Contents


```
% Yonatan Carver
% ECES 352 - Lab 1

% 3 - Laboratory: Manipulating Sinusoids with MATLAB

clear ; clc ; close all
```

(a)

```
tt = -0.001 : 0.000001 : 0.001;
% These bounds were chosen so that tt covers a range of t that will exhibit
% approximately 2 cycles of the 1250 Hz sinusoids
% The step size was chosen so that there are more than 25 samples per
% period
```

(b)

```
A2 = 21;                % age
A1 = 1.2 * A2;                  % = 25.2
M = 7;                  % month of birthday
D = 30;                 % day of birthday
freq = 1250;            % frequency
T = 1/freq;             % = 0.0008, period

% tm1 & tm2 are both time shifts in the sinusoids
% tm1 causes the sinusoid to be shifted to the left
tm1 = -(37.2/M) * T;    % = -0.0043, time delay 1
% tm2 causes the sinusoid to be shifted to the right
tm2 = (41.3/D) * T;     % = 0.0011, time delay 2

% Generate two 1250 Hz sinusoids with amplitude A1 & A2 and time shifts tm1
% & tm2
x1 = A1 * cos( 2 * pi * freq * (tt - tm1));
x2 = A2 * cos( 2 * pi * freq * (tt - tm2));
```

(c)

Sum of x1 and x2 sinusoids

```
x3 = x1 + x2;
```

(d)

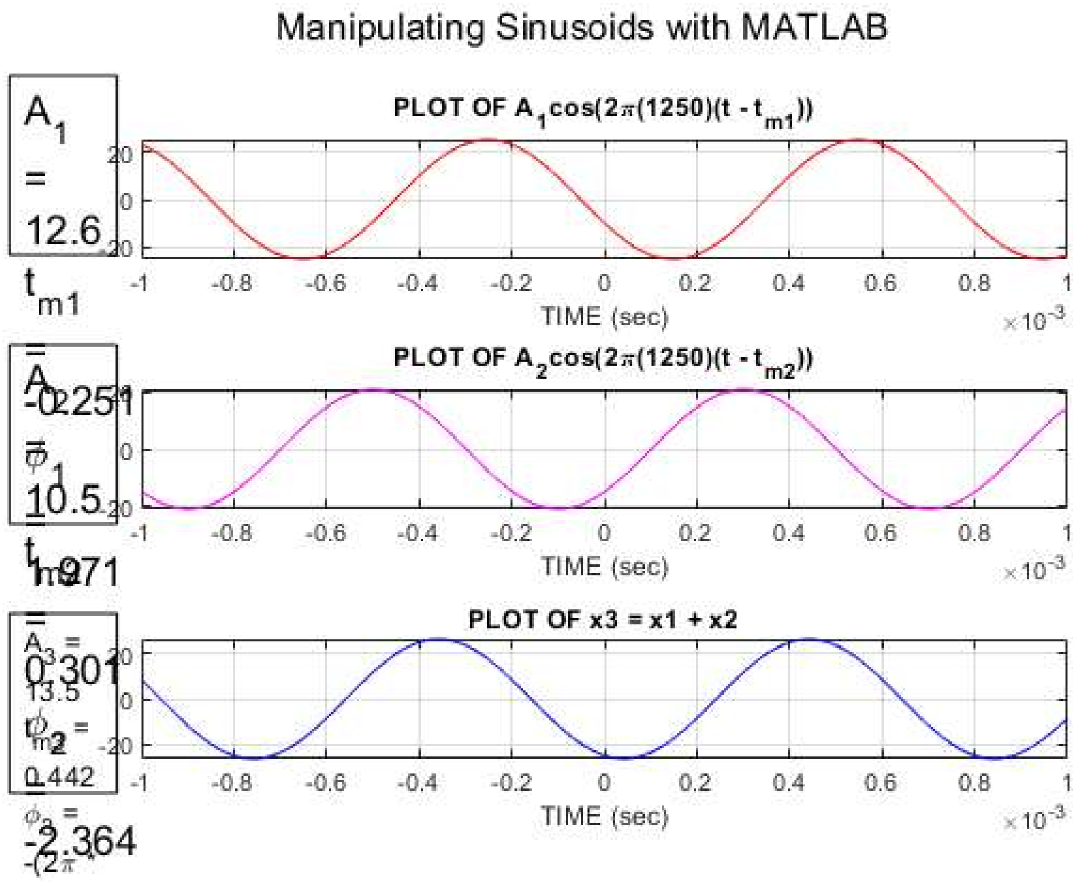
```
subplot(3,1,1)
plot( tt, x1, 'r-')
grid on
% title('PLOT OF x1')
title('PLOT OF A_1cos(2\pi(1250)(t - t_m_1))')
xlabel('TIME (sec)')
annotation('textbox', [0.02 0.7 0.09 0.2], 'String', {...
        'A_1 = 12.6' ...
        't_m_1 = -0.251' ...
        '\phi_1 = 1.971'}, ...
        'FontSize', 14)

subplot(3,1,2)
plot( tt, x2, 'm-')
hold on
% plot(tt, A2*cos(2*pi*1250*tt))        % for testing purposes
grid on
% title('PLOT OF x2')
title('PLOT OF A_2cos(2\pi(1250)(t - t_m_2))')
xlabel('TIME (sec)')
annotation('textbox', [0.02 0.4 0.09 0.2], 'String', {...
        'A_2 = 10.5' ...
        't_m_2 = 0.301' ...
        '\phi_2 = -2.364'}, ...
        'FontSize', 14)

subplot(3,1,3)
plot( tt, x3, 'b-')
hold on
% plot(tt, 26.3*cos(2*pi*1250*tt))      % for testing purposes
grid on
title('PLOT OF x3 = x1 + x2')
xlabel('TIME (sec)')
annotation('textbox', [0.02 0.1 0.09 0.2], 'String', {...
        'A_3 = 13.5' ...
        't_m_3 = 0.442' ...
        '\phi_3 = -(2\pi * T) * t_d = -3.471'}, ...
        'FontSize', 10)

sgtitle('Manipulating Sinusoids with MATLAB')   % subplot title

hold on
```



