Lab 2: Introduction to MATLAB: Signal Plotting and Basic Programming

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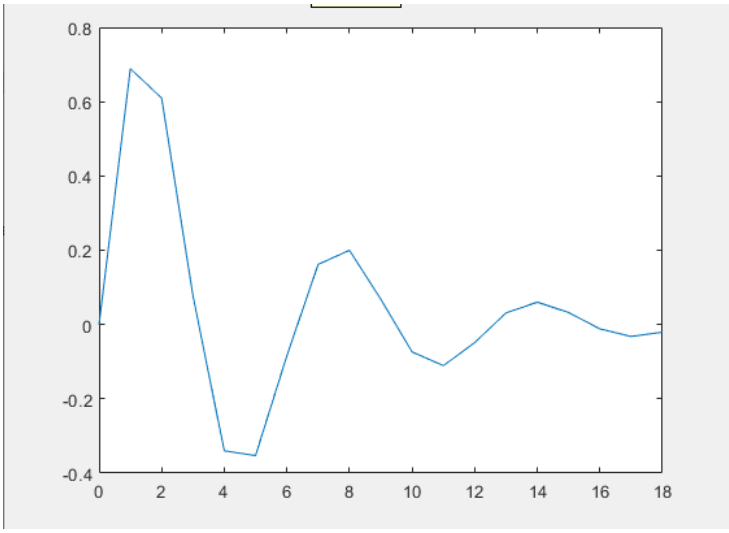
Objectives:

Once MATLAB is installed; it is time to start using it. MATLAB is best understood by entering the instructions in your computer one at a time and by observing and studying the responses. Learning by doing is probably the most effective way to maximize retention.

Pre-lab Task:

Task 01: Plot a function $e-0.2xsin(x)$ between the interval 0 to 6π.

```
x=0:1:6*pi
y=exp(-0.2*x).*sin(x);
plot(x,y)
```



In-lab Tasks

Task 02: Make a function 'my_sum' which takes two vectors x and y as input. The vectors should have different sizes. Firstly, make size of both the input vectors same by padding (concatenating) zeros. Now add both the vectors element wise. The function should return a variable z which should contain the

sum of all the elements of the vectors formed as a result of summation of input vectors x and y.

```
function y = my_sum(x,y)
if length(x)>length(y)
  a =  length(x)-length(y)
y = [y.zero(a)]
elseif length(y)>length(x)
    = length(y)-length(x)
   x = [x.zero(a)]
end
z = x+ y
```

Command Window:

```
x = [1 2 3 4]
y= [5 6 7 8]
add(a,b)
x =
   1    2    3    4
y=
   5    6    7    8
z =
   6    8   10   12
```

<u>Task 03:</u> Write MATLAB programs to find the following with for loops and vectorization. Time both versions in each case.
a) 12+22+32+42+⋯+10002

~Using For loop:

```
tic
s=0;
for n=1:1000
s=1+n^2;
end
s
toc
s =
    1000001
Elapsed time is 0.041310
```

~ Using Vectorization:

```
tic
s=0;
n=1:1000
s=sum(n.^2);
s
toc
s =
 333833500
Elapsed time is 0.013456
seconds.
```

b) $1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}+\frac{1}{9}-\cdots\cdots-\frac{1}{1003}$

