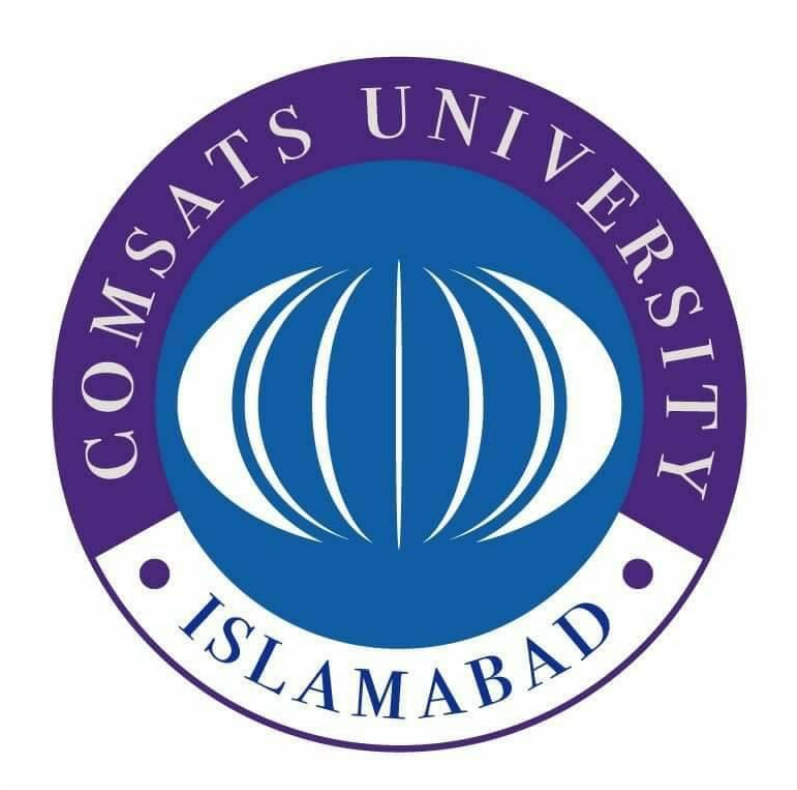

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LAB 2
Introduction to MATLAB: Signal Plotting and Basic Programming

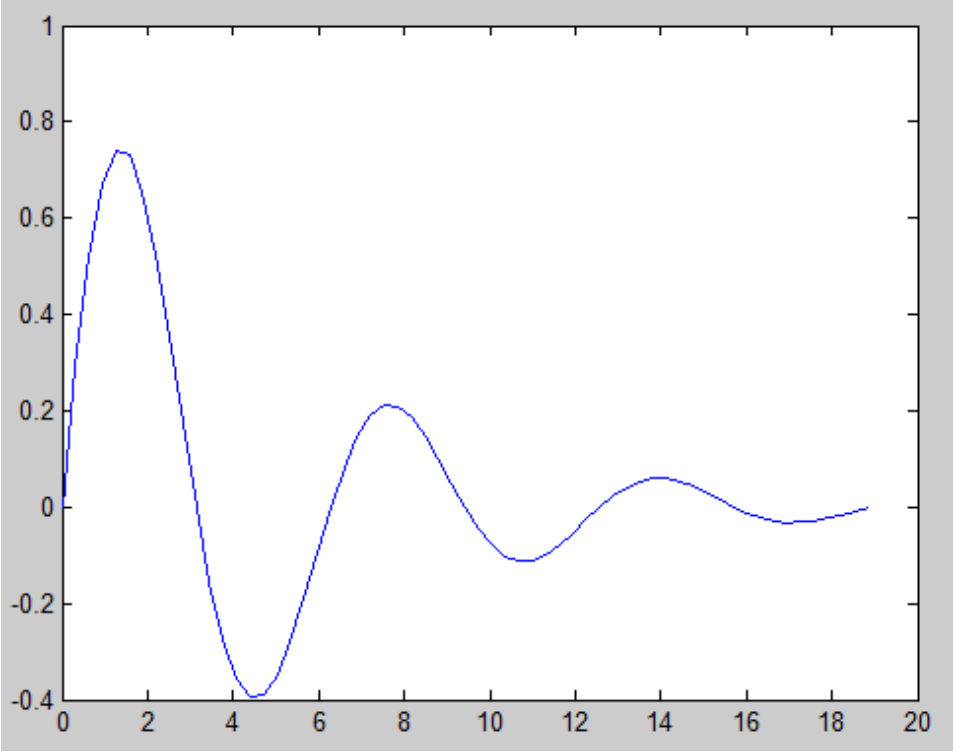
Task 1:

Plot a function $e\ {-0.2x}\ sin(x)$ between the interval 0 to 6π .