3.1 Theoretical Calculations

(a) & (b)

```
% Calculations for time_delay, amplitude, phase (phi), and omega (w)

% The amplitude (P-P) of the signals were found using the findpeaks()
% function. This function returns the coordinates (x, y) of the maxima on
% the graph. One must convert the function's returned x value to be on the
% same scale as tt (the time window).

% T (period) is found by calculating the distances between two peaks of the
% signal (found using the findpeaks() function), i.e. subtracting two
% subsequent x values

% Omega (w) is found using the equation: (2pi)/T, where T is the period of
% the sinusoid

% Phi (phase) is found using the equation: w*-t_d, where w is the frequency
% and t_d is the time delay

% x1 amplitude = 12.6 (25.2 P-P)
[y_x1, x_x1] = findpeaks(x1);   % find x & y values of peaks
% x1_x_peaks = tt(x_x1)                 % get actual x values from tt
% peak 1: (-0.251, 25.2)
% peak 2: (0.549, 25.2)
% T_x1 = 0.549 - -0.251                 % T = 0.8 (same for all sinusoids)
w_x1 = 2 * pi / 0.8;                    % w = 7.854
phi_x1 = -7.854 * -0.251;               % phi = 1.971
```

```
% x2 amplitude = 10.5 (21 P-P)
[y_x2, x_x2] = findpeaks(x2);   % find x & y values of peaks
% x2_x_peaks = tt(x_x2)                 % get actual x values from tt
% peak 1: (-0.5, 21)
% peak 2: (0.301, 21)
% T_x2 = 0.301 - -0.5                   % T = 0.8 (same for all sinusoids)
w_x2 = 2 * pi / 0.8;                    % w = 7.854
phi_x2 = -7.854 * 0.301;                % phi = -2.364

% x3 amplitude = 13.5 (26.3 P-P)
[y_x3, x_x3] = findpeaks(x3);   % find x & y values of peaks
% x3_x_peaks = tt(x_x3)                 % get actual x values from tt
% peak 1: (-0.358, 26.3)
% peak 2: (0.442, 26.3)
% T_x3 = 0.442 - -0.358                 % T = 0.8 (same for all sinusoids)
w_x3 = 2 * pi / 0.8;                    % w = 7.854
phi_x3 = -7.854 * 0.442;                % phi = -3.471
```

(c)

```
x1_exp = A1 * exp(1j * 2500 * pi * tt); %* exp(1j * 1250 * 2 * pi * -0.0043);   % x1 written
in exponential form
x2_exp = A2 * exp(1j * 2500 * pi * tt); %* exp(1j * 1250 * 2 * pi * 0.0011);    % x2 written
in exponential form
x3_new = real(x1_exp) + real(x2_exp);   % sum of real parts of x1 & x2

[y_x3_new, x_x3_new] = findpeaks(x3_new);       % find x & y values of peaks
x3_new_x_peaks = tt(x_x3_new);                          % get actual x values from tt
% peak 1: (-0.000388, 32.8028)
% peak 2: (0.0004120, 32.8028)
% Amplitude = 16.4014 (32.8028 P-P)
```

