel('Amplitude');

%%%%%%%%%%%%%%%%%%%%%%%%%%%% 2 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%
% Setting different Values for Fs then sample and sinc interpolation
%%%% Fs = 50;
% sampling signals
fs_new = 50;
ts_new = 0: 1/fs_new :0.2 ;
ys1_new = sin(2*pi*f*ts_new) + cos(4*pi*f*ts_new);
ys2_new = sawtooth(2*pi*f*ts_new);

figure(5);
subplot(2,1,1);
plot(t,y1);
hold on;
stem(ts_new,ys1_new);
title("signal y1 sampled with Fs = 50Hz");
xlabel('Time');
ylabel('Amplitude');
legend('Original signal', 'Sampled signal');
subplot(2,1,2);
plot(t,y2);
hold on;
stem(ts_new,ys2_new);
title("signal y2 sampled with Fs = 50Hz");
xlabel('Time');
ylabel('Amplitude');
legend('Original signal', 'Sampled signal');

% reconstructing signals by sinc interpolation
yr1_new = zeros(size(t));
yr2_new = zeros(size(t));

for i = 1 : length(t)
```

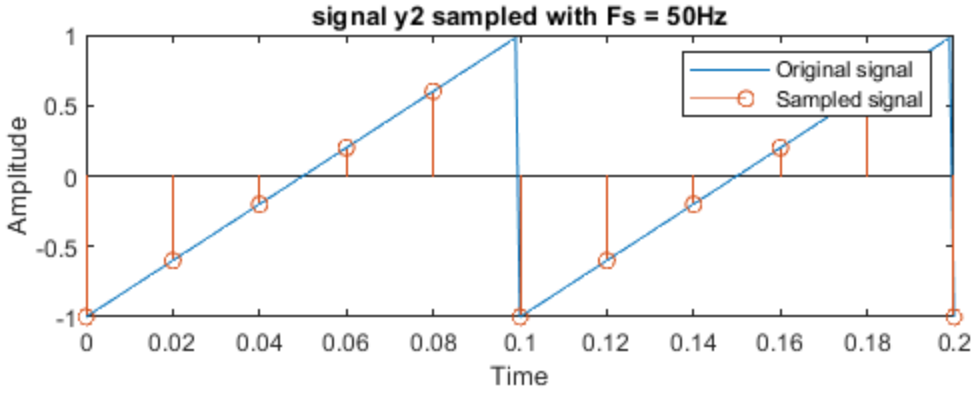
```
 for n = 0 : length(ts_new) - 1
 yr1_new(i) = yr1_new(i) + ys1_new(n + 1) * sinc((t(i) - n * (1/
fs_new)) *fs_new);
 yr2_new(i) = yr2_new(i) + ys2_new(n + 1) * sinc((t(i) - n * (1/
fs_new)) *fs_new);
 end
end

% plot signals
figure(6);
subplot(2, 1, 1);
plot(t,y1);
hold on;
stem(ts_new, ys1_new);
hold on;
plot(t, yr1_new);
grid minor;
title('Reconstructed signal y1 by sinc interpolation (Fs = 50Hz)');
xlabel('Time [sec]');
ylabel('Amplitude');
legend('Original signal', 'Sampled signal','reconstructed signal');

subplot(2, 1, 2);
plot(t,y2);
hold on;
stem(ts_new, ys2_new);
hold on;
plot(t, yr2_new);
grid minor;
title('Reconstructed signal y2 by sinc interpolation (Fs = 50Hz)');
xlabel('Time [sec]');
ylabel('Amplitude');
legend('Original signal', 'Sampled signal','reconstructed signal');

%%%% Fs = 35
% sampling signals
fs_new = 35;
ts_new = 0: 1/fs_new :0.2 ;
ys1_new = sin(2*pi*f*ts_new) + cos(4*pi*f*ts_new);
ys2_new = sawtooth(2*pi*f*ts_new);