Script:

```
X=0:pi/10:6*pi;
Y=exp((-0.2).*X).*(sin(X));
plot(X,Y)
```

Plot:



Task 2:

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.

Script:

```
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)

 a = length(y)-length(x)

 x = [x.zero(a)]

end

z = x+ y
```

Command Window:

```
>> A=[ 5 6 7 8 ]

A =

     5     6     7     8

>> B = [ 8 3 4 5 ]

B =

     8     3     4     5

>> TASK_2(A, B)

z =

    13     9    11    13
```

Task 3:

Write MATLAB programs to find the following with for loops and vectorization. Time both versions in each case.

a) $1^2 + 2^2 + 3^2 + 4^2 + \cdots + 1000^2$

- Using Loops:

Script:

```
tic
s=0;
for n=1:1000
s=1+n^2;
end
s
toc
```

Command Window:

```
>> TASK_3_A_1

s =

     1000001

Elapsed time is 0.000731 seconds.
```

- Using Vectorization:

Script:

```
tic
s=0;
n=1:1000
s=sum(n.^2);
s
```

toc

Command Window:

```
s =

   333833500

Elapsed time is 0.006224 seconds.
```

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

- Using Loops:

Script:

tic

s=0;

for n=1:1003

s=s+(-1^n+1/2*n-1);

end

s

toc

Command Window:

```
s =

      249747

Elapsed time is 0.004513 seconds.
```

- Using Vectorization:

Script:

tic

s=0;

n=1:1003

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

Command Window:

```
s =

      249747

Elapsed time is 0.009949 seconds.
```

Task 4:

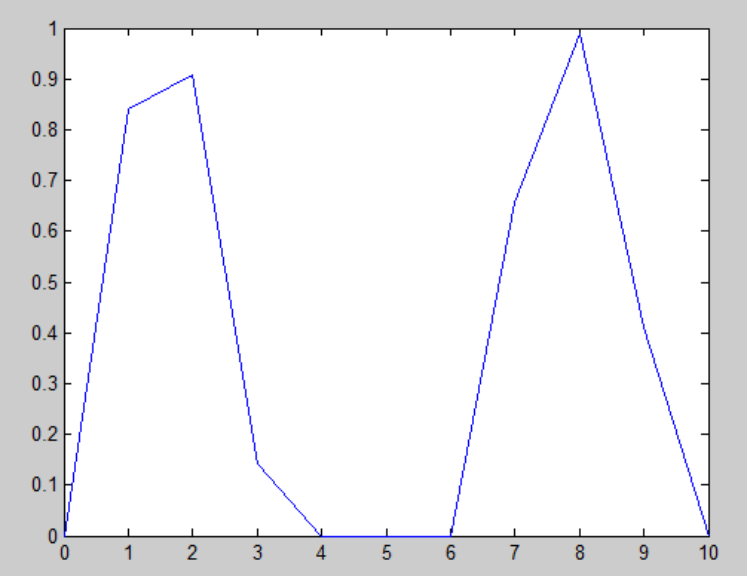
Graph the following function in MATLAB over the range of 0 to 10.

$$y(x) = \begin{cases} sin(x), & (sin(x) > 0) \\ 0, & (sin(x) \leq 0) \end{cases}$$

Script:

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

Plot:



Task 5:

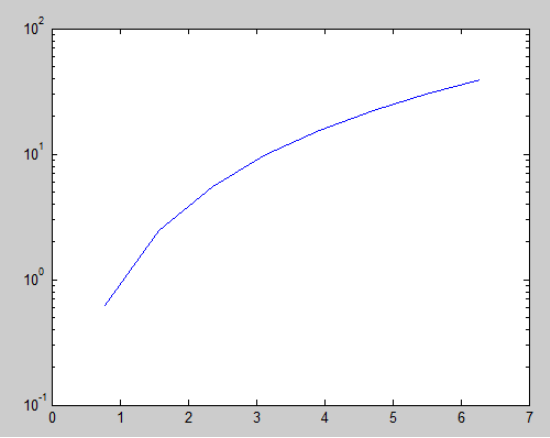
Use the semi log graph to graph x^2 , x^3 , x^4 *and* ex^2 over the interval of $0 \leq x \leq 2\pi$.