~Using For loop:

```
tic
s=0;
for n=1:1003
s=s+(-1^n+1/2*n-1);
end
s
toc
```

s = 249747

Elapsed time is 0.003472

~ Using Vectorization:

```
tic
s=0;
n=1:1003
s=sum(-1.^n+1./2*n-1);
s
toc
```

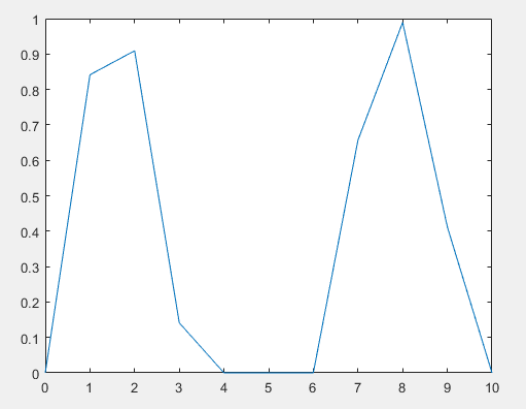
s = 249747

Elapsed time is 0.059343

Task 04: Graph the following function in MATLAB over the range of 0 to 10

$$y(x)=\{sin(x),\ (sin(x)>0)0,\ (sin(x)\leq 0)$$

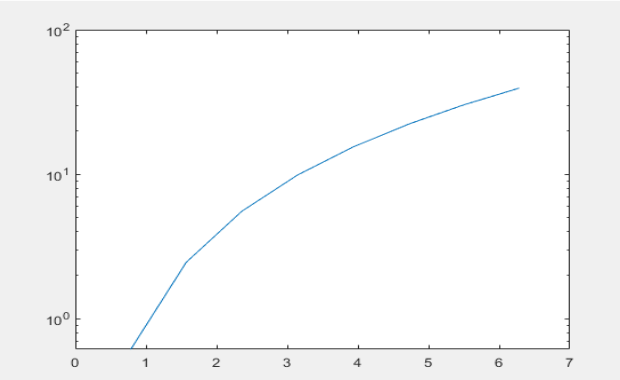
```
x=0:1:10
y=(sin(x)>0).*sin(x);
plot(x,y)
```



Task 05: Use the semi log graph to graph x^2, x^3, x^4 and e^{x^2} over the interval of $0 \leq x \leq 2\pi$.

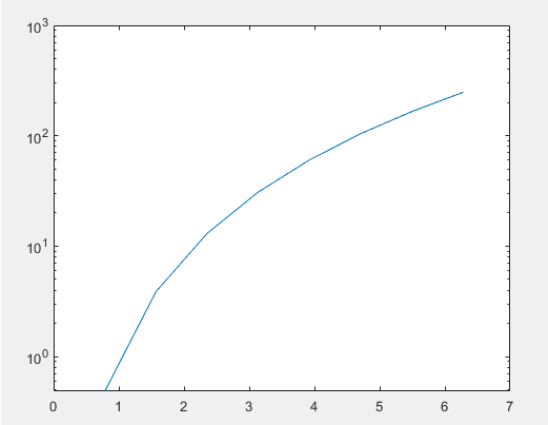
```
x=0:pi/4:2*pi;
semilogy(x,x.^2)
```

x^2



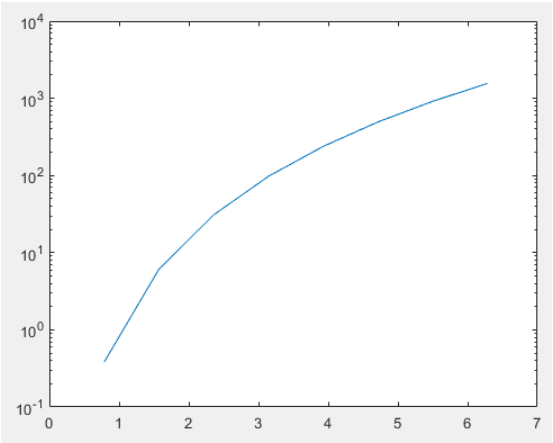

```
x=0:pi/4:2*pi;
semilogy(x,x.^3)
```

x^3



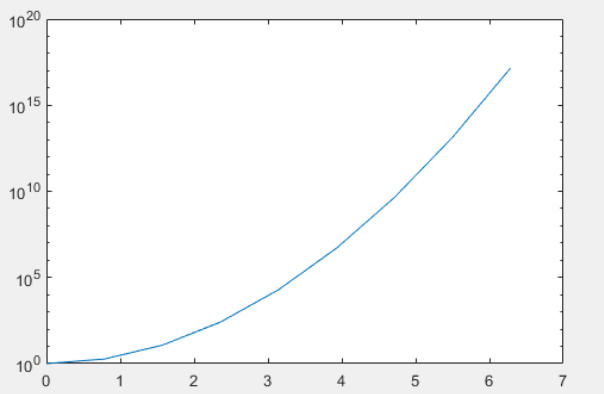

```
x=0:pi/4:2*pi;
semilogy(x,x.^4)
```

x^4



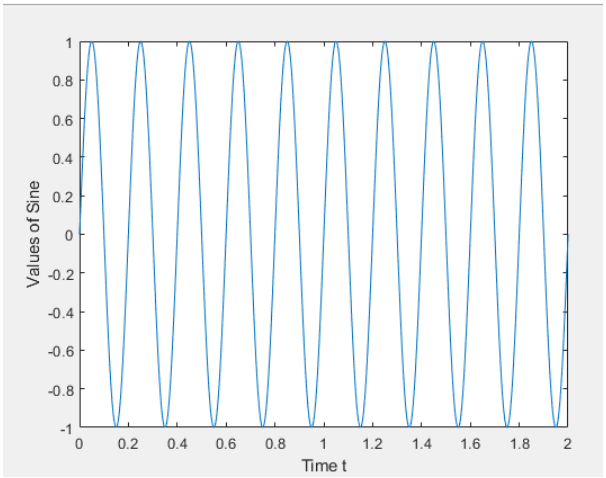
```
x=0:pi/4:2*pi;
semilogy(x,exp(x.^2))
```

