MATLAB EXERCISES

1. Matlab is a program for doing calculations and drawing graphs that makes extensive use of matrices. Type the following code into the command window

```
>> x=5
>> x=6;
>> x=
>> % x=7
>> x=
```

And then make use of the results to explain

a. The affect of the semicolon
b. What the percent sign does

2. Type the following code into the command window. And then make use of the results to explain the symbols. Determine, in particular, whether the argument of the cosine is in frequency or radians.

```
>> f1 = 2*3
>> f2 = 2^3
>> f3 = sqrt (10)
>> f4 = cos (2)
>> f5 = exp (2)
>> f6 = log10 (10)
>> f7 = log (10)
```

3. Type the following code into the command window

```
>> x = 0:3;
>> y = 2*x;
>> x =
>> y =
>> x(1) =
>> x(2) =
>> y(1) =
>> y(2) =
```

Then make use of your results to determine the following

a. What row vector is generated by x = 0 : 3
b. How is the vector y is related to the vector x
c. How is x(1) related to the vector x
d. How is x(2) related to the vector x

4. Type the following code into the command window

```
>> x = 0 : 0.2 : 0.6;
>> y = 2*x;
>> x =
>> y =
>> x(1) =
>> x(2) =
>> y(1) =
>> y(2) =
```

Then make use of your results to determine the following

a. What row vector is generated by $x = 0 : 0.2 : 0.6$
b. How is the vector y related to the vector x
c. How is x(1) related to the vector x
d. How is x(2) related to the vector x

5. Type the following code into the command window

```
>>  w = [1 2];
>>  x = [3 4];
>>  y = [w  x]
>>  z = [w ; x]
```

Then make use of your results to

a. Explain how the row vector y is related to w and x. Note that we refer to this as **concatenation**. Memorize this term.
b. Explain how z is related to w and x. What in particular is the affect of the semicolon

6. Type the following code into the command window

```
>>  x = 0 : 0.2 : 0.6;
>>  y=2*x;
>>  w = [x ; y]'
```

Then make use of your results to

a. Describe the result of the code
b. What in particular does the apostrophe do

7. Up to now we've been both writing and running our programs in the Command Window. It's actually more convenient to write them in what are called M-files. These files make it much easier to modify programs as well as run them with different parameters. To write, save and then run the following M-file

(1) Link Matlab with the location where you're going to be saving your M-files

(2) Go to *files*, choose *new* and then type in the following M-file

```
f=1000;  ph=1.2;  fs=2500;  Ts=1/fs;
n = 0 : 9;
x = 5*cos(2*pi*f*n*Ts + ph);
w = [n; x]'
```

(3) Save this M-file as sample1.m

(4) Run the M-file in the Command Window with

```
>>  sample1
```

Make use of your results to

a. Explain what this M-file is doing

8. Write and then run an M-file for obtaining the first 5 samples of $x(t) = 3\cos(2\pi 2000t - 1.4)$ sampled at $f_s = 6000$ samples/sec

9. Copy, save and then run the following M-file

```
A = 2;  ph = 1.2;  f = 1000;  T = 1/f;
```

```
t = 0: T/100: T;
x = A * cos (2*pi*f*t + ph);
plot (t, x)
grid;
title ('cosine'); xlabel ('t');  ylabel ('x(t)');
```

Then use your results to

a. Explain what this program is doing
b. What do the "grid", "title", "xlabel" and "ylabel" instructions do

10. Write and run an M-file to plot two periods of $x(t) = 2\cos(2\pi 100t) + 3\cos(2\pi 200t)$

11. Copy, save and then run the following M-file

```
A = 2;  ph = 1.2;  f = 1000;  fs = 10,000;  Ts = 1/fs;
n = 0: 10;
x = A * cos (2*pi*f*n*Ts + ph);
stem (n,x)
grid;
title ('sampled cosine'); xlabel ('n');  ylabel ('x[n]');
```

Then use your results to

a. Explain what this program is doing
b. What does the instruction "stem" do

12. Write and then run an M-file to make a stem plot of one period of the following sum of sinusoids $x(t) = 2\cos(2\pi 100t) + 3\cos(2\pi 200t)$

13. Copy and save the following M-file

```
function  samples(A, f, ph, N)
T = 1/f;
t = 0 : T/100 : N*T;
x = A * cos (2*pi*f*t + ph);
plot (t, x)
grid;
title ('cosine'); xlabel ('t');  ylabel ('x(t)');
end
```

And then run it in the Command Window with

```
samples(2, 1000, 0, 2)
```

How are Matlab functions different from "regular" M-files

14. Write and run your own example of a Matlab function

15. Copy and then run the following M-file for calculating the response of the following nonrecursive difference equation

$$y[n] = 0.7x[n] + 2x[n-1]$$

to a unit step for $n = 0$ to $n = 10$

```
b0 = 0.7;  b1 = 2;
%  x(1)=x[-1],  x(2)=x[0],  x(3)=x[1], . . . , x(12)=x[10]
```

```
%  y(1)=y[-1],  y(2)=y[0],  y(3)=y[1], . . . , y(12)=y[10]
x = ones (1, 12);
x(1) = 0;
for n = 2: 12
     y(n) = b0*x(n) + b1*x(n-1);
end
n = 1: 12;
w = [n-2; y]'
```

For this program
   a. What is x = ones (1, 12)
   b. Describe the syntax for the *for loop*

16. Copy and then run the following M-file for calculating the response of the following recursive difference equation

$$y[n] = 0.7y[n-1] + 2x[n] \qquad y[-1] = -0.5$$

to a unit step for $n = 0$ to $n = 10$

```
a1 = 0.7;  b0 = 2;
%  x(1)=x[-1],  x(2)=x[0],  x(3)=x[1], . . . , x(12)=x[10]
%  y(1)=y[-1],  y(2)=y[0],  y(3)=y[1], . . . , y(12)=y[10]
x = ones (1, 12);
x(1) = 0;
y(1) = -0.5
for n = 2: 12
     y(n) = a1*y(n-1) + b0*x(n);
end
n = 1: 12;
w = [n-2; y]'
```

Explain what's going on in this program

17. Write and run an M-file to calculate the response of the following difference equation

$$y[n] = 0.5y[n-1] + 1.5x[n] + 0.5x[n-1] \qquad y[-1] = 0.3$$

for $n = 0$ to $n = 10$

18. Write and run an M-file to calculate the response of the following difference equation

$$y[n] = 0.4y[n-2] + 0.9y[n-1] + 1.2x[n] \qquad y[-1] = 0.3$$

for $n = 0$ to $n = 10$

19. Copy and run the following M-file

```
x1 = ones(1, 10);   x2 = zeros(1, 10);
y = [x1 x2];
n = 0 : 19;
plot (n, y)
```

Describe what this program does and how it does it

20. Make use of the M-file in the last Investigation to plot three periods of a pulse train. Hint -

make use of a for loop

21. Copy the following M-file for obtaining a graph of the following frequency response

$$G(jf) = \frac{10000}{j2\pi f + 10000}$$

```
x = 0 : 0.1 : 5;
f = 10 ^ x;
G = abs(10^4/(j*2*pi*f + 10^4);
plot (x, G)
```

Based on the results

a. What does abs do
b. Is the indpendent axis plotted on a linear or log scale. How can you tell