Signals Systems and Transforms
EEET-332
Lab 1

Educational Objective:

Become familiar with MATLAB .m files, functions and row vectors.

For each section:

1) Create a new *.m or *.mlx file. Save it. (*.mlx are live code files that offer a more interactive experience)
2) Place ***init();*** on the first line of each file (except functions).

A quiz will be given at the beginning (1st 10 minutes) of the lab covering the content of the prelab. NO make-up quizzes will be given.

Prelab:

1) Open MATLAB and click the "New Script" button to create a new script file.
2) Enter the code below and save it using the function name as the file name (make_plot.m). Save the file in a folder that you plan to use during this lab.

```
function make_plot(x_data,y_data,graph_title,x_label,y_label,x2_data,y2_data,y2_marker)
  global fig_num;
  figure(fig_num);
  fig_num = fig_num + 1;

  plot(x_data,y_data);
  grid on;
  xlabel(x_label); ylabel(y_label);
  title(graph_title);
  if nargin==8
      hold on;
      plot(x2_data,y2_data,y2_marker);
  end
end
```

3) Repeat step 2 for init.m.

```
function init
  clc; close all;
  global fig_num
  fig_num = 1;
end
```

4) Research the following MATLAB commands: figure, plot, grid, xlabel and nargin.
5) Research "create arrays in MATLAB" and "arithmetic array operators in MATLAB". The correct array operation for addition is **+** and multiplication **.*** (note the period in front of the multiplication sign). Determine the correct operation for subtraction, division and power.

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Section 1:

1) Copy the function made in pre-lab (make_plot.m) into a directory you choose for lab.
2) Select the Editor ribbon and create a new script file and name it section1.m. If you want to use a different name, make sure your name does not use any spaces. The underscore is usually used instead of a space.
3) Place a call to init.m on the first line. This will be the first line of all scripts.

```
init();
```

4) Add code to create a row vector Vd and assign it values 0 and 0.8 in 0.02 increments.

```
Vd=0:0.02:0.8;
```

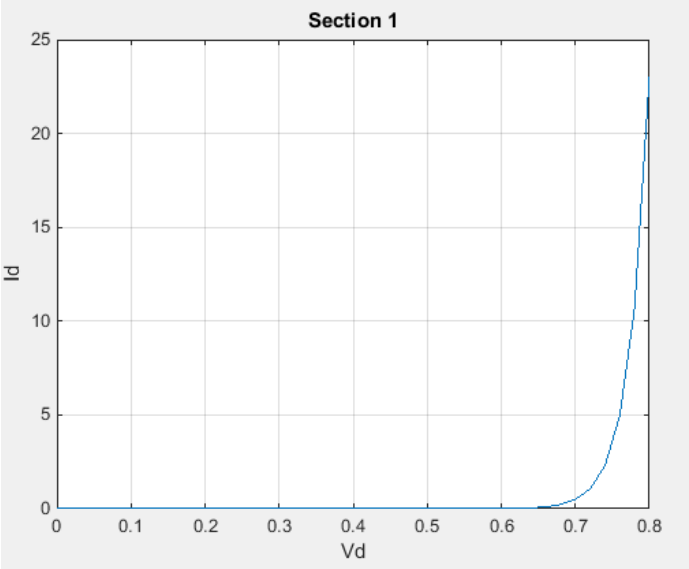
5) To create a plot of Shockley's equation, Id = Is*(exp(Vd/(n*Vt))-1) where Is = 1pA (enter as 1e-12 without units), n = 1, Vt = 26mV enter the code below, replacing the blanks with the proper code.

The make_plot function call only sends 5 parameters for a single plot.

6) In the section1.m script click the Run button in the Editor ribbon.

```
Is = 1e-__; n=1; Vt=0.026;
Id = ____*(exp(Vd/(n*Vt))-1);
make_plot(Vd,Id,'Section 1','Vd','Id');
```

7) Compare your plot to the next page and if correct, print.



Submit the plot of Shockley's equation.

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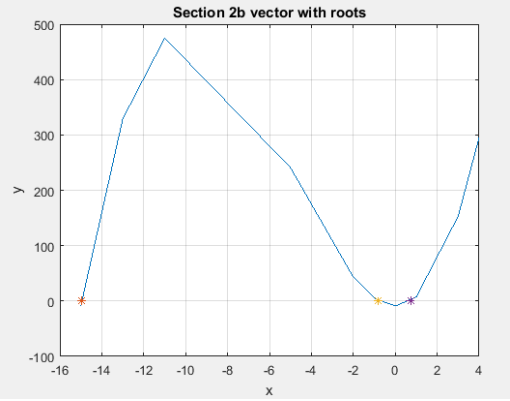
Section 2:

1) Close the previous script files and create a new script file. Choose a name and save the new script file. Place init(); on the first line.
2) Add the code below replacing the blanks using the information below.
   a) Create a row vector x with values -15 -13 -11 -5 -2 -1 0 1 3 4. *FOR HELP: search MATLAB help for "Empty Matrices, Scalars, and Vectors" and look at the Vector section. Remember row vectors are a single row matrix and are entered in brackets [ ].*
   b) Use poly2sym to create a symbolic expression for our function $y = x^3 + 15x^2 - 9$. See https://www.mathworks.com/help/symbolic/sym.poly2sym.html. Hint: You pass the coefficients to the function.
   c) Calculate $y = x^3 + 15x^2 - 9$ for each value of x using the "polyval(p,x)" function. In polyval "p" holds the coefficient and "x" is the input array. *FOR HELP: Type "help polyval" in the command window.*
   d) Calculate the roots of "p" using the roots command and assign them to a row vector "r". *FOR HELP: type "help roots" in the command window.*
   e) Plot the x,y data using the make_plot function. *Common problem: if your plot looks different check your p matrix. The polynomial y does not have an "x" term so a zero must be placed in p to hold its place.*
   f) With 8 arguments, the make_plot function uses "hold on" to put additional points on the graph.

```
init();
ysym=poly2sym([___________])
x=___________
p=___________
y=polyval(_________________
r=roots(___________________
make_plot(x,y,'Section 2b vector with roots', 'x' ,'y' ,r ,[0 0 0], '*');
```

3) Compare your plot to the one below and if correct print.

