EEE 391 Basics of Signals and Systems
MATLAB Exercises

(with courtesy of Erdem Ulusoy who prepared this material)

1 Filling Arrays or Creating Signals in MATLAB

Create the following arrays or matrices in MATLAB without using any "for" loop:

- A 1×100 array consisting of all zero elements (Hint: Use the command **zeros**)
- A 10×12 matrix consisting of all ones (Hint: Use the command **ones**)
- 5×5 identity matrix (Hint: Use the command **eye**)
- A 1×100 array whose elements are $1, 2, 3, 4, \ldots, 99, 100$
- A 1×4 array whose elements are $7, 17, 27, 37$
- A 1×100 array whose elements are $3, 7, 11, 15, \ldots, 395, 399$
- A 1×100 time array **t** such that **t(1,1)**=0, **t(1,2)**=0.01, ..., **t(1,100)**=0.99
- A 1×100 array **x** such that **x(1,1)**=cos($2\pi 5 \times 0$), **x(1,2)**=cos($2\pi 5 \times 0.01$), ..., **x(1,10)**=cos($2\pi 5 \times 0.99$)

2 Functions with array inputs in MATLAB

Let **t** denote the time array whose elements are $-1, -0.999, -0.998, \ldots, -0.001, 0, 0.001, \ldots, 0.998, 0.999, 1$. Recall that we can create **t** by issuing the command **t** = [−1 : 0.001 : 1];. On this time grid, compute the values of the following functions without using any "for" loop. Use as few lines of code as you can.

- $x(t) = 1$
- $x(t) = 2t + 3$
- $x(t) = 3t^2 - 5t + 1$
- $x(t) = \frac{2t^2 - 4t + 1}{3t^3 - 2t^2 + 5t + 2}$
- $x(t) = 2\cos(2\pi 5t + 1)$
- $x(t) = \sin^3(2\pi 7t)$
- $x(t) = \cos^5(2\pi 2t^2)$

- $x(t) = 3\sin(2\pi\frac{4t+3}{2t^2+1}) - 4$
- $x(t) = \frac{2\cos\left(\sqrt{\frac{2|t|+1}{4t^2+1}}\right)}{3\sin^3(5t-2)+4}$
- $x(t) = e^{j2\pi 10t}$
- $x(t) = e^{j\pi 3t^2}$
- $x(t) = e^{-\frac{t^2}{2}}$
- $x(t) = e^{-|t|}$

3 Extracting Parts of a Matrix or an Array

Let $\mathbf{x}$= [x_1 x_2 x_3 x_4 ... x_{98} x_{99} x_{100}]. Prepare the following arrays using single-line commands: To test your codes, you may take $\mathbf{x}$= [1 2 3 ... 98 99 100].

- $\mathbf{y}$ = [x_{22} x_{23} x_{24} ... x_{55} x_{56}]
- $\mathbf{y}$ = [x_{61} x_{60} x_{59} ... x_{42} x_{41}]
- $\mathbf{y}$ = [x_2 x_4 x_6 ... x_{98} x_{100}]
- $\mathbf{y}$ = [x_1 x_3 x_5 ... x_{97} x_{99}]
- $\mathbf{y}$ = [x_{12} x_{19} x_{26} ... x_{75} x_{82}]
- $\mathbf{y}$ = [x_{97} x_{92} x_{87} ... x_{37} x_{32}]
- $\mathbf{y}$ = [x_1 0 0 0 x_2 0 0 0 x_3 0 0 0 ... x_{99} 0 0 0 x_{100} 0 0 0]
- $\mathbf{y}$ = [0 0 x_1 0 0 0 x_2 0 0 0 x_3 0 ... 0 0 x_{99} 0 0 0 x_{100} 0]
- $\mathbf{y}$ = [0 x_{100} 0 0 x_{99} 0 0 x_{98} 0 ... 0 x_2 0 0 x_1 0]
- $\mathbf{y}$ = [0 0 x_{42} 0 0 0 0 x_{46} 0 0 0 0 x_{50} 0 0 ... 0 0 x_{78} 0 0 0 0 x_{82} 0 0]
- $\mathbf{y}$ = [0 0 x_{95} 0 0 x_{91} 0 0 x_{87} ... 0 0 x_{39} 0 0 x_{35}]

4 Some Common Programming Mistakes

4.1

Suppose $\mathbf{x}$ of size 1×1000 represents a signal $x(t)$, and $\mathbf{y}$ of size 1×1000 represents a signal $y(t)$. Let $\mathbf{g}$ represent the signal $g(t)$ defined as $g(t) = x(t)\, y(t)$. The following code tries to compute $\mathbf{g}$ but it contains a mistake so that MATLAB gives an error message. Find the mistake. What is the message that MATLAB gives?

```
g=x*y
```

4.2

Suppose we have an image $x[m,n]$ that is stored in a matrix **x** of size 512×512. Let $y[m,n] = x^2[m,n]$. Now, we want to compute the matrix **y** which is again 512×512 and which contains $y[m,n]$. The following code tries to do it but it contains a mistake. What is the mistake?

```
y=x ^ 2
```

4.3

The following code tries to sum 100 complex sinusoids over a time array given by **t**. The frequencies are contained within an array named **omega** and the amplitudes are contained within **A**. However, it contains a bug. Find it.

```
MySum=zeros(size(t));
for j=1:100
MySum=MySum+A(j)*exp(j*omega(j)*t);
end
```

4.4

Suppose we have a 1×1000 array named **x** which consists only of zeroes and ones. Our purpose is to search the array from the beginning and set an alarm when the number of ones reach 10. The following code tries to do this but it contains a mistake. In particular, one line of code appears in a place where it should not be. Find that line and put it in the correct position so that the code works.

```
alarm=0;
index=0;
while(alarm==0)
count=0;
index=index+1;
if x(index)==1    count=count+1;    end
if count==10    alarm=1;    end
end
```

4.5

The following code tries to form a periodic signal $x(t)$ by adding the Fourier series components for $-10 \leq k \leq 10$. Suppose the coefficients are given within a 1×21 array whose name is **X**. However, the code contains a small programming mistake so that MATLAB gives an error message. Find that mistake. What is the error message that MATLAB gives?

```
x=zeros(size(t));
for k=-10:1:10
x=x+X(k)*exp(j*2*pi*k*t/T);
end
```