figure(7);
subplot(2,1,1);
plot(t,y1);
hold on;
stem(ts_new,ys1_new);
title("signal y1 sampled with Fs = 35Hz");
xlabel('Time');
ylabel('Amplitude');
legend('Original signal', 'Sampled signal');
subplot(2,1,2);
plot(t,y2);
hold on;
stem(ts_new,ys2_new);
```

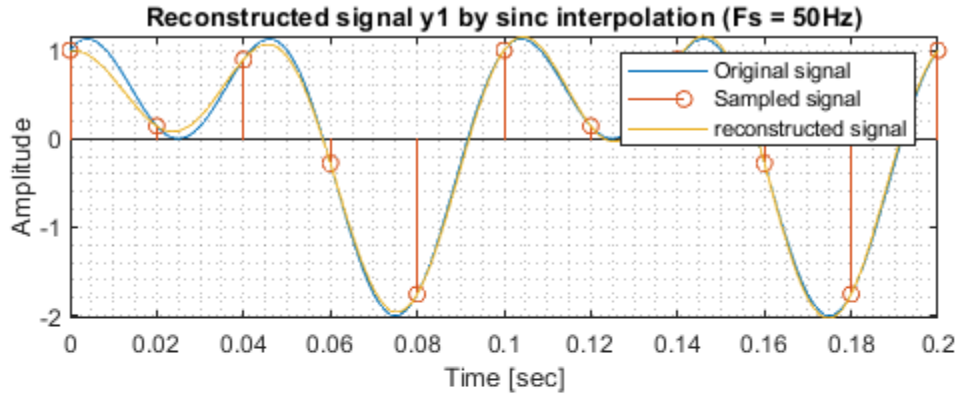
```
title("signal y2 sampled with Fs = 35Hz");
xlabel('Time');
ylabel('Amplitude');
legend('Original signal', 'Sampled signal');

% reconstructing signals by sinc interpolation
yr1_new = zeros(size(t));
yr2_new = zeros(size(t));

for i = 1 : length(t)
 for n = 0 : length(ts_new) - 1
 yr1_new(i) = yr1_new(i) + ys1_new(n + 1) * sinc((t(i) - n * (1/
fs_new)) *fs_new);
 yr2_new(i) = yr2_new(i) + ys2_new(n + 1) * sinc((t(i) - n * (1/
fs_new)) *fs_new);
 end
end

% plot signals
figure(8);
subplot(2, 1, 1);
plot(t,y1);
hold on;
stem(ts_new, ys1_new);
hold on;
plot(t, yr1_new);
grid minor;
title('Reconstructed signal y1 by sinc interpolation (Fs = 35Hz)');
xlabel('Time [sec]');
ylabel('Amplitude');
legend('Original signal', 'Sampled signal','reconstructed signal');

subplot(2, 1, 2);
plot(t,y2);
hold on;
stem(ts_new, ys2_new);
hold on;
plot(t, yr2_new);
grid minor;
title('Reconstructed signal y2 by sinc interpolation (Fs = 35Hz)');
xlabel('Time [sec]');
ylabel('Amplitude');
legend('Original signal', 'Sampled signal','reconstructed signal');


%%%%%%%%%%%%%%%%%%%%%%%%%%%% 3 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%
figure(9);
subplot(2, 1, 1);
plot(t,y1);
hold on;
plot(t, yr1_new);
grid minor;
title('Reconstructed signal y1 vs the Original (Fs = 35Hz)');
```

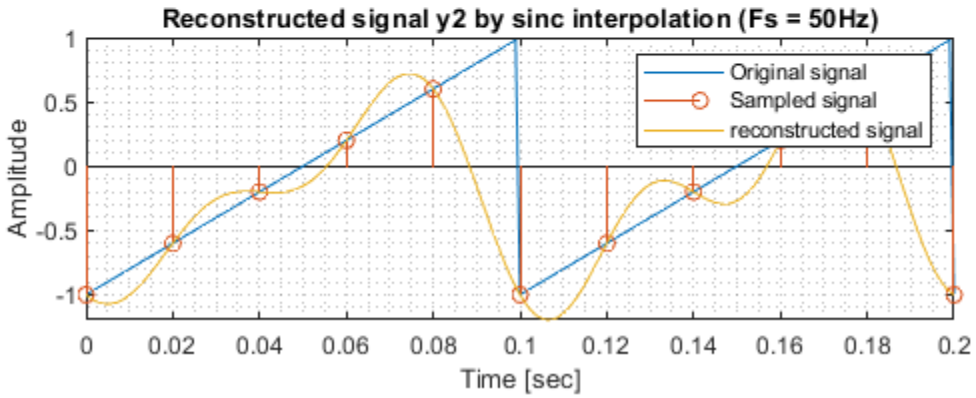
```
xlabel('Time [sec]');
ylabel('Amplitude');
legend('Original signal', 'reconstructed signal');