a) x^2:

Script:

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

Plot:

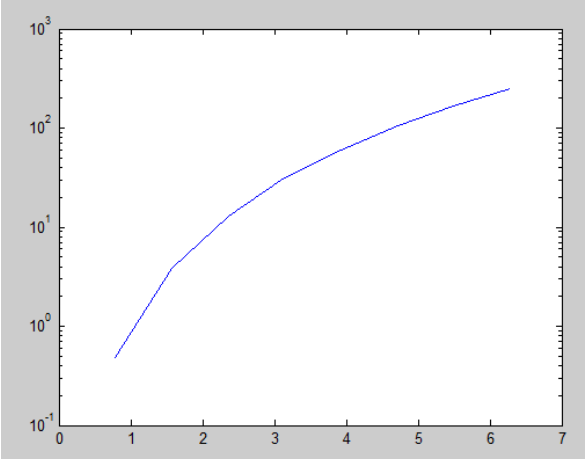


b) x^3

Script:

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

Plot:

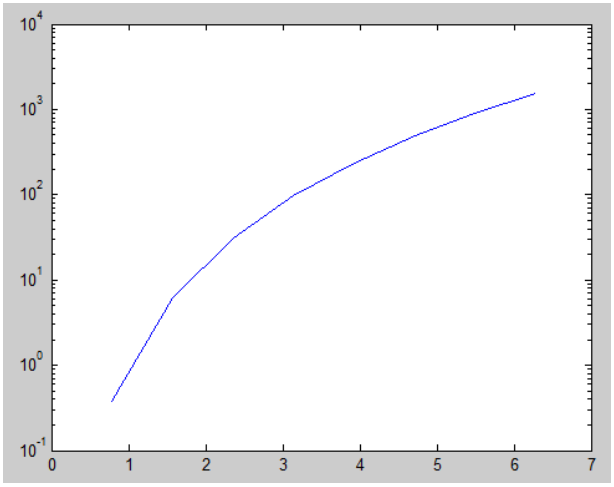


c) x^4

Script:

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

Plot:

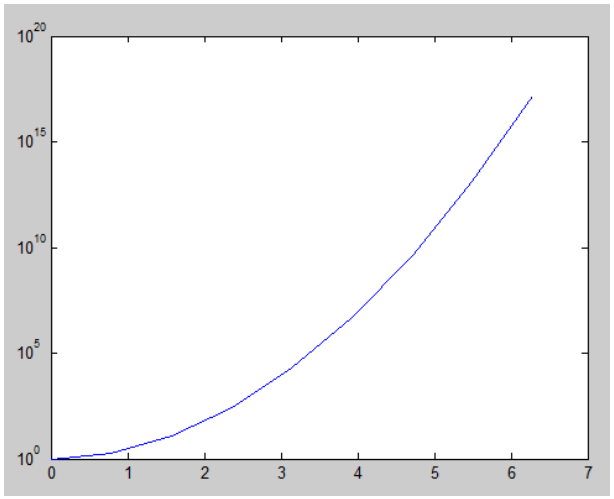


d) e^x^2

Script:

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

Plot:



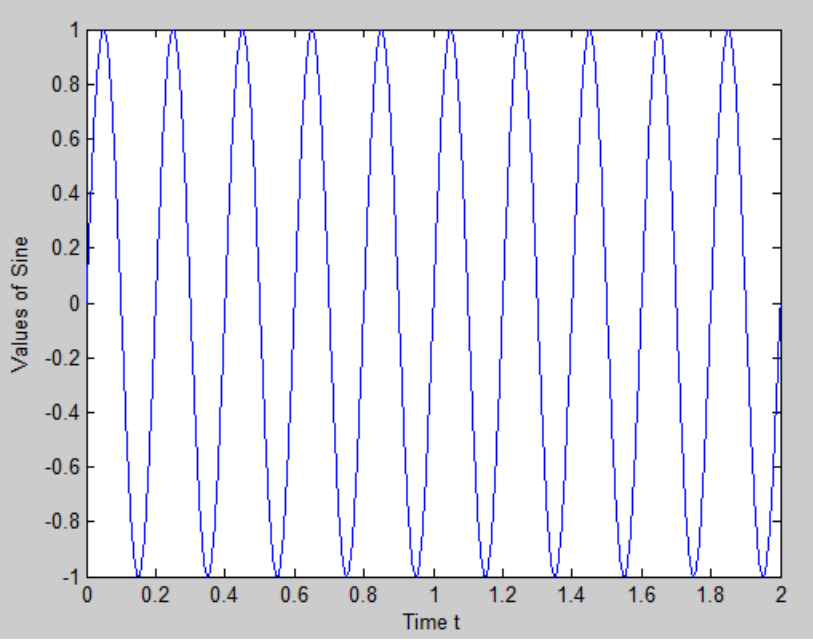
Task 6:

