ECE580: Matlab Mini-project

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```
xx = [zeros(1,3), linspace(0,1,5), ones(1,4)]
```

```
xx =
         0         0         0         0    0.2500    0.5000    0.7500    1.0000 ...
```

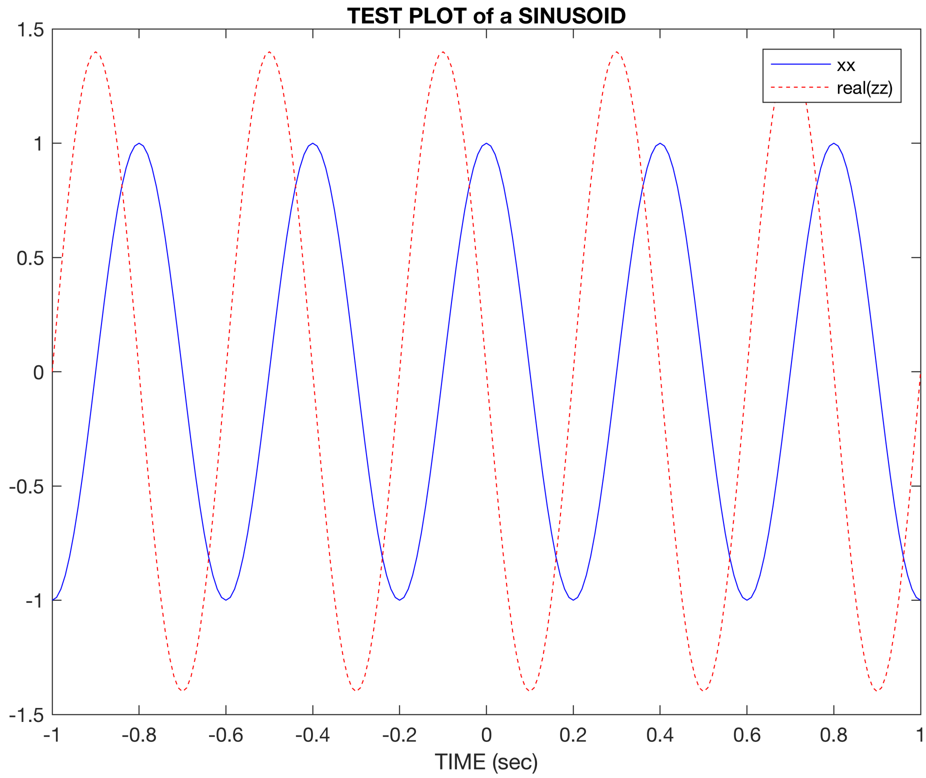
```
xx(4:6);
size(xx);
length(xx);
xx(2:2:length(xx));
xx(2:2:end);
```

Mini-Lab Question 1: Now write a statement that will take the vector `xx` defined in part (b) and replace the even indexed elements (i.e., `xx(2)`, `xx(4)`, etc) with the constant π ^π . Use a vector replacement, not a loop.

```
xx(2:2:end) = pi^pi
```

```
xx =
         0   36.4622         0   36.4622    0.2500   36.4622    0.7500   36.4622 ...
```

```
tt = -1 : 0.01 : 1;
xx = cos(5*pi*tt);
zz = 1.4*exp(j*pi/2)*exp(j*5*pi*tt);
plot(tt, xx, 'b-', tt, real(zz), 'r--') %<--- plot a sinusoid grid on
title('TEST PLOT of a SINUSOID'); xlabel('TIME (sec)');
legend('xx', 'real(zz)')
```




