Introduction to MATLAB

Signals and Systems: Lab 1

Muhammad Usman

February 9, 2018

Contents

1 Lab Task 1 : Vectors in MATLAB

1.1 The Colon Operator

- a = 0 : 6
  Prints 0 to 6 through step 1.
  0, 1, 2, 3, 4, 5, 6
- b = 2 : 4 : 17
  Prints 2 to 17 through step 4.
  2, 6, 10, 14, 18
- c = 99 : -1 : 88
  Prints 99 to 88 through step -1
  99, 98, 97, 96, 95, 94, 93, 92, 91, 90, 89, 88
- d = 2 : $\frac{1}{9}$: 4
  Prints 2 to 4 through step $\frac{1}{9}$
- e = π * [0:0.1:2];
  Prints 0 to 2π through step $\frac{\pi}{10}$

1.2 Vector Insertion and Extraction

1.2.1 MATLAB Code

```
f = [ zeros(1,3), linspace(0,1,5), ones(1,4) ]
f(4:6)
size(f)
length(f)
f(2:2:length(f))
```

1.2.2 MATLAB Output

```
f =

  Columns 1 through 9

         0         0         0         0    0.2500    0.5000    0.7500    1.0000    1.0000

  Columns 10 through 12

    1.0000    1.0000    1.0000

ans =

         0    0.2500    0.5000
```

```
ans =

     1    12

ans =

         0         0    0.5000    1.0000    1.0000    1.0000
```

1.2.3 Interpretation

Output of all the four commands enlisted above can be interpreted respectively as

1. f = [zeros(1,3), linspace(0,1,5), ones(1,4)]
   It combines three row vectors as
   - zeros(1,3)
     A row vector of size 3, each element being zero.
   - linspace(0,1,5)
     An equally space vector of size 5, starting from 0 and ending at 1. Which computes to be a step of 0.25.
   - ones(1,4)
     A row vector of size 4, each element being one.
2. f(4:6)
   Extracts 4^{th}, 5^{th}, and 6^{th} element of the row vector *f*
3. size(f)
   Returns size of *f* as a *2 by 1* matrix representing number of rows and columns respectively.
4. length(f) Returns the length of the vector irrespective of the fact if it is a row or column vector.
5. f(2:2:length(f))
   Extracts every 2^{nd} element of vector *f*.

1.3 Assignments

1.3.1 Code

```
g = f; g(4:6) = pi*(1:3)
```

1.3.2 Output

```
g =

  Columns 1 through 9
```

```
         0         0         0    3.1416    6.2832    9.4248    0.7500    1.0000    1.0000

  Columns 10 through 12

    1.0000    1.0000    1.0000
```

1.3.3 Interpretation

The vector f has bee assigned to g and its 4^{th} to 6^{th} elements have been changed to multiples of π for 1 to 3 respectively.

2 Lab Task 2 : Vector Manipulation

2.1 π^π

Replacing even indices of f by π^π

2.1.1 MATLAB Code

```
g = f;
g(2:2:length(g)) = pi^pi
```

2.1.2 MATLAB Output

```
g =

  Columns 1 through 9

         0   36.4622         0   36.4622    0.2500   36.4622    0.7500   36.4622    1.0000

  Columns 10 through 12

   36.4622    1.0000   36.4622
```

2.2 The Cosine Problem

```
h = cos( pi*(0:11)/4 )
```

2.2.1 MATLAB Output

```
h =

  Columns 1 through 9

    1.0000    0.7071    0.0000   -0.7071   -1.0000   -0.7071   -0.0000    0.7071    1.0000

  Columns 10 through 12

    0.7071    0.0000   -0.7071
```

2.2.2 Interpretation

The command represents the function

$$h = \cos \frac{\pi}{4} x$$

for domain $x = \mathbb{Z}^+, x \leq 11$.