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.

Script:

```
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');
```

Plot:



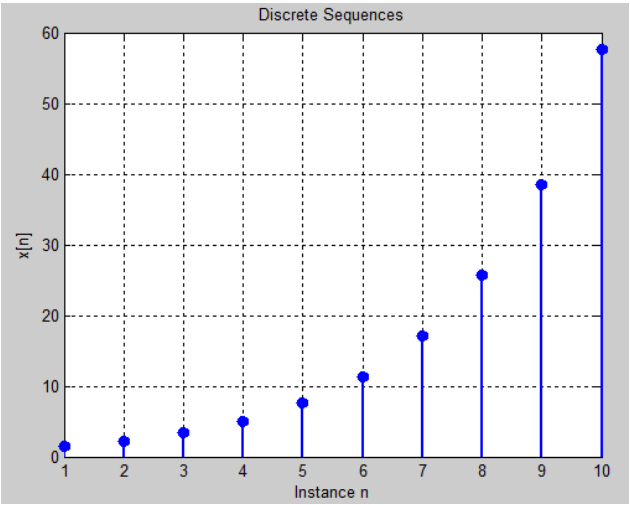
Task 7: Plot the following discrete sequences

a. $x[n] = \alpha\, n\ 0 \leq n \leq 10, \alpha = 1.$

Script:

```
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');
```

Plot:



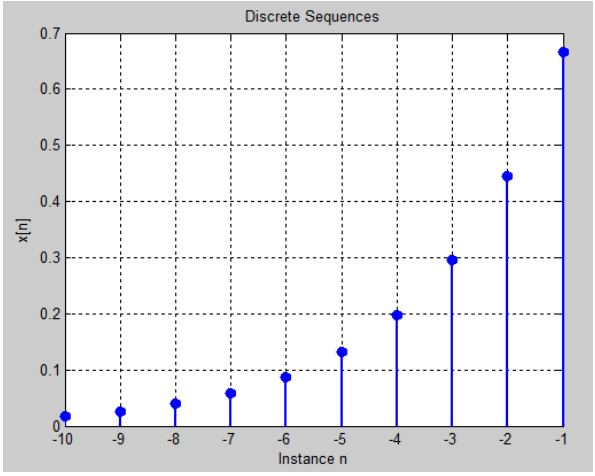
b. $x[n] = \beta\, n - 10 \leq n \leq -1, \beta = 1.5.$