```
amplitude = abs(max(zz))
```

```
amplitude = 1.4000
```

Mini-Lab Question 2: Explain why the plot of `real(zz)` is a sinusoid. What is its phase and amplitude? Make a calculation of the phase from a time - shift measured on the plot.

Answer:

The plot of 'real(zz)' is a sinusoid because of Eulers formula. e^ix = cos *x* + *i sin x*. The real components of e^ix is a cosine function, which is a sinusoid.

Phase: 0.3 seconds (cosine function right shifted by 0.3 seconds)

Amplitude: 1.40

Time calculated phase: 0.3 seconds

Mini-Lab Question 3: Now you're on your own. Include a short summary of this Section with plots in your Lab report. Write a MATLAB script file to do steps (a) through (d) below. Include a listing of the script file with your report.

(a) Generate a time vector (`tt`) to cover a range of t that will exhibit approximately two cycles of the 4000 Hz sinusoids defined in the next part, part (b). Use a definition for `tt` similar to part 3.2(d). If we use T to denote the period of the sinusoids, define the starting time of the vector `tt` to be equal to $-T$, and the ending time as $+T$. Then the two cycles will include t = 0. Finally, make sure that you have at least 25 samples per period of the sinusoidal wave. In other words, when you use the colon operator to define the time vector, make the increment small enough to generate 25 samples per period.

```
T = (2*pi)/(8000*pi);
tt = (-T : T/25 : T);
```

(b) Generate two 4000 Hz sinusoids with arbitrary amplitude and time - shift.

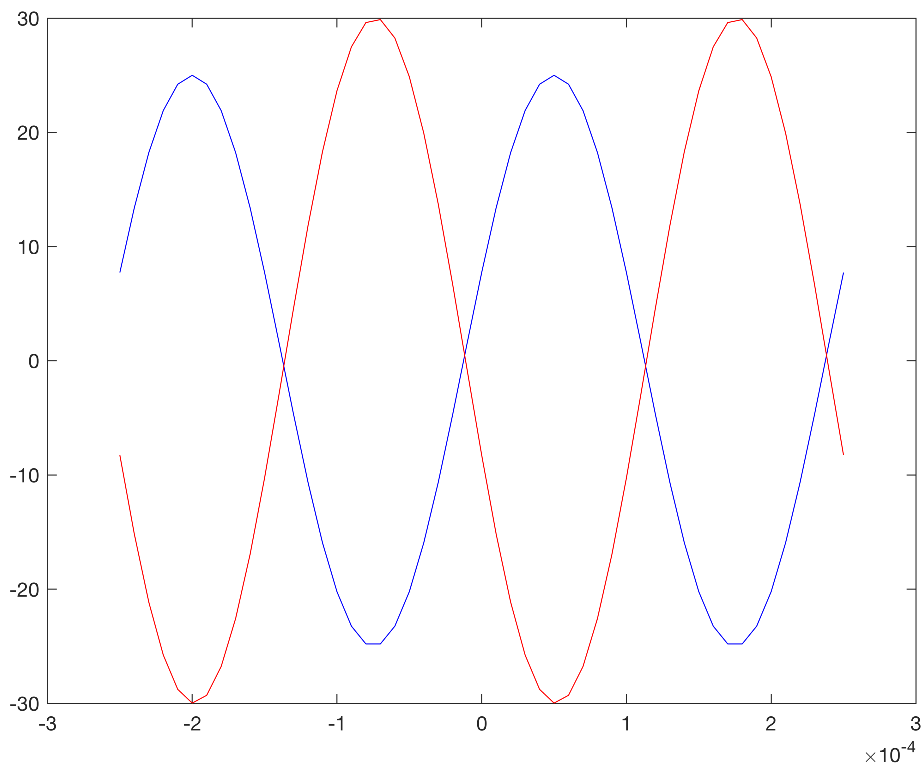
x1(t) = A1 cos(2π(4000)(t − tm1))   x2(t) = A2 cos(2π(4000)(t − tm2))

