ENGR 14100
MATLAB 2 ACT

Recall the guidelines for activities:

1. You should work as a team; **all** team members will be held responsible for all material.
2. You should work on this Task using one computer for the entire team unless otherwise directed.
3. The time estimate given is approximately three times the amount required for an experienced user to complete the task. If you are not making progress, take action to get unstuck.
4. Do not write on the activity sheets and be sure to return them at the end of class.

Task 1 (of 5)

Learning Objectives: Practice plotting data using MATLAB. Use colon operator to perform operations across values in an array.
Computer Operator: The person whose birthday is the closest to Flag Day.

Background:
The sine function is often utilized in engineering when making calculations to evaluate systems. Many approximations of the sine function have been found including the Taylor series approximation, which is indicated by the following equation, where Y approximates the value of sine and x is equal to the angle in Rad:

$$y = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!}$$

Using the colon and the dot operators, create a vector called X with values from -50 to 50 in increments of 0.1 and compute the values of Y. Plot the values of Y with respect to the values of X. Using the xlabel(), ylabel(), and title() functions, label the graph appropriately. Experiment with changing the color of the line to blue and the markers to squares.
Remember to start **all** your (main) **scripts** with a `clc` and `clear` command to remove any previously generated data/output such that your program is off to a fresh/clean start.

Save your script as:

`ML2_ACT_Task1_`*`login`*`.m`

Task 1 Files:

1) `ML2_ACT_Task1_`*`login`*`.m`

Task 2 (of 5)

Learning Objectives: Practice manipulating arrays and matrices and displaying results to screen.
Computer Operator: The person who has the most pencils in their backpack.

Background:
Consider the Maclaurin series expansion that approximates the exponential relationship with the following equations:

$$e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots, \ -50 < x < 50 \quad \text{Eq (1)}$$

$$e'^x = A * (1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots), \ -50 < x < 50 \quad \text{Eq (2)}$$

For the above equations build a vector named X from -50 to 50 in increment of 0.5. Then calculate the values of e^x and e'^x for this collection of values. Plot the values of these two functions for *n*=0 to 4 with the following formats:

1. For a value of A = 2, using only one figure, plot Eq (1) with a blue line and Eq (2) with a red line.
2. For a value of A = 5, using one figure, but with two different subplots in the same figure, plot Eq (1) in the top subplot and Eq (2) in the bottom subplot.
3. For a value of A = 10, using one figure, plot Eq (1) using a dotted line and Eq (2) with red circular markers.
4. For a value of A = 3, plot in one figure with 4 different subplots:
   a) Subplot 1 (located in top left corner) should be both Eq (1) and Eq (2) with blue and red lines respectively,
   b) Subplot 2 (located in top right corner) should be both Eq (1) and Eq (2) with blue triangular and red circular markers respectively.
   c) Subplot 3 (located in bottom left corner) plot ONLY Eq (1).
   d) Subplot 4 plot ONLY Eq (2).

For all plots above, appropriate labels should be included (no units are associated with these equations so you need not include them). For plots with more than one line plotted, use the function legend() to differentiate plots.

Save your script as:

`ML2_ACT_Task2_`*`login`*`.m`

Task 2 Files:

1) `ML2_ACT_Task2_`*`login`*`.m`

Task 3 (of 5)

Learning Objectives: Practice plotting functions and understanding plot resolution.
Computer Operator: The person who's backpack has the loudest colors.

Background:
Plotting functions in MATLAB are very useful to understanding the shape of the function. However, plotting a function requires proper use of step spacing to fully grasp what the shape of the plot is. Consider the sine function again; instead of using the approximation used in task 1, use the `sin()` function built into MATLAB to plot data.

1. Write a script that plots a sine wave from x = 0 to x = 10 at every 2 units of x.
2. Add a new section (use %%) and plot the sine wave again from x = 0 to x = 10 to the same figure (no subplot). This time at every 1 unit of x.
3. Add yet another section and plot the sine wave at every .01 units of x.
4. Make sure to use different colors for each plot.

Answer the following questions:

1) What are the differences between the plots?
2) What is an appropriate step size to plot the sine wave shape "accurately"?
3) When is it appropriate to choose a lower resolution?

Save your response to these questions to `ML2_ACT_`*`login`*`.pdf`.

Save your script as:

`ML2_ACT_Task3_`*`login`*`.m`

Task 3 Files:
1) `ML2_ACT_`*`login`*`.pdf`
2) `ML2_ACT_Task3_`*`login`*`.m`

Task 4 (of 5)

Learning Objectives: Practice plotting using the histogram and random capabilities of MATLAB
Computer Operator: The person who last went to a dining court.

Background:
Pseudo-random function generator algorithms are often used to simulate the probability of random events. One advantage of creating randomized data sets from computer algorithms is that they take a significantly shorter time to collect than a true random data set. These data sets can then be used to create predictive models and test systems for robustness.

Part A:
Write a MATLAB script that will simulate the rolling of 100 six sided dice and store it in a one-dimensional array. This can be achieved by calling `randi()` with appropriate parameter (check `help` doc). Think of it as: each roll of the die corresponds to an event that is recorded at index *i*.
Use the `histogram()` function to create a histogram of the results. Specify your number of bins appropriately (default is 10). Save a picture of the histogram in `ML2_ACT_`*`login`*`.pdf`.

