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Experiment 8: Sampling Theorem

In this experiment, we will verify the Sampling Theorem which states that a sampled signal can be reconstructed exactly if the sampling rate is at least twice the maximum frequency component in it. It is expected that the student will write a "readable" MATLAB code in a file and execute for the following problems.

1. (i) Generate a cosine signal of frequency 0.25Hz and amplitude 5V.

   (ii) plot the cosine signal by sampling the signal using a sampling frequency of

   (a) fs1=1.6*fm (b) fs2=2*fm,and (c) fs3= 8*fm.

   (iii) Use subplots to show the original signal, the signal when sampled at fs1, fs2 and fs3.

   Answer:

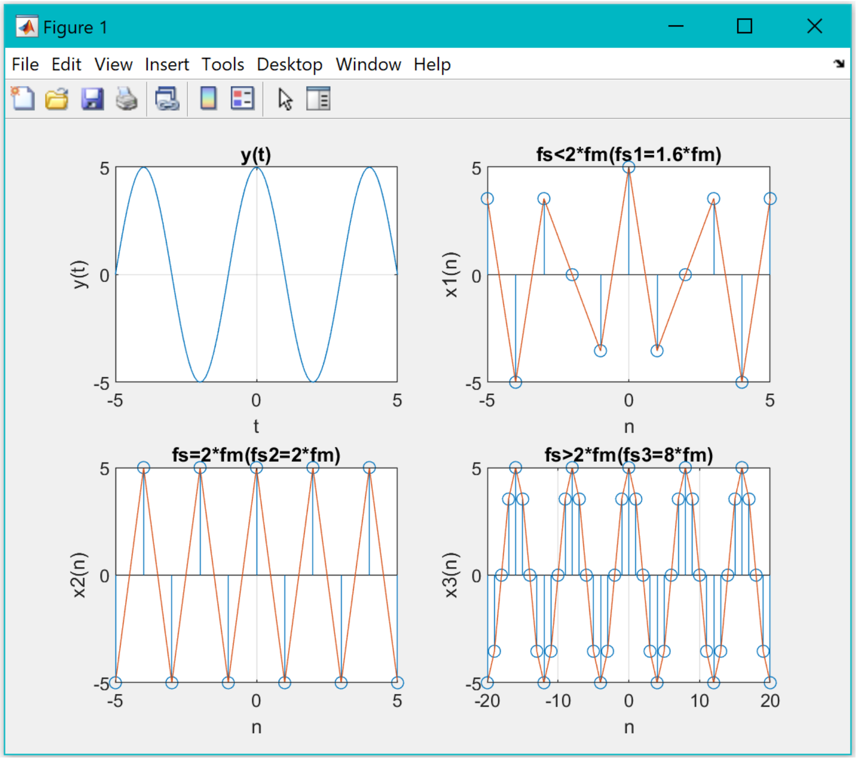
```
clc;
clear all;
close all;
t=-5:0.1:5;
y=5.*cos(2*pi*0.25*t);
subplot(2,2,1);
plot(t,y);
grid on;
title('y(t)');
xlabel('t');
ylabel('y(t)');

n=-5:5;
y1=5.*cos(2*pi*n*(1./1.6));
subplot(2,2,2);
stem(n,y1);
grid on;
hold on;
plot(n,y1);
```

```
title('fs<2*fm(fs1=1.6*fm)');
hold off;
xlabel('n');
ylabel('x1(n)');

n=-5:5;
y2=5.*cos(2*pi*n*(1./2));
subplot(2,2,3);
stem(n,y2);
grid on;
hold on;
plot(n,y2);
title('fs=2*fm(fs2=2*fm)');
hold off;
xlabel('n');
ylabel('x2(n)');

n=-20:20;
y3=5.*cos(2*pi*n*(1./8));
subplot(2,2,4);
stem(n,y3);
grid on;
hold on;
plot(n,y3);
title('fs>2*fm(fs3=8*fm)');
hold off;
xlabel('n');
ylabel('x3(n)');
```



2. (i) Plot the given signal x(t)=1cos(31.4t)+2cos(188.5t)+0.5cos(43.98t)