e^{x^2}



Task 06: Plot the first ten cycles of sinusoid (sin) with time period of 2 seconds. The horizontal axis corresponds to time period of the sinusoid while vertical axis depicts the values of sinusoid.

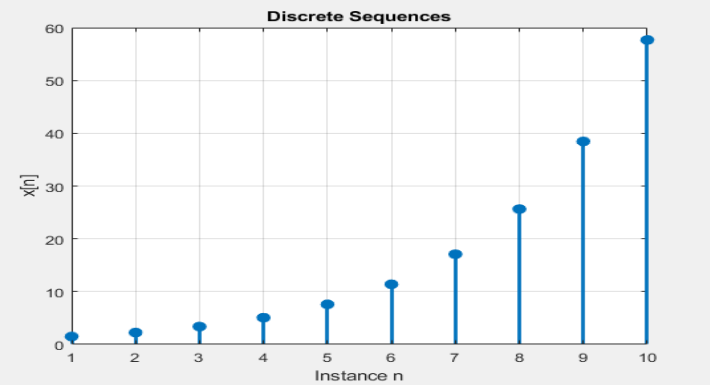
```
x=0:0.001:2;
y=pi/0.5;
z=sin(x.*y/0.2);
plot(x,z);
xlabel('Time t');
ylabel('Values of Sine');
```



Task 07: Plot the following discrete sequences. Horizontal axis corresponds to instances n and vertical axis depicts $x[n]$ values.

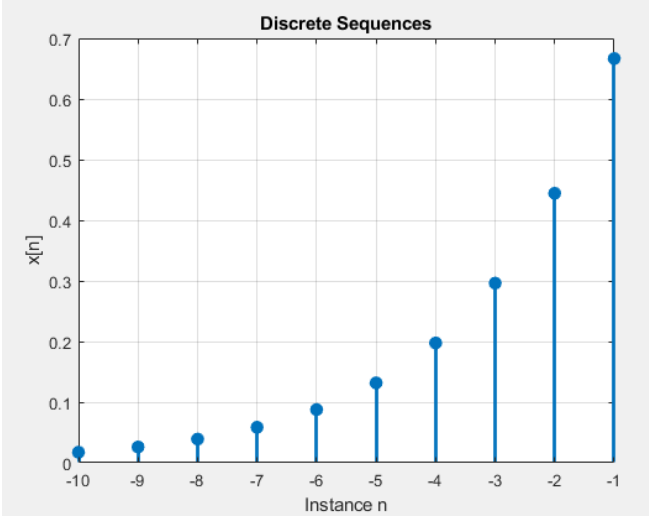
a) $x[n] = \alpha^n \qquad 0 \leq n \leq 10, \alpha = 1.5$

```
n=1:10;
a=1.5;
x=a.^n;
stem(n,x,'fill','linewidth',2),grid on
xlabel('Instance n');
ylabel('x[n]');
title('Discrete Sequences');
```



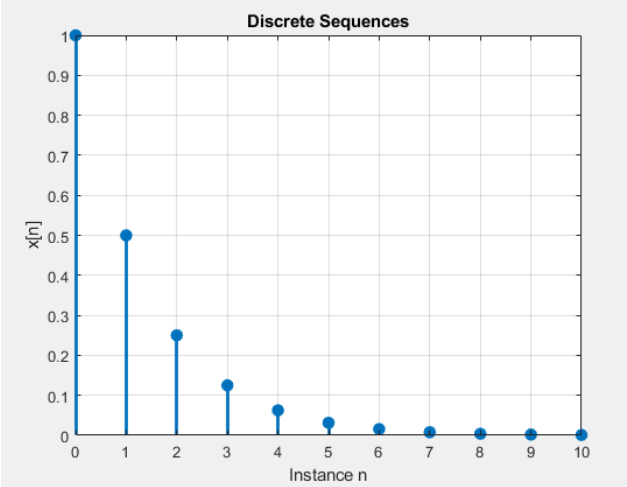
b) $x[n] = \beta^n \quad -10 \leq n \leq -1, \beta = 1.5$

```
n=-10:-1;
b=1.5;
x=b.^n;
stem(n,x,'fill','linewidth',2),grid
on
xlabel('Instance n');
ylabel('x[n]');
title('Discrete Sequences');
```



