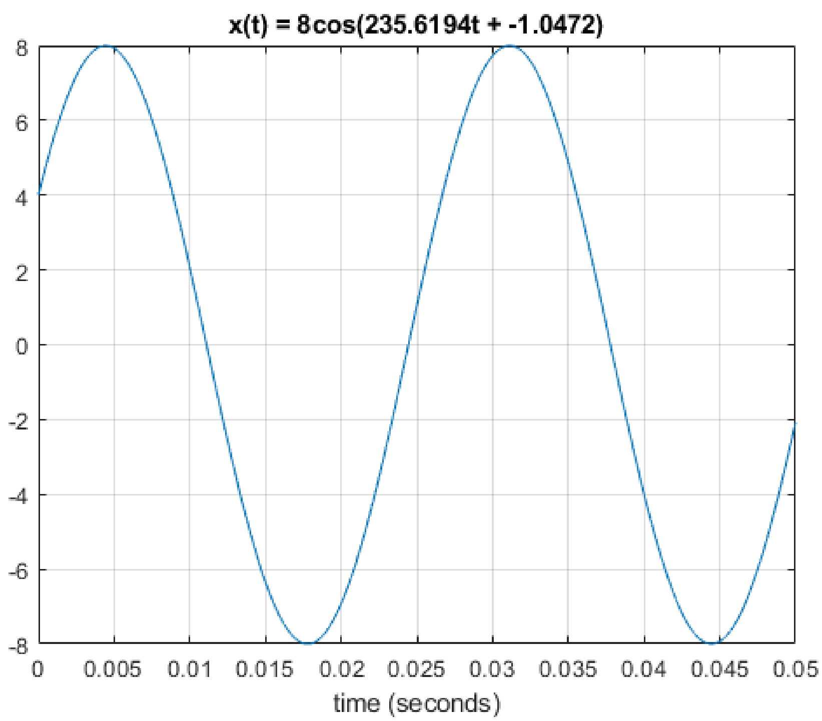
Contents


```
% Yonatan Carver
% ECES 352 - Lab 2 - Introduction to Complex Exponentials

clear ; clc ; close all
```

4 - Warm-Up: Complex Exponentials

function: mycos

```
% function [values, times] = mycos(A, w, phase, dur)
[t, val] = mycos(8, (75*pi), (-pi/3), 0.05);
% generates a plot
```



4.1.1, 4.1.2, 4.1.3 Write the Function M-File

function: syn_sin

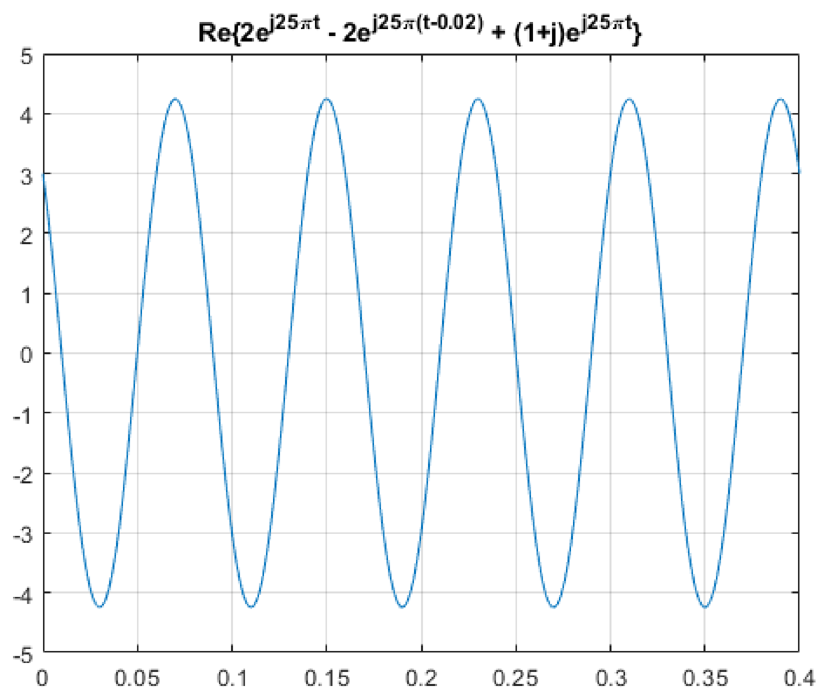
```
f1 = 440;
f2 = 555;
f3 = 660;

X1 = 2000 * exp(1j * (pi/2));
X2 = 2000 * exp(1j * (pi/2));
X3 = 2000 * exp(1j * (pi/2));
```

```
fs = 11000;
dur = 1;        % 1 second

% function [xx, yy] = syn_sin(fk, Xk, fs, dur, tstart)
[x1, y1] = syn_sin([f1, f2, f3], [X1, X2, X3], fs, dur, 0);
soundsc(x1)             % play sound
```

4.2 - Representation of Sinusoids with Complex Exponentials

(a)

```
tt = 0 : 1/1000 : 0.4;  % range ot t that will cover 4 periods
signal = real( (2 * exp(1j * 25 * pi * tt)) - (2 * exp(1j * 25 * pi * (tt - 0.02))) + ((1 + 1j) * exp(1j * 25 * pi * tt)) );

plot(tt, signal)
grid on
title('Re\{2e^{j25\pit} - 2e^{j25\pi(t-0.02)} + (1+j)e^{j25\pit}\}')
```