   (ii) For the given above signal, identify the sampling frequency (fs) and

   (iii) plot by assuming a value for Fs < 2*fmax, Fs > 2*fmax

   Answer:

```
clc;
clear all;
close all;

t=-1:0.1:1;
y=1.*cos(31.4.*t)+2.*cos(188.5.*t)+0.5.*cos(43.98.*t);
subplot(2,2,1);
plot(t,y);
grid on;
title('y(t)');
xlabel('t');
ylabel('y(t)');

n=-10:10;
y1=1.*cos((2.*pi.*4.997.*n)./30)+2.*cos(2.*pi.*30.*n./30)+0.5.*cos((2.*pi.*6.999
.*n)./30);
```

```
subplot(2,2,2);
stem(n,y1);
grid on;
hold on;
plot(n,y1);
title('fs<2*fm(fs=30Hz)-undersampling');
hold off;
xlabel('n');
ylabel('x1(n)');

n=-10:10;
y2=1.*cos((2.*pi.*4.997.*n)./120)+2.*cos(2.*pi.*30.*n./120)+0.5.*cos((2.*pi.*6.9
99.*n)./120);
subplot(2,2,3);
stem(n,y2);
grid on;
hold on;
plot(n,y2);
title('fs>2*fm(fs=120Hz)-oversampling');
hold off;
xlabel('n');
ylabel('x2(n)');

n=-10:10;
y3=1.*cos((2.*pi.*4.997.*n)./60)+2.*cos(2.*pi.*30.*n./60)+0.5.*cos((2.*pi.*6.999
.*n)./60);
subplot(2,2,4);
stem(n,y3);
grid on;
hold on;
plot(n,y3);
title('fs=2*fm(fs=60Hz)-critical sampling');
hold off;
xlabel('n');
ylabel('x3(n)');
```

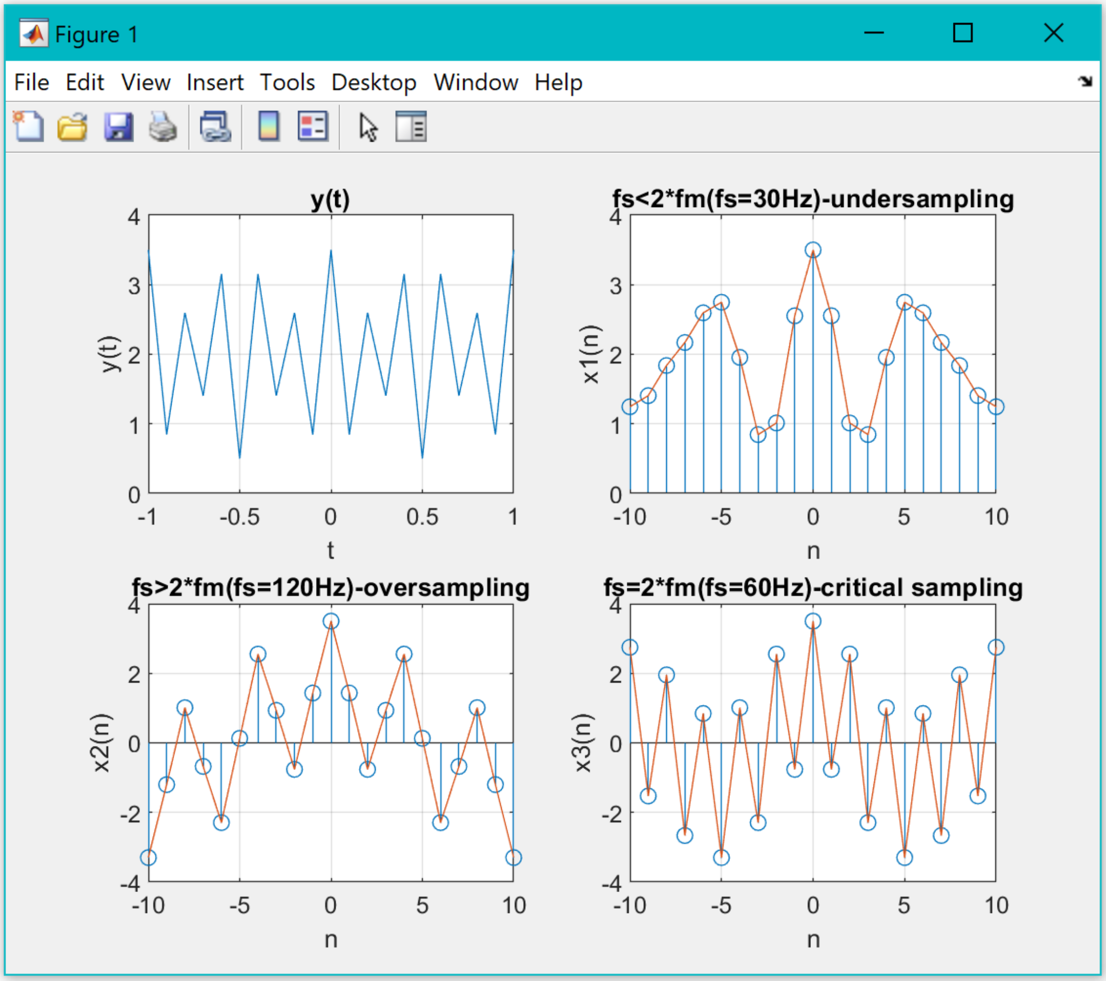


Figure 1
File Edit View Insert Tools Desktop Window Help
y(t)
fs<2*fm(fs=30Hz)-undersampling
fs>2*fm(fs=120Hz)-oversampling
fs=2*fm(fs=60Hz)-critical sampling
y(t)
x1(n)
x2(n)
x3(n)
t
n