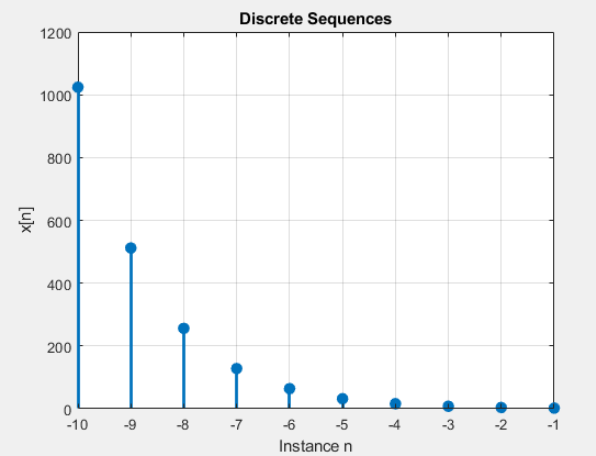
c) $x[n] = \gamma^n \qquad 0 \leq n \leq 10, \gamma = 0.5$

```
n=0:10;
y=0.5;
x=y.^n;
stem(n,x,'fill','linewidth',2),grid
on
xlabel('Instance n');
ylabel('x[n]');
title('Discrete Sequences');
```



d) $x[n] = \varphi^n \quad -10 \leq n \leq -1, \varphi = 0.5$

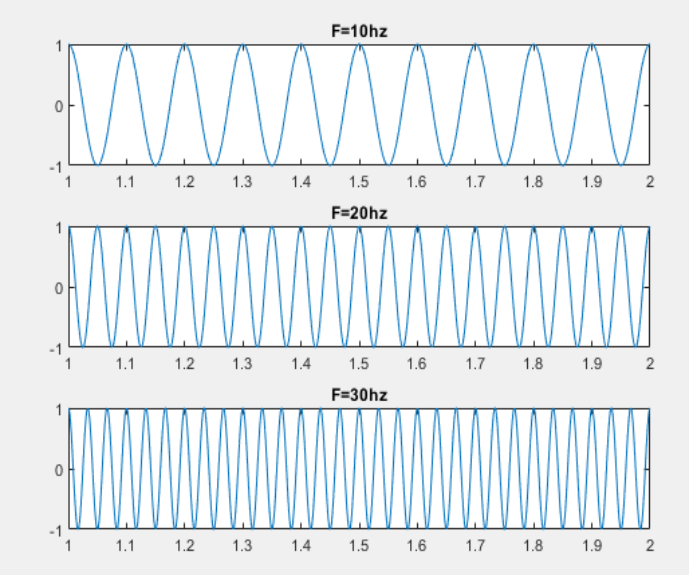
```
n=-10:-1;
o=0.5;
x=o.^n;
stem(n,x,'fill','linewidth',
2),grid on
xlabel('Instance n');
ylabel('x[n]');
title('Discrete Sequences');
```



Task 08: $x(t) = A\ \mathbb{R}\{ej(\omega 0t+\varphi)\}$

Where A = 1, f0 = 10 Hz, φ=0 Plot the second and third harmonics of the above sinusoid…

```
t=1:0.0001:2;
A=1;
f0=10;
f1=20;
f2=30;
O=0;
k=2*pi*f0*t+O;
l=2*pi*f1*t+O;
m=2*pi*f2*t+O;
a=exp(1i.*k);
b=exp(1i.*l);
c=exp(1i.*m);
x1=A*real(a);
x2=A*real(b);
x3=A*real(c);
subplot(3,1,1),plot(t,x1),title('F=10
hz');
subplot(3,1,2),plot(t,x2),title('F=20
hz');
subplot(3,1,3),plot(t,x3),title('F=30
hz');
```



Post Lab Tasks:

Critical Analysis/Conclusion:

In this lab I learnt about relational operators and the logical operators that returns one when the answer is true and zero otherwise. Different functions like ischar, isreal (tells whether array is real) etc. are used. Code is written in MATLAB using the script file or the function file. Loops like for and while are used to do a task repeatedly. If else statement is used to check the right statement. Discrete graphs can be plotted by using the stem command. Subplots command is used to show different graphs in the same window.