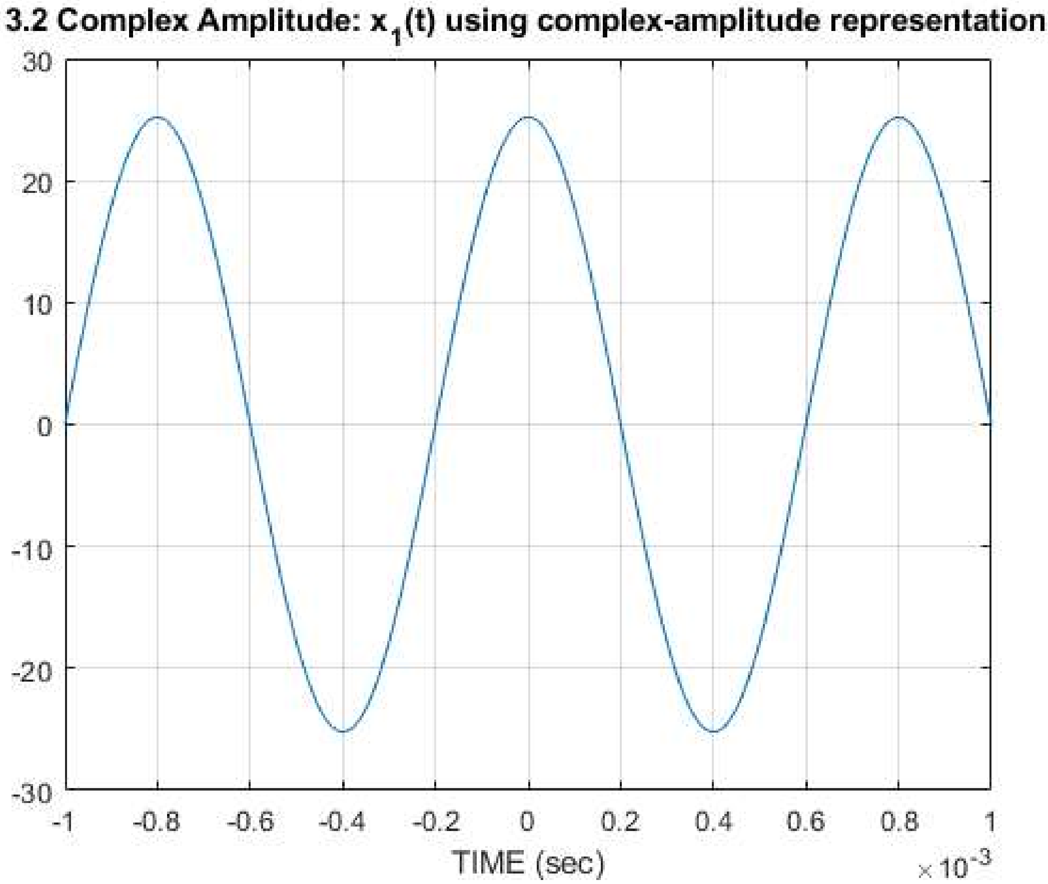
3.2 Complex Amplitude

```
% Generate values of the sinusoid x_1(t) using complex-amplitude
% representation:
figure; plot(tt, real(x1_exp)); grid on
title('3.2 Complex Amplitude: x_1(t) using complex-amplitude representation')
xlabel('TIME (sec)')


x11 = 25.2*exp(1j * 10.75 * pi);                % x1 in the form: x + jy = -17.8191 + j17.819
1
phasorr_x11 = @(x11) [abs(x11) angle(x11)];             % angle in radians
phasorr_x11(x11);       % = 25.2 * exp(1j * 2.3562)
% phasord_x1(x11)

% ----------------------------------------------------------------------

x21 = 21*exp(1j * -2.7 * pi);           % x2 in the form: x + jy = -12.3435 - j16.9894
phasorr_x21 = @(x21) [abs(x21) angle(x21)];             % angle in radians
phasorr_x21(x21);       % = 21 * exp(1j * -2.1991)
% phasord_x2(x21)
```




```
x11 = 25.2*exp(1j * 10.75 * pi);
real(x11)

x21 = 21*exp(1j * -2.7 * pi);
real(x21)
```

```
ans =

  -17.8191


ans =

  -12.3435
```

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