Script:

```
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');

Plot:



c. $x[n] = \gamma\, n\ 0 \leq n \leq 10, \gamma = 0.5$

Script:

n=0:10;

y=0.5;

x=y.^n;

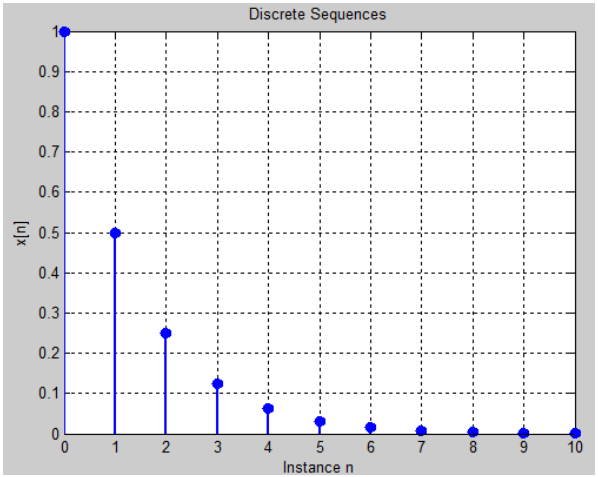
stem(n,x,'fill','linewidth',2),grid on

xlabel('Instance n');

ylabel('x[n]');

title('Discrete Sequences');

Plot:

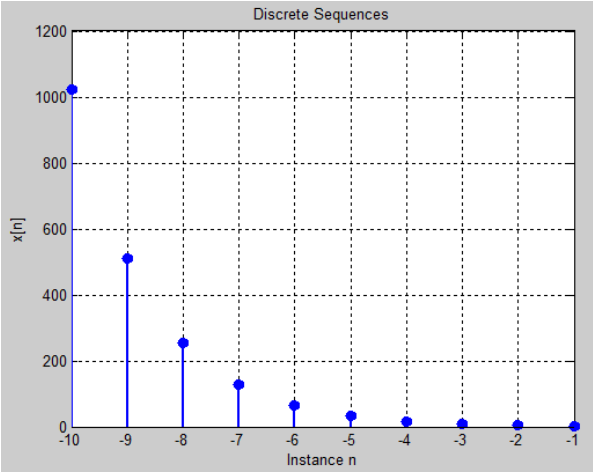


d. $x[n] = \varphi\, n - 10 \leq n \leq -1, \varphi = 0.5$

Script:

```
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');
```

Plot:



Task 8:

$x(t) = A\, \mathbb{R}\{e\, j(\omega 0t+\varphi)\}$

Where A = 1, f0 = 10 Hz, $\varphi = 0$

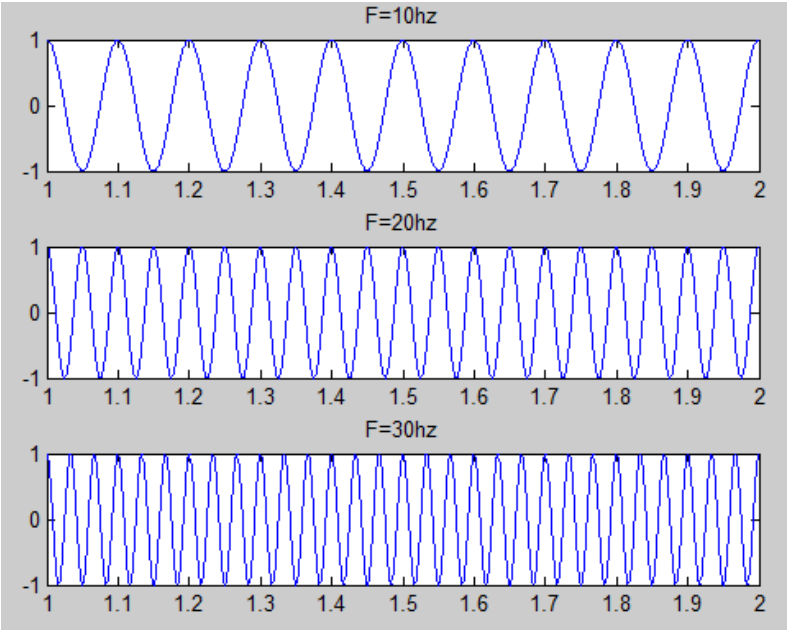
Plot the second and third harmonics of the above sinusoid. Use SUBPLOT command for drawing in the same manner as in previous question. After plotting explain the relation of fundamental Time period and harmonics Time period clearly. Your answer should corroborate the graphs drawn.

Script:

```
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=10hz');
subplot(3,1,2),plot(t,x2),title('F=20hz');
subplot(3,1,3),plot(t,x3),title('F=30hz');
```

Plot:



Answer.

The plot of the fundamental, second, and third harmonics shows that as the harmonic number increases, the oscillation frequency increases and the time period decreases. This means that higher harmonics oscillate more frequently within the same time span compared to the fundamental.

Post Lab Tasks:

Critical Analysis/Conclusion:

This lab introduced us to MATLAB for plotting signals and basic programming. We learned to visualize mathematical functions, create custom functions, and compare loop-based and vectorized computations. Vectorization was faster and more efficient, especially for large datasets. We also explored discrete sequences and saw how powers and exponentials affect signals. By plotting harmonics, we understood the relationship between the fundamental frequency and higher harmonics.