Note $h(0)$ is not defined in this case since MATLAB indices begin from 1.
Any such attempt result in output

```
Subscript indices must either be real positive integers or logicals.
```

3 Lab Task 3 : Vector as Functions

3.1 MATLAB Code

```
g = [ ];
g((-5:5)+6) = cos( (-5:5)*pi/3 ) ;
g
```

3.2 MATLAB Output

g =

0.5000 -0.5000 -1.0000 -0.5000 0.5000 1.0000 0.5000 -0.5000 -1.0000 -0.5000 0.5000

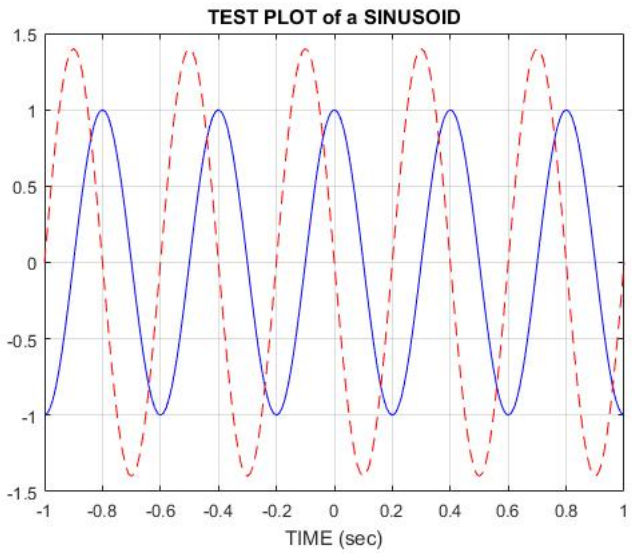
Note An integral addition of 6 was necessary to avoid negative indices which are not allowed in MATLAB.
The error response is same as that of Section 2.2 .

4 Lab Task 4 : Plotting Vectors

4.1 MATLAB Code

```
clc;
t = -1 : 0.01 : 1;
x = cos( 5*pi*t );
y = 1.4*exp(j*pi/2)*exp(j*5*pi*t);
plot( t, x, 'b-', t, real(y), 'r--' ), grid on
title('TEST PLOT of a SINUSOID')
xlabel('TIME (sec)')
```

4.2 MATLAB Output



4.3 Interpretation

The code attempts to plot two equations

$$x = \cos 5\pi t \quad y = \mathbb{R}\big(1.4e^{j\frac{\pi}{2}}e^{j5\pi t}\big)$$

where y can be simplified to be

$$y = 1.4 \sin 5\pi t$$

whose phase is zero and amplitude is *1.4* .

4.3.1 Graphical Analysis

Graphically it can be observed that the sine and cosine waves have amplitudes 1.4 and 1 respectively, and they are 90° out of phase.

5 Lab Task 5 : Algorithms on Vectors

Create a function *sigadd* to add two sequences x_1 and x_2. Function

$$[y, n] = sigadd(x1, n1, x2, n2)$$

Where x_1 and x_2 are two sequences and n_1 and n_2 are their respective indices vectors. Add values of x_1 and x_2 at corresponding indices, pad zeros if length of two sequences are not same.

5.1 MATLAB Code

```
function [ S ] = sig_add( X1, N1, X2, N2 )

S = zeros(1, max(max(N1), max(N2)));
for iteration = 1 : length(S)
    if (ismember(iteration, N1) && iteration <= length(X1))
        S(iteration) = S(iteration) + X1(iteration);
    end
    if (ismember(iteration, N2) && iteration <= length(X2))
        S(iteration) = S(iteration) + X2(iteration);
    end
end

end
```

5.2 MATLAB Output

```
>> X1

X1 =

    1.0000    1.6667    2.3333    3.0000    3.6667    4.3333    5.0000

>> N1

N1 =

     1     4     7    10

>> X2

X2 =

    1.0000    1.5000    2.0000    2.5000    3.0000    3.5000    4.0000    4.5000    5.0000
```

```
>> N2

N2 =

     1     3     5     7     9

>> sig_add(X1, N1, X2, N2)

ans =

     2     0     2     3     3     0     9     0     5     0
```