Dan Wortmann, Lab 2 and Warm-Up, February 10th, 2014

Table of Contents

4.2.1 Syn_sin function

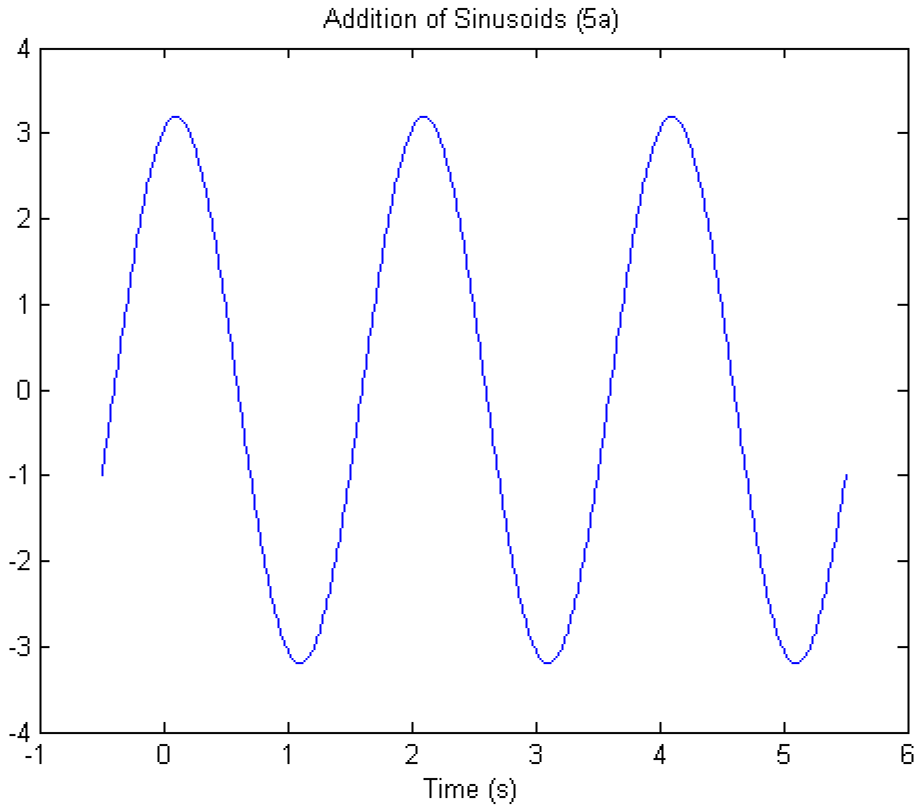
```
function [ xx,tt ] = syn_sin( fk,Xk,fs,dur,tstart )

%SYN_SIN Function to synthesize a sum of cosine waves
% usage:
% [xx,tt] = syn_sin(fk, Xk, fs, dur, tstart)
% fk = vector of frequencies
% (these could be negative or positive)
% Xk = vector of complex amplitudes: Amp*e^(j*phase)
% fs = the number of samples per second for the time axis
% dur = total time duration of the signal
% tstart = starting time (default is zero, if you make this input optional)
% xx = vector of sinusoidal values
% tt = vector of times, for the time axis
%
% Used as a function to find the sum of sinusoids with different
% frequencies and complext amplitudes.

if nargin < 5,
    tstart = 0;
end;

tt = tstart:1/fs:dur-tstart;
xx = zeros(size(tt));
N = length(fk);

for k=1:N
    xx = xx + real(Xk(k)*exp(2j*pi*fk(k)*tt));
```

```
end
```

Error using Lab2 (line 26)
Not enough input arguments.

5(a)

```
fk = [.5 , .5 , .5];                    % all frequency are the same
Xk = [2,2*exp(j^2*1.25*pi),(1-j)];      % only one sinusoid had a phi
fs = 100;                               % picked a larger sampling rate
dur = 3 * (1/.5);                       % 3 times the period
[xx,tt] = syn_sin(fk,Xk,fs,dur,-.5);
plot(tt,xx);
```



5(b)

```
%frequency:
%   I found the period of the sinusoid by measuring the distance from
%   peak to peak to get: 2.1 - .1 = 2 seconds
%   So the frequency is the inverse of that: .5 Hz
%phase:
%   I took the measurement of time delay to the first peak: 0.1s
%   So the phase is timeShift * frequency * 360 = 18 degrees
%   18*(pi/180)                                 = .314 rad
%   Since the graph is ahead of the 0, we consider this phase
```

```
%   to be negative: -0.314 rad
%amplitude:
%   I measured the highest peaks Y value: 3.2 and lowest value: -3.2
%   indicating that the amplitude is in fact 3.2.
```

