Solution to Introductory Computer Assignment
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Problem 1

(a)
```
A=[4 3 2; 5 6 3; 3 5 2]
B=[3 -1 2 6; 7 4 1 5; 5 2 4 1]
b= [1 0 0]'

AB = A*B

AB =

    43    12    19    41
    72    25    28    63
    54    21    19    45

A_inv = inv(A)

A_inv =

    3.0000   -4.0000    3.0000
    1.0000   -2.0000    2.0000
   -7.0000   11.0000   -9.0000

X = A_inv * B

X =

   -4.0000  -13.0000   14.0000    1.0000
   -1.0000   -5.0000    8.0000   -2.0000
   11.0000   33.0000  -39.0000    4.0000
```

```
x= A_inv * b
x =

    3.0000
    1.0000
   -7.0000
```

(b)

```
x1=0:1:5

x1 =

     0     1     2     3     4     5

x2=0:5

x2 =

     0     1     2     3     4     5

x3=2:4:14

x3 =

     2     6    10    14

x4=13:-4:2

x4 =

    13     9     5

x5=pi*[0:1/2:2]

x5 =

         0    1.5708    3.1416    4.7124    6.2832
```

(c) `x(2:2:N)`

(d)

```
%The important point here is the use of length(x) or end
x(1:2:length(x))
%or alternatively:
x(1:2:end)
```

(e)
```
x6 = zeros(1,10)

% A for loop solution would be:
for n=2:2:length(x6)
    x6(n)=exp(1);
end
x6 %To display the result

%Using an indexing technique
x6(2:2:end) = exp(1)
```

Problem 2 - Complex numbers

We have $z_1 = 2 + j$ and $z_2 = 3 - 4j$.

(a) First we find

$$z_1^* = 2 - j \tag{1a}$$

$$z_2^* = 3 + 4j \tag{1b}$$

$$z_1 z_2 = (2 + j)(3 - 4j) = 10 - 5j \tag{1c}$$

$$\frac{z_1}{z_2} = \frac{2 + j}{3 - 4j} = \frac{2 + j}{3 - 4j}\frac{3 + 4j}{3 + 4j} = \frac{2 + 11j}{25} \tag{1d}$$

Then it is clear

$$\text{Re}(z_1^*) = 2$$
$$\text{Im}(z_1^*) = -1$$

$$\text{Re}(z_1 z_2) = 10$$
$$\text{Im}(z_1 z_2) = -5$$

$$\text{Re}(\frac{z_1}{z_2}) = \frac{2}{25} = 0.08$$
$$\text{Im}(\frac{z_1}{z_2}) = \frac{11}{25} = 0.44$$

(b) The magnitude and phase of a complex number $z = a + bj$ is given as

$$|z| = \sqrt{a^2 + b^2}$$
$$\angle z = \tan^{-1}(\frac{\text{Im(z)}}{\text{Re(z)}})$$

Thus we find

$$
\begin{aligned}
|z_1| &= \sqrt{2^2+1^2} = \sqrt{5} \\
\angle z_1 &= \tan^{-1}(\frac{1}{2}) \approx 0.4636 \\
|z_2| &= \sqrt{3^2+(-4)^2} = \sqrt{25} = 5 \\
\angle z_2 &= \tan^{-1}(\frac{-4}{3}) \approx -0.9273 \\
|z_1^*| &= |z_1| = \sqrt{5} \\
\angle z_1^* &= -\angle z_1 \approx -0.4636 \\
|z_1 z_2| &= |z_1||z_2| = 5\sqrt{5} \\
\angle z_1 z_2 &= \angle z_1 + \angle z_2 \approx -0.5404 \\
|\frac{z_1}{z_2}| &= \frac{|z_1|}{|z_2|} = \frac{\sqrt{5}}{5} \\
\angle \frac{z_1}{z_2} &= \angle z_1 - \angle z_2 \approx 1.3909 \\
z_1 &= \sqrt{5}\, e^{j\,0.4636}
\end{aligned}
$$

(c) As seen above we have $|z_1| = |z_1^*|$ and $\angle z_1 = -\angle z_1^*$. This result holds for all complex numbers.

(d) As seen above we have $|z_1 z_2| = |z_1||z_2|$ and $\angle z_1 z_2 = \angle z_1 + \angle z_2$. This result holds for all pairs of complex numbers.

The results in (c) and (d) are easy to prove. Write the complex numbers in the form $z = re^{j\,\varphi}$ and you are almost done.

Verification can be done as shown below.

```
%a)
z1 = 2+j;
z2 = 3-4j;

disp('Displaying solution to problem 2a');

real(z1')
imag(z1')

real(z1*z2)
imag(z1*z2)

real(z1/z2)
imag(z1/z2)

%b)
disp('Displaying solution to problem 2b');
```

```
abs(z1)
angle(z1)

abs(z2)
angle(z2)

abs(z1')
angle(z1')

abs(z1*z2)
angle(z1*z2)

abs(z1/z2)
angle(z1/z2)

%c)
disp('Displaying solution to problem 2c');
disp('Can be observed from 2b');

%d)
disp('Displaying solution to problem 2d');
disp('Can be observed from 2b');
```

Problem 3 - Plotting functions

(a)
```
%Defining variables
t=0:0.001:2*pi;


%Calculating function values
y1=sin(t);
y2=t.^2 +cos(t) +exp(t.^2)/10^16;
y3=cos(t);


%Plotting
figure(1);
plot(t,y1);
xlabel('t');
ylabel('y_1');
title('y_1=sin(t)');

figure(2);
plot(t,y2);
```

```
xlabel('t');
ylabel('y_2');
title('y_2=t^2 +cos(t) + e^{t^2}/10^{16}');


figure(3);
plot(t,y1);
hold on;
plot(t,y3,'r');
hold off;
xlabel('t');
ylabel('y_1 and y_3');
title('y_1=sin(t), y_3=cos(t)');

figure(4);

subplot(2,1,1);
plot(t,y1);
hold on;
plot(t,y3,'r');
hold off;
xlabel('t');
ylabel('y_1 and y_3');
title('y_1=sin(t), y_3=cos(t)');


subplot(2,1,2);
plot(t,y2);
xlabel('t');
ylabel('y_2');
title('y_2=t^2 +cos(t) + e^{t^2}/10^{16}');
```