(b), (c)

```
% T = 0.08
% w = (2*pi)/T = 78.54
% phase = -w * t_d = -5.50
% A = 4.2426 (2.1213)

% A*exp(1j * w * t) * exp(1j * phase)
```

5 - Multipath Fading ==

(a)

```
% vehicle location: (xv, 0)
% transmitter location: (0, dt)

xv = 0 : 1/100 : 400;                   % vehicle position (x-value)
dt = 1700;                                              % transmitter location (y-value)
```

```
c = 2.9e8;                                             % speed of light

t1 = sqrt((xv.^2) + (dt.^2)) / c;       % distance from transmitter to vehicle

% fprintf('time delay from transmitter to vehicle: %i seconds\n', t1)
```

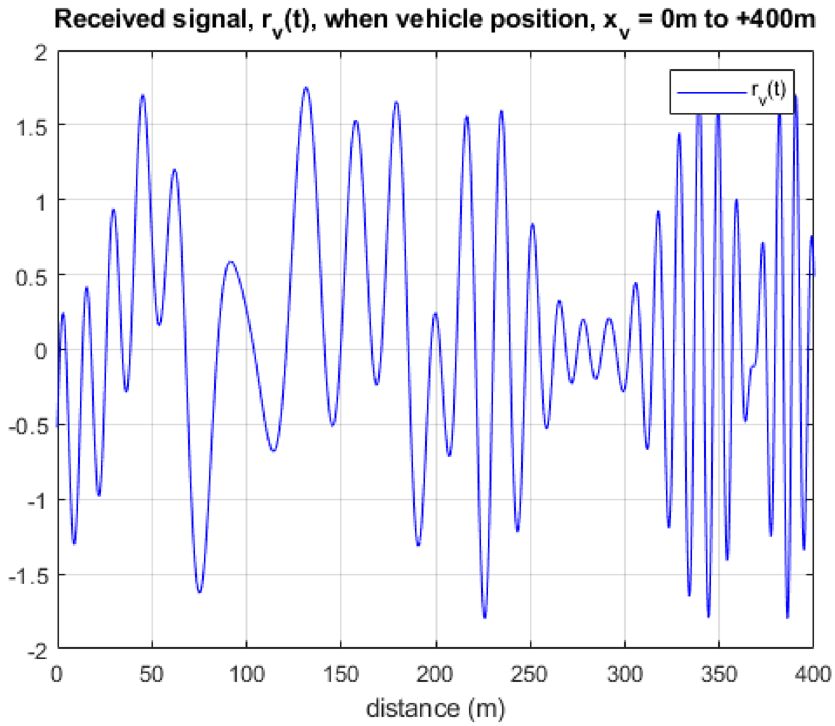
(b)

```
% reflector location: (dxr, dyr)

dxr = 150;
dyr = 800;

distance_t_to_r = sqrt(((dt-dyr).^2) + (dxr.^2)) / c;   % distance from transmitter to reflector
distance_r_to_v = sqrt(((dyr).^2) + ((dxr-xv).^2)) / c; % distance from reflector to vehicle
t2 = (distance_t_to_r + distance_r_to_v);

% fprintf('time delay from transmitter to reflector to vehicle: %i seconds\n', t2)
```

(c), (d), & (e)

```
F = 133e6;                                      % 133 MHz
tt = 0 : 1/100 : 400;           % time range aka vehicle position 0m to +400m
st = cos(2 * pi * F * tt);      % source signal

% received signal at the vehicle
%       =      s(t - t_1)                                                  - 0.8 * s(t - t_2)
rvt = real(exp( 1j .* 2 .* pi .* F .* (tt - t1))) - real( 0.8 .* exp( 1j .* 2 .* pi .* F .* (tt - t2)));

plot(tt, rvt, 'b')
grid on; hold on
legend('r_v(t)')
title('Received signal, r_v(t), when vehicle position, x_v = 0m to +400m')
xlabel('distance (m)')

% find peak value from the complex amplitude
% since there are multiple peaks, the maximum peak value is found using
% max(y_rvt) - which finds the maximum y-value from the signal
[y_rvt, x_rvt] = findpeaks(rvt);
x_rvt = tt(x_rvt);

% largest and smallest values of received signal strength
% we get these values because of interference and signal degredation after
% being reflected
fprintf('Maximum amplitude value from r_v(t): %i\n', max(y_rvt))
fprintf('Minimum amplitude value from r_v(t): %i\n', min(y_rvt))

% there do not appear to be any vehicle positions where we get complete
% signal cancellation
```

```
Maximum amplitude value from r_v(t): 1.774911e+00
Minimum amplitude value from r_v(t): -1.220336e+00
```




```
direct = real(exp( 1j .* 2 .* pi .* F .* (tt - t1)));
reflected = real( 0.8 .* exp( 1j .* 2 .* pi .* F .* (tt - t2)));
figure
grid on; hold on
plot(direct)
plot(reflected)
plot(rvt)

title('Plot of direct path, reflected path, and received signal')
xlabel('distance (m)')
legend('direct path', 'reflected path', 'r_v(t)')
```