```
A1 = 25;
tm1 = (37.2/6)*T;
tm2 = -(41.3/18)*T;
x1 = A1*cos(2*pi*4000*(tt-tm1));
x2 = (A1*1.2)*cos(2*pi*4000*(tt-tm2));
```

Select the value of the amplitudes and time - shifts as follows: Let `A1` be equal to your age and set A2 = 1.2A1. For the time - shifts, set tm1 = (37.2/M)T and tm2 = −(41.3/D)T where D and M are the day and month of your birthday, and T is the period.

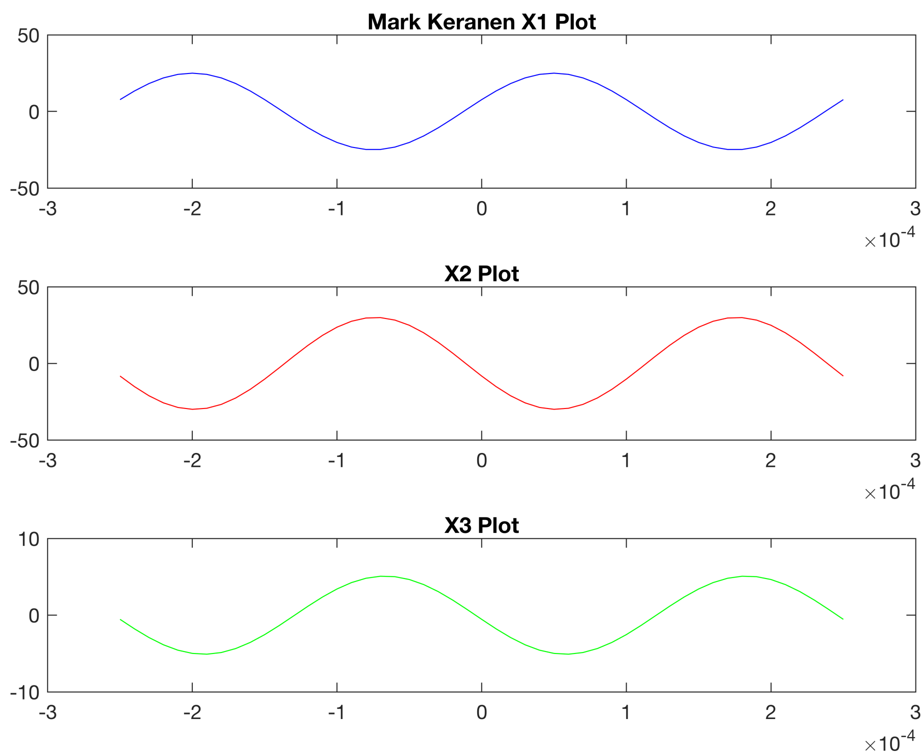
Make a plot of both signals over the range of −T ≤ t ≤ T. For your final printed output in part (d) below, use `subplot(3,1,1)` and `subplot(3,1,2)` to make a three - panel figure that puts both of these plots in the same figure window. See `helpwin subplot`.

```
plot(tt,x1,'b-', tt, x2, 'r-')
```



(c) Create a third sinusoid as the sum: x3(t) = x1(t) + x2(t). In MATLAB this amounts to summing the vectors that hold the values of each sinusoid. Make a plot of x3(t) over the same range of time as used in the plots of part (b). Include this as the third panel in the plot by using `subplot(3,1,3)`.

```
x3 = x1 + x2;
subplot(3,1,1), plot(tt,x1,'b-')
title('Mark Keranen X1 Plot')
subplot(3,1,2), plot(tt,x2,'r-')
title('X2 Plot')
subplot(3,1,3), plot(tt,x3,'g-')
title('X3 Plot')
```



(d) Before printing the three plots, put a title on each subplot, and include your name in one of the titles.