subplot(2, 1, 2);
plot(t,y2);
hold on;
plot(t, yr2_new);
grid minor;
title('Reconstructed signal y2 vs the Original (Fs = 35Hz)');
xlabel('Time [sec]');
ylabel('Amplitude');
legend('Original signal','reconstructed signal');
```

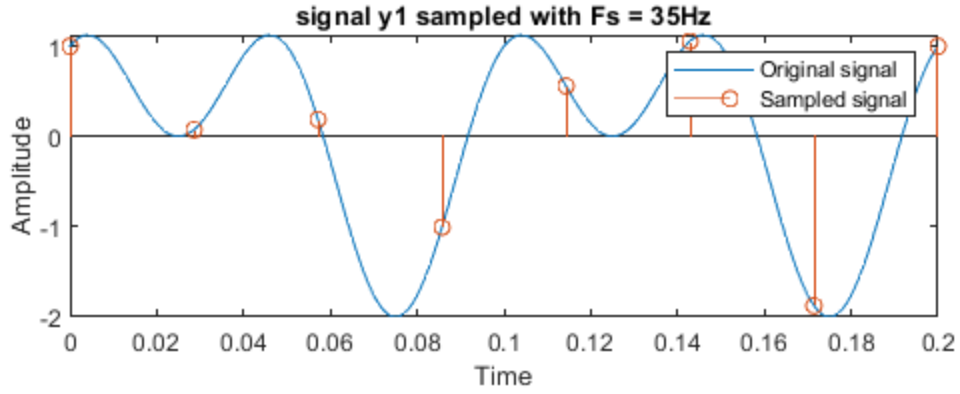


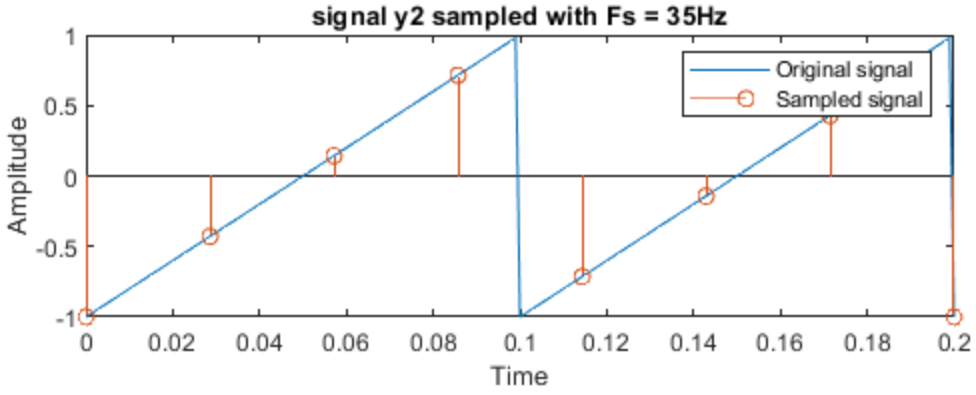

signal y1 sampled with Fs = 50Hz
Original signal
Sampled signal
Amplitude
Time

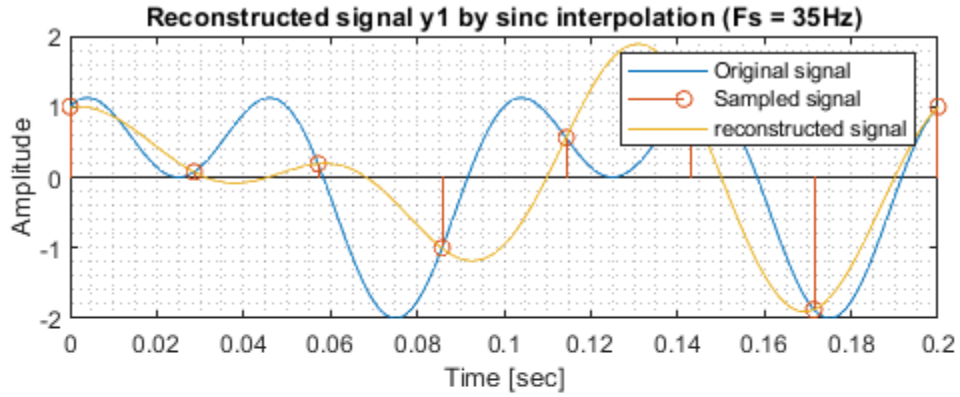

signal y2 sampled with Fs = 50Hz
Original signal
Sampled signal
Amplitude
Time

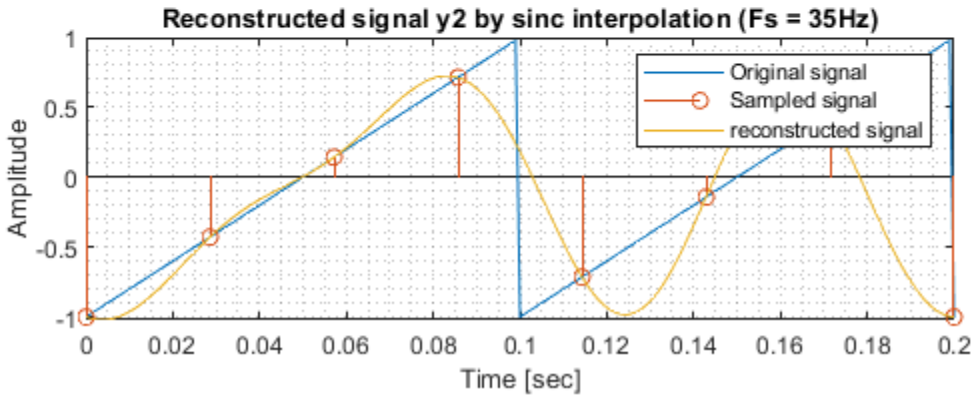

Reconstructed signal y1 by sinc interpolation (Fs = 50Hz)
Original signal
Sampled signal
reconstructed signal
Amplitude