Note: semicolons are optional at the end of each line of code. If a line of code has semicolon, the results are not shown in the command window.



Submit the plot of the polynomial.

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Section 3:

1) Close the script file from the previous section.
2) Create a new script file and save it. Enter init() to the first line.
3) Create row vectors A, B that will generate the values shown below. If you need help creating row vectors, search MATLAB help for “Create Numeric Arrays” (as before). Run the script and verify A and B. Note: semicolons at the end of commands suppress display in the command window.
4) Create Btrans, the transpose B by using: Btrans = B’. Transpose makes the row into a column. Run the script and verify.
5) Create C = A.*B and verify the operation by hand, showing how the element-by-element multiplication works. Refer to https://www.mathworks.com/help/matlab/ref/times.html
6) Create Cmat = A*Btrans and verify the operation by hand, showing how the matrix multiplication produces a single number. Refer to https://www.mathworks.com/help/matlab/ref/mtimes.html.
7) Create Cerror = A*B. The error “Error using * Inner matrix dimensions must agree” is what you get when you try to do an element-by-element multiplication without the dot. Most of the calculations made in this lab are element-by-element using that requires the dot multiply, so this is a common error.
8) Run the remaining commands and verify all the results.
9) Get a sign-off.
10) Close the script.

```
A =
     1     2     3     4
B =
     2     4     6     8
Btrans =
     2
     4
     6
     8
C =
     2     8    18    32
Cmat =
     60
Cerror =
Error using  *
Inner matrix dimensions must agree.
```

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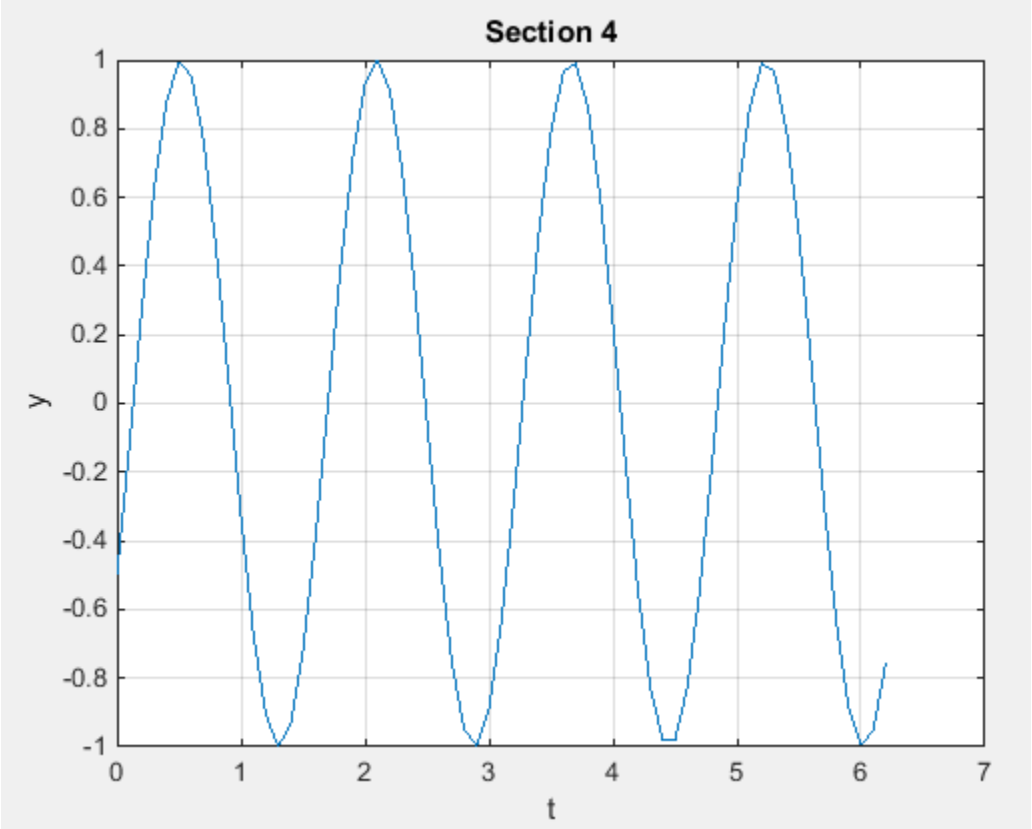
Section 4:

1) Create a new script file.
2) Create a vector t with values between 0 and 2*pi in 0.1 increments.
3) Let w=4
4) Generate y = (exp(1j*(w*t)) - exp(-1j*(w*t))) / (2j) with one change. Change the function so it has a -30 degree (pi/6) phase shift.
5) Use the make_plot.m function to plot the function.
6) Compare your plot to the one below and if correct, get a sign-off.



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Report:

Create your own cover page.

Submit your cover page, the requested prints (sections 1 and 2 only) and this sign-off sheet through MyCourses.

Recommendation: Learn the essentials of MATLAB through this free, two-hour self-paced MATLAB Tutorial. Google: MATLAB Onramp

Sign-offs

Name _____

Section 3: Transpose and element-by-element multiply

	/ /
Signature	Date

Section 4: Sine wave

	/ /
Signature	Date