(b)
```
%Defining variables
n=-10:10;
%Calculating function values
y4=cos(2*pi.*n/10)

figure(5);
stem(n,y4);
xlabel('n');
ylabel('y_4');
title('y_4=cos(2\pi n/10)');
```

Figures for both 3(a) and 3(b) are shown below.

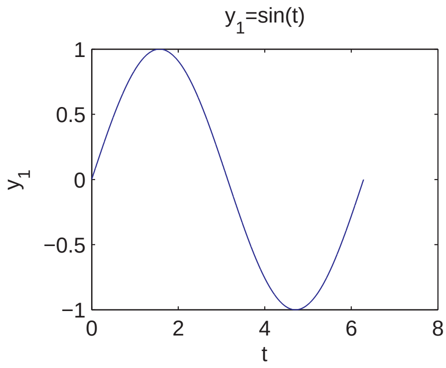

Figure 1

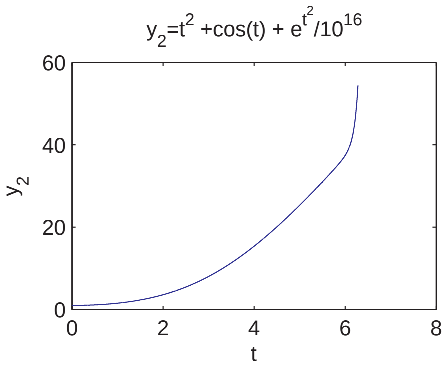

Figure 2

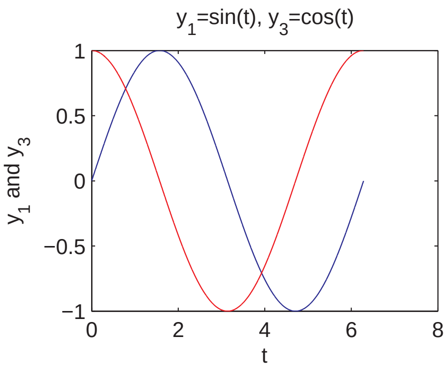

Figure 3

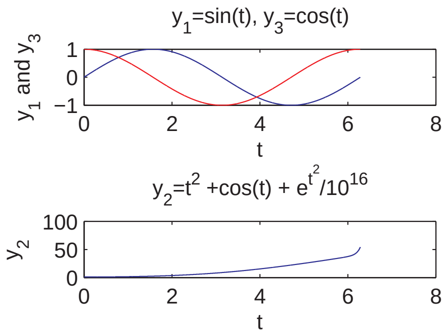

Figure 4

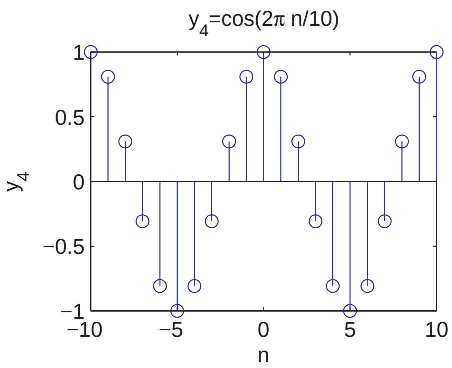

Figure 5

Problem 4 - Playing with sinusoids

(a)
```
%Defining frequencies
fA=220.00;
fC=130.813;
fD=146.8632;
fE=164.814;
fF=176.614;
fG = 195.998;
fG_high=2195.998;

%Defining amplitudes
A=1.5;

%Defining time vectors
t = 0:0.0001:.33;
t_l=0:0.0001:.66;

%Calculating function values
yA = A*sin(2*pi*fA.*t);
yC = A*sin(2*pi*fC.*t);
yCl = 1.2*sin(2*pi*fC.*t);
yD = A*sin(2*pi*fD.*t);
yE = A*sin(2*pi*fE.*t);
yEl = A*sin(2*pi*fE.*t +pi/4);
yF = A*sin(2*pi*fF.*t);
yG = A*sin(2*pi*fG.*t);
yGl = A*sin(2*pi*fG_high.*t);
```

(b)
- **Frequency** - The change in frequency is clearly audible.
- **Amplitude** - The change in amplitude is clearly audible.
- **Phase** - The change in phase is not audible.

```
%Comparing
%Using the pause function to avoid that the sinusoids are
%played (partly) simultaneously. Pausing for 1 second.

disp('Now playing yA vs yGl');
sound(yA);
pause(1);
sound(yGl);
pause(1);

disp('Now playing yC vs yCl');
sound(yC);
```

```
pause(1);
sound(yCl);
pause(1);

disp('Now playing yE vs yEl');
sound(yE);
pause(1);
sound(yEl);
pause(1);
```

(c)
```
%Changing variables
yCl= 1.2*sin(2*pi*fC.*t_l);
yEl= A*sin(2*pi*fE.*t_l +pi/4);
yGl = A*sin(2*pi*fG*t_l);
```

(d)
```
s1=[yC yD yE yF yGl yGl yA yA];
s2=[yA yA yGl yF yF yF yF];
s3=[yEl yEl yD yD yD yD yCl];
y=[s1 s2 s3];
sound(y);
```