General Instructions

<u>Due Date:</u> Sunday, September 18^{th}, 2022 by 11:59pm (submit via Zybooks)

Assignment Summary Instructions:
This assignment has one problem, summarized below. You will use MATLAB as a tool to solve the problem for the given test cases, ensuring that your code is flexible for any additional test cases that might be used to evaluate it.

- Arctic Ice Thickness (Application to Climate Change and Environmental Engineering)

zyBooks Submission Instructions:
After completing this assignment in MATLAB, to receive credit, you must submit your code in Zybooks. The following components must be submitted under the specified chapter of the course Zybooks before the deadline to receive credit.

- Chapter 31.1 MA2: Projection Function
- Chapter 31.2 MA2: Main Script

To submit your script, copy and paste your code into the submission window, making sure to remove any housekeeping commands. You may submit to Zybooks as many times as you want before the deadline, without any penalty. The highest score attained before the deadline will be graded. All components are due before the due date. No credit will be given if it is not submitted through the Zybooks platform before the deadline. Credit for each component will be awarded based upon the percentage of successfully completed assessments.

Explanation of P-Code:
Under the Additional Resources folder accompanying this prompt, you will find a file named **Projection_Solution.p**. This is a working solution to the Projection function required to complete this problem. This file is unopenable and the contents can't be read in a text editor, but it can be called like a typical .m function file in MATLAB. If you get stuck and are unable to successfully develop your own Projection function, you are encouraged to instead copy Projection_Solution.p to your working folder and rename it **Projection.p**. Now, when your main script calls the Projection function, it will automatically call the .p file and you will now have an opportunity to successfully finish developing your main script.

Proficiency Time: Times are included with the Background and Task sections. These times are the estimated amount of time it should take you to **redo** an assignment once you are fully proficient in material that it covers. To practice, reread the background in the given Comprehension Time and attempt to complete the problem in the given Proficiency Time.

Academic Honesty Reminder

The work you submit for this assignment should be your work alone. You are encouraged to support one another through collaboration in brainstorming approaches to the problem and troubleshooting. In this capacity, you are permitted to view other students' solutions, however, copying of another student's work is strongly discouraged.

This assignment will be checked for similarity using a MATLAB code. The similarity code will check each submission for likeness between other student submissions, past student submissions, the solution manual, and online resources and postings. If your submission is flagged for an unreasonably high level of similarity, it will be reviewed by the ENGI 1331 faculty, and action will be taken by faculty if deemed appropriate.

NOTE: Since this is an automated system for all sections, if any of your work is not your own, you will be caught. Changing variable names, adding comments, or spacing will not trick the similarity algorithm.

Background: Comprehension Time: 10 – 15 min

In order to study the effects of climate change on the Arctic ice sheet, a team of scientists have collected ice thickness data across several locations.

Some examples of these efforts in practice can be found at the following link.

- Polar Portal: Monitoring Ice and Climate in the Arctic
  - http://polarportal.dk/en/sea-ice-and-icebergs/sea-ice-thickness-and-volume/
- Polar Science Center
  - http://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/
- National Snow and Ice Data Center (NSIDC)
  - https://nsidc.org/cryosphere/sotc/sea_ice.html

You are given this assignment and must write a code that will support these efforts and provide basic data statistics of a provided matrix named **Ice**. The matrix contains the thickness of the ice [meters] measured at various locations across several days, with each row representing a different day and each column representing a different location. A string array named **LocationID** contains the names of those locations and a vector named **Days** contains the day number that the measurement was taken. Due to weather conditions, it was not possible to take measurements in consecutive days.

NOTE: The number of rows in **Ice** is equal to the number of different days provided in **Days** and the number of columns in **Ice** is equal to the number of different locations given in **LocationID**. See the tables below for a visual representation. All data provided is within **MA2_data.mat**. You will need to load in this .mat file in order to achieve the tasks below.

LocationID

Days	NW102	SE221	WSW324	ESE020	NNW011
1	2.147	2.187	1.86	2.093	3.08
2	2.933	0.213	2.6	1.46	1.253
5	2.12	3.06	0.793	2.513	1.847
6	1.8	1.74	0.313	0.033	0.407
8	2.247	2.32	1.06	1.507	2.207
10	0.28	2.42	0.767	2.393	0.293
12	0.733	0.353	0.94	0.273	1.173
16	2.807	2.267	1.32	2.62	0.093
24	2.187	1.947	2.373	1.913	2.313
25	1.707	1.327	3.333	1.047	0.66
26	1.58	0.667	1.447	0.46	3.02
32	2.087	3.147	2.973	2.113	3.12
35	2.027	0.193	2.267	2.7	2.033
50	3.033	1.633	2.513	3.207	2.14
52	1.12	1.853	1.147	1.853	0.22
60	0.313	2.053	1.727	0.28	0.08

Ice

Tasks: Proficiency Time: 1 hr 15 min – 1 hr 50 min

TASK 1: (2 – 5 min)
Load in **MA2_data.mat**. Prompt the user to select a day and a location based on the data provided. On the command window, output the day, location, and ice thickness [m] for that day.

NOTE (avoid hardcoding): Your code should produce different results if the data for **Ice** changes. The options for the location or day chosen should change if the number of values in **LocationID** or **Days** changes.