5(c)

```
z1 = 2;
z2 = 2*exp(j*j*1.25*pi);
z3 = 1-j;
zvect(z1+z2+z3);

%this gave me a vector: 3.0394 - j1
%so to find the magnitude:

sqrt(3.0394^2+1^2);
ans = 3.1997;

%So very close to the value calculated from the graph: 3.2 - 3.1997 = .0003

%To get the phase:

atan(-1/3.0394);
ans = -0.3179;

% to verify the phase angle based off the vector picture we know we are
% in the 4th quadrant so the phase should be -0.3179 or -18.21 degrees.
% This is also very close to the previous values from syn_sin.
```

6(a)

```
%function [ t1 ] = time_1( Xv )
%T1 Calculates the time delay of an wave

t1 = sqrt(dt^2 + Xv^2)/(3*10^8);
%end
```

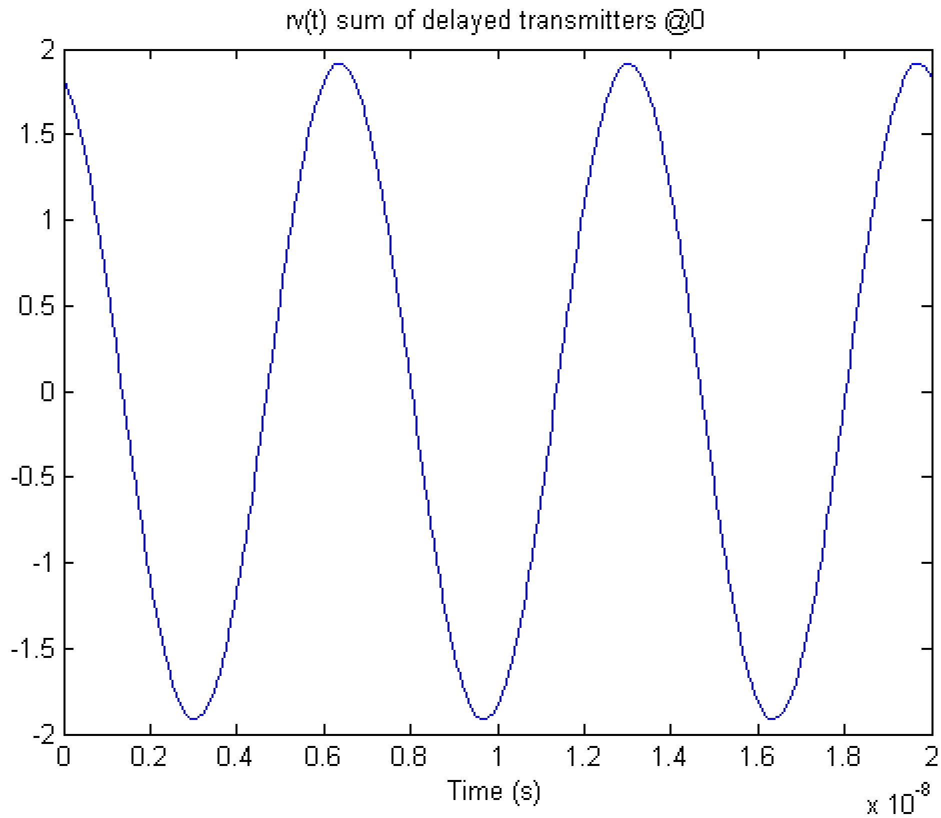
6(b)

```
%function [ t2 ] = time_2( Xv )
%T2 Calculates the time delay of a bounced off wave

t2 = ( sqrt((0 - dxr)^2 + (dt - dyr)^2) + sqrt((dxr - Xv)^2 + dyr^2) )/(3*10^8);
%end
```

6(c)

```
t1 = time_1(0);
t2 = time_2(0);
fo = 150e6;
```

```
tt = 0:1/(fo*100):(1/fo)*3;
xx = cos(2*pi*fo*([0:1/(fo*100):(1/fo)*3]-t1)) -cos(2*pi*fo*([0:1/(fo*100):(1/fo)*
plot(tt,xx);

%Measured Amplitude: 1.915
```



6(d)

```
w = 2*pi*fo;
exp(1j*w*t1) - exp(1j*(w*t2+pi));

ans = 1.8354 - 0.5496i

zprint(ans);
% Z =      X     +      jY      Magnitude     Phase     Ph/pi    Ph(deg)
%       1.835     -0.5496       1.916    -0.291    -0.093   -16.67

%Since the two waves are on the same frequency, we are allowed to use
%complex amplitude addition method in the form of Ae^(j*phi). From this we
%are give a complex number in form of a vector that we can easily extract
%the magnitude from, or use the zprint function.
```