Time [sec]

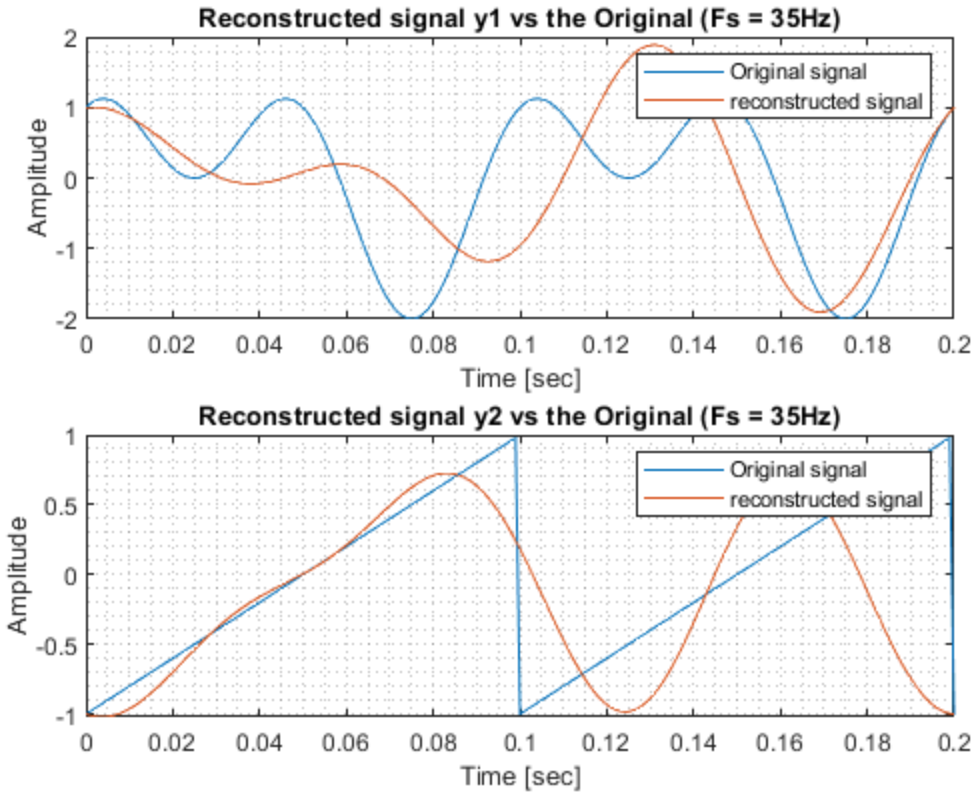

Reconstructed signal y2 by sinc interpolation (Fs = 50Hz)
Original signal
Sampled signal
reconstructed signal
Amplitude
Time [sec]


signal y1 sampled with Fs = 35Hz
Original signal
Sampled signal
Amplitude
Time


signal y2 sampled with Fs = 35Hz
Original signal
Sampled signal
Amplitude
Time


Reconstructed signal y1 by sinc interpolation (Fs = 35Hz)
Original signal
Sampled signal
reconstructed signal
Amplitude
Time [sec]


Reconstructed signal y2 by sinc interpolation (Fs = 35Hz)
Original signal
Sampled signal
reconstructed signal
Amplitude
Time [sec]



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