Answer the following question:

1) What can you say about the "randomness" of the generator? Does the histogram look like what you expected if the experiment was performed with a (perfectly uniform) real die?

Save your response to `ML2_ACT_`*`login`*`.pdf`.

Part B:
Modify your MATLAB script to simulate rolling 100 sets of three six sided dice.
Hint: In Part A you generated an array (vector) of events for a single die. In MATLAB, how would you add the events of the three dice together without using loops?

Answer the following questions:

2) What is the difference between adding lists together in python to adding arrays together in MATLAB?
3) Of the two programs, which is easier to perform operations on large data sets?

Save your response to these questions to `ML2_ACT_`*`login`*`.pdf`.

Task 4 Files:
3) `ML2_ACT_`*`login`*`.pdf`
4) `ML2_ACT_Task4_`*`login`*`.m`

Task 5 (of 5)

Learning Objectives: Practice using data mapping with MATLAB.
Computer Operator: The team member who has traveled the most.

Background:
An important part of electrical engineering is printed circuit board (PCB) design. There are a number of design considerations concerning printed circuit boards, such as space, complexity, and cost. As a recently-hired intern at a robotics company, you have been asked to develop a board involving a small computer called a microcontroller. However, the same microcontroller is often sold in multiple "pin packages", with larger pin packages having more pins (and thus more inputs and flexibility) at the cost of size, complexity, and price. Develop a MATLAB function that requests input on whether to use an LQFP100, LQFP144, or LQFP176 pin package for the STM32F4Discovery microcontroller and outputs the corresponding pin package. The MATLAB function should receive an input of 1, 2, or 3 to determine the respective pin package. Think of it as a label maker with a dial input. It should be made sure that the full strings are returned and outputted to the console. Use a method other than the switch/case or if/else structures in order to develop this solution (i.e. build a matrix).

Answer the following questions:

1) In this context, explain the terminology 'map'.
2) What is a good way of storing such a map in MATLAB?
3) How would you change the function to use 0, 1, and 2 as inputs instead of 1, 2, and 3?
4) How does MATLAB differ from Python when using arrays / lists?

Save your responses to `ML2_ACT_`*`login`*`.pdf`.

Save your function as:

`ML2_ACT_Task5_`*`login`*`.m`

Task 5 Files:
5) `ML2_ACT_`*`login`*`.pdf`
6) `ML2_ACT_Task5_`*`login`*`.m`

Bonus Activity Submissions

Instructions: Complete and submit **ALL** Task materials associated with this Activity (see 'Submit Files' below). You are allowed to combine the work you and your team completed during the Activity with materials you individually (or as a team) complete outside of class. The Bonus Activity Submission will not be graded and returned to you like a typical assignment. Instead, it will be reviewed, and the bonus point awarded, for its completeness, i.e., for completing ALL the Tasks associated with the Activity. Submitting an incomplete Bonus Activity (something less than all of the Tasks) will be considered an act of **Academic Dishonesty** for which the penalty will be forfeiture of the opportunity to earn future Bonus Activity Submission points.

There are two options for completing the materials for the Bonus Activity Submission:

As an Individual: Combine the work you and your team completed in class with materials you have individually completed outside of class. When submitting an individual Bonus Activity Submission you will append your electric signature (i.e., your typed name) at the top of the file that represents your individual work. Your electronic signature indicates that this is your individual work and you have not collaborated with other individuals (other than the teaching team) to obtain the final materials being submitted – working with other individuals/groups (e.g., discussing ideas and concepts, helping find errors, talking about potential solutions to errors) is permissible up to the point where the work represents a coloration (i.e., working with another person or group to achieve an answer). Any work previously completed by your team should include each team member's electronic signature. The significance of an electronic signature by an individual for team work is stated below.

As a Team or Ad Hoc Group: Combine the work you and your team completed in class with materials your team (or ad hoc group) completed outside of class **(For the Bonus Activity Submission ONLY**: you are allowed to work with any other members of the class to complete the assignment). However, you should exercise care when appending your electronic signature to ensure you are in full compliance). When submitting a Bonus Activity that has been worked on as a team (or ad hoc group) each person will append his/her electronic signature (i.e., his/her typed name) at the top of the file that represents the collaborative work. The electronic signature of each individual implies he/she was an active participant in the preparation of the materials; and has a general understanding of **ALL** the materials being submitted. Even for work submitted as a team, each individual who wishes to receive credit must submit the team's file (with all appropriate signatures) to their own individual assignment drop box.

Submit Files: Submit *all* files electronically via Blackboard to the appropriate box on time.

1) `ML2_ACT_`*`login`*`.pdf`
2) `ML2_ACT_Task1_`*`login`*`.m`
3) `ML2_ACT_Task2_`*`login`*`.m`
4) `ML2_ACT_Task3_login.m`
5) `ML2_ACT_Task4_`*`login`*`.m`
6) `ML2_ACT_Task5_`*`login`*`.m`