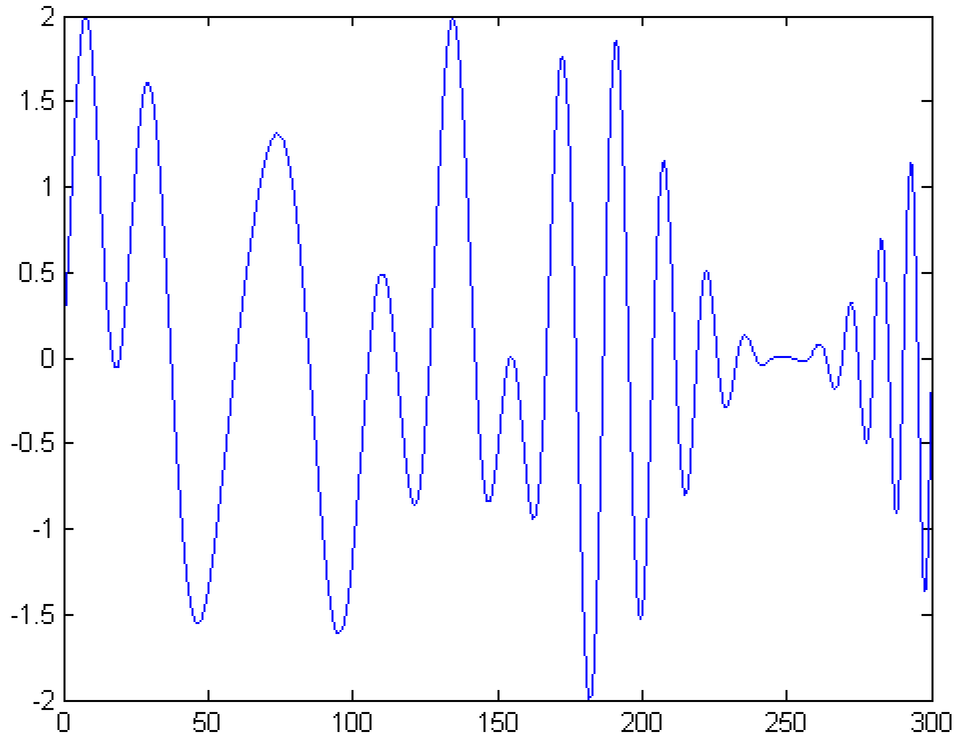
6(e)

```
%function [ xx, ss ] = sig_str( Xv )
```

```
%SIG_STR : Calculates transmission interference
%   Using a give position of a radio transmitter and another location that
%   specifies a reflector in the area that puts the wave 180 out of phase,
%   the SIG_STR calculates the Sum of the two signals as a car moves along
%   the x axis (starting at 0) Xv meters away.

%Given:
%   Transmitter and reflector positions
%   Frequency of the wave
%   Range of values for position of car

fo = 150e6;

xXv = 0:.1:Xv;
N = length(xXv);

%Calculate the time delays based on changing position of the car

t1 = sqrt(1500^2 + ([0:.1:Xv]).^2)/(3*10^8);
t2 = (sqrt((0 - 100)^2 + (1500 - 900)^2)+sqrt((100 - [0:.1:Xv]).^2 + 900^2) )/(3*1

%Calculate both phases using time delays t1,t2 and frequency
%   first phase is the original
%   second phase is pi radians out of phase from original
%   phi = w0*t+phase
w0 = fo *pi * 2;
phi1 = j*(w0 * t1 + 0);
phi2 = j*(w0 * t2 + pi);

%Now put in complex amplitude for
A1 = 1;
A2 = 1;
Xk1 = A1*exp(phi1);
Xk2 = A2*exp(phi2);

ss = Xk1 + Xk2;
xx = xXv;

%end
```

6(f)

```
[xx,ss] = sig_str(300);
plot(xx,ss)                             %imaginary part is ignored by plot
```




```
%In order to get the peak value at a complex amplitude we can covert the
%value at that point given in the form of a complex amplitude A*e^(jphi)
%and covert it to rectangular for using MATLAB or a calculator, and then
%use that value to get the magnitude of the vector. The magnitude of that
%vector gives us the peak value at that point.
```

6(g)

```
%The range of values of the two signals are from -2 to +2. Since the
%amplitudes of the two waves are a maximum of +1/-1, we can only get these
%values when the peaks/trophs of both the direct and reflected signals line
%up exactly. This is constructive interference. There are also some points
%on the graph where we get a signal strength of 0 meaning the two waves had
%destructive interference.
%
%To get these positions, we check for all intersection of the graph with
%the line x = 0;
%
%These points fall on: 17.1 19.3 37.2 59.5 85 105.5 115 126.6 142.3 155.2
%166.8 177.3 186.5 195.4 203.7 211.5 218.9 226.1 232.9 239.5 263.6 269.1
%274.7 280 285.2 290.3 295.3
%
%There is a particular cluster of signal cancelation around 248-250m where
%the sinusoid is not only equal to 0, but also its slope is 0.
```

Published with MATLAB® R2013a