```
%Done in Section (c)
```

Mini-Lab Question 4: Use **this** vectorization idea to write 2 or 3 lines of code that will perform the same task as the following MATLAB script without using a for loop.

–

This: The power of MATLAB comes from its matrix - vector syntax. In most cases, loops can be replaced with vector operations because functions such as `exp()` and `cos()` are defined for vector inputs, e.g., `cos(vv) = [cos(vv(1)), cos(vv(2)), cos(vv(3)), ... cos(vv(N))]` where `vv` is an N - element row vector. Vectorization can be used to simplify your code. If you have the following code that plots a certain signal,

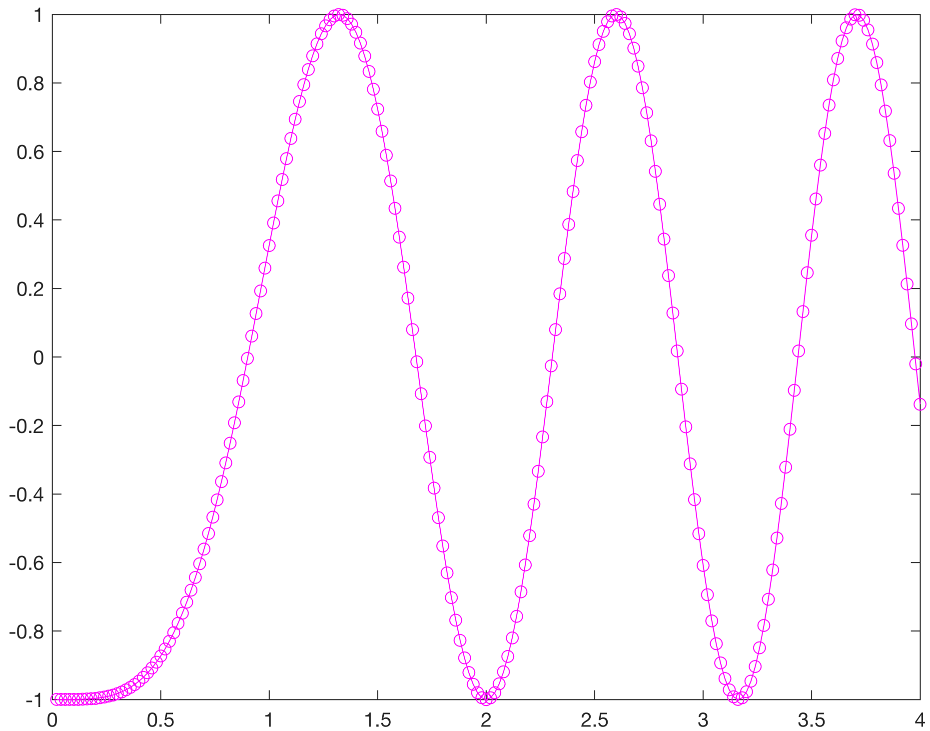
```
M = 200;
for k=1:M
    x(k) = k;
    y(k) = cos( 0.001*pi*x(k)*x(k) );
end
plot( x, y, 'ro-' )
```

then you can replace the for loop and get the same result with 3 lines of code:

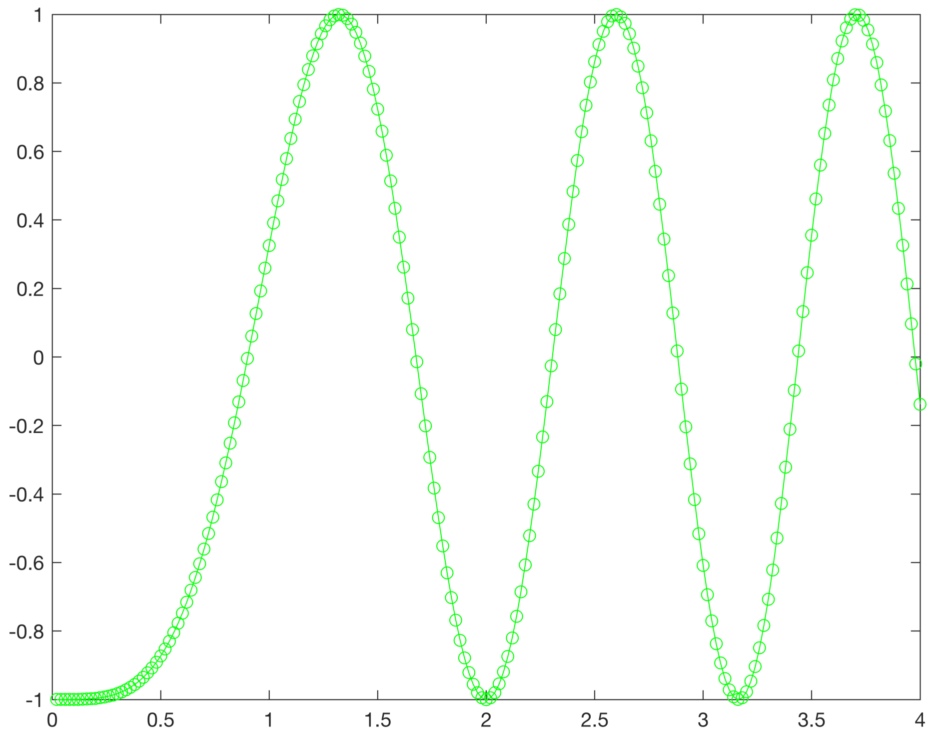
```
M = 200;
y = cos( 0.001*pi*(1:M).*(1:M) );
plot(1:M, y, 'ro-' )
```

_

```
%--- make a plot of a weird signal
N = 200;
for k=1:N
    xk(k) = k/50;
    rk(k) = sqrt( xk(k)*xk(k) + 2.25 );
    sig(k) = exp(j*2*pi*rk(k));
end
figure()
plot( xk, real(sig), 'mo-')
```

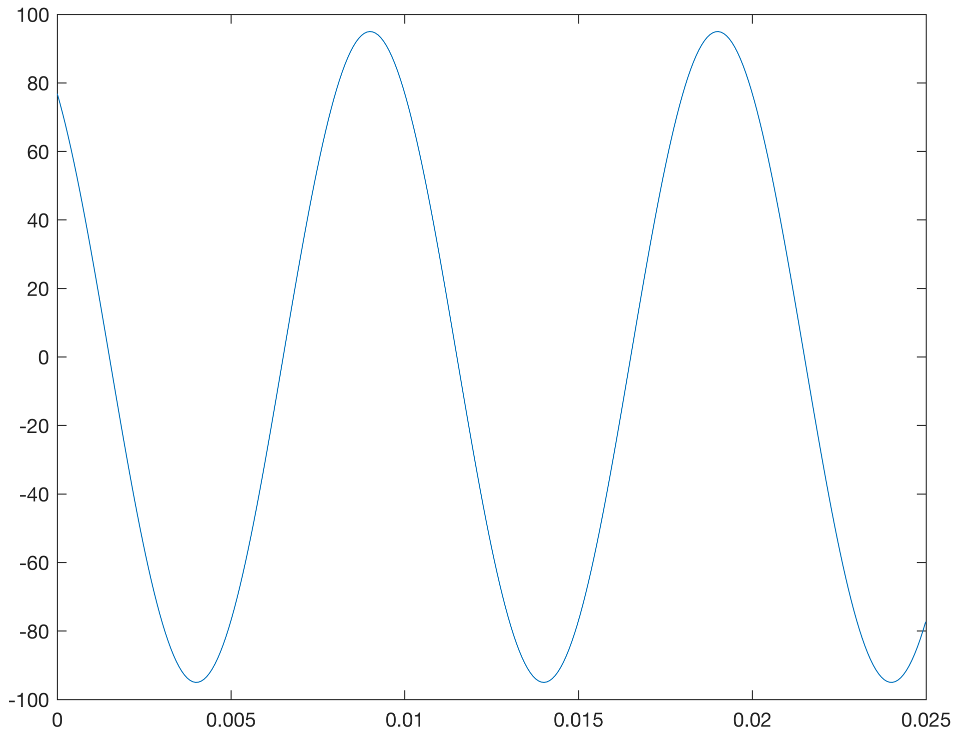



```
%--- code using vectorization
figure()
xk(1:N/50);
rk(1:N) = sqrt(xk(1:N).*xk(1:N) + 2.25 );
y = exp(j*2*pi*rk(1:N));
plot(xk, real(sig), 'go-')
```



Mini-Lab Question 5: Write a function that will generate a single sinusoid, x(t) = Acos(ωt+φ), by using four input arguments: amplitude (A), frequency (ω), phase (φ) and duration (`dur`). The function should return two outputs: the values of the sinusoidal signal (x) and corresponding times (t) at which the sinusoid values are known. Make sure that the function generates 20 values of the sinusoid per period. Call this function `one_cos()`.

```
[xx,tt] = one_cos(95, 200*pi, pi/5, 0.025);
plot(xx,tt)
```




```
function [tt, xx] = one_cos(A, w, phase, dur)

    tt = (0 : 1/(20*w) : dur);       %20 samples per period
    xx = A * cos(w*tt + phase);      %Calculate sinusoid and assign to xx

end
```