TASK 2: (25 – 35 min)
Five(5) days after the last day of previously recorded data, your field team collects additional data. Prompt the user to enter the ice thickness data for this day for all locations. Update the **Days** vector with the new day and the **Ice** matrix with the newly recorded data. Additionally, on this day a new location was found and recorded. Prompt the user to enter the new location ID and the ice data for the new location on this day. Since your field team does not have past data for the ice thickness at the new location, you assume that the ice thickness at the new location is the average of the other locations' ice thickness for each day previously recorded. Update the **LocationID** string array with the new location, and the **Ice** matrix with the newly recorded data. Add a new column to the end of the **Ice** matrix corresponding to the new location and fill in this column of the **Ice** matrix with the average ice thickness for each of the previously recorded days and the user-inputted ice data value for the new location on the new day. Save the three updated variables as **MA2_Task2.mat**. On the command window, output the new location ID and the average ice thickness of the new day.

NOTE (avoid hardcoding): Your code should produce different results if the data in **Ice** changes or if the size of **Ice** changes (rows or columns). The final lengths of **LocationID** or **Days** should change if their starting lengths change.

TASK 3: (25 – 35 min)
Using the **updated data** from Task 2, determine the number of locations and total number of measurements taken. Output these two values to the command window. Then calculate and output to the command window the following:

- The location with the highest average ice thickness with the calculated value
- The maximum overall ice thickness measurement with the associated location and day
- The overall average ice thickness

NOTE (avoid hardcoding): Your code should produce different results if **Ice** changes. The day and location ID should be indexed from the **Days** and **LocationID** variables based on the position of the value found in the **Ice** matrix.

TASK 4: (20 – 30 min)
Prompt the user to enter a projected percent reduction in artic ice thickness a year after the last recorded day (0 – 100%). Create a user-defined function named **Projection.m.** In the function**,** determine the projected ice thickness a year after the last recorded day for each location. This function will have two inputs (projected percent reduction, updated ice data from Task 2) and one output (vector of projected ice thicknesses for each location). In your main script, append the projected ice thicknesses to the **Ice** matrix and save that new matrix as **MA2_Task4.csv**.

TASK 5: (3 – 5 min)
Prompt the user to select a location ID, and graphically show the ice thickness for all recorded days. Do not include the projected thickness. Your plot must include the following formatting:

- Title (the Location ID shown in the sample output is not required)
- X-axis label
- Y-axis label
- Gridlines
- Shown as experimental data (scatter plot)

NOTE (avoid hardcoding): Your code should produce different plots if the data for **Ice** changes. The number of days in your updated **Days** vector should equal the number of points on the graph. For an added challenge, have the Location ID automatically update in the title if a different location is chosen from the menu (not required).

Sample Output:

Sample output for given data:

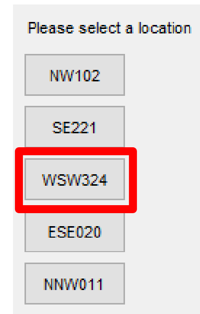
- Expected exported files are given below. Note the different file types of the exported files.
- Additional test case scenarios are described in the Additional Resources folder accompanying this prompt.

Sample Output to Command Window

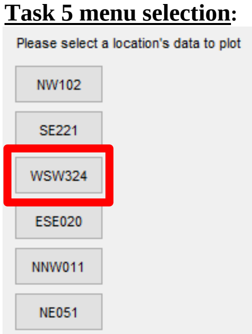
Command Window

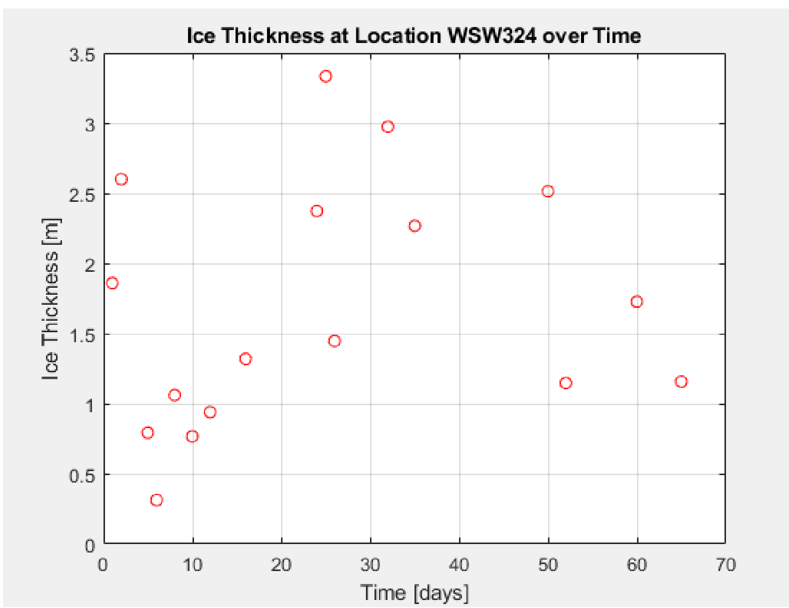
```
On Day 16, at location WSW324, the ice thickness was 1.320 [m].

Enter ice thickness data for 5 days after the last recorded day, as a vector:
[0.665 1.853 1.157 0.689 0.245]
A new location was found. Enter an ID for it: NE051
Enter ice thickness for the new day at the new location: 1.68

The new location ID is NE051
The average ice thickness of the newly recorded day is 1.048.

There are 6 locations and a total of 102 measurements in the data.
The highest average ice thickness is 1.752 [m], which occurs at location NW102
The maximum overall thickness is 3.333, which occurs on Day 25 at location WSW324
The overall average ice thickness is 1.642.

Enter a projected percent reduction rate [0 - 100%]: 35
Projected ice thicknesses calculated. See MA2_Task4.csv.>>
```

Task 1 menu selections:



Task 5 menu selection:





Sample Output for Exported Files

MA2_Task2.mat:

	1	2	3	4	5	6
1	NW102	SE221	WSW324	ESE020	NNW011	NE051

	1
1	1
2	2
3	5
4	6
5	8
6	10
7	12
8	16
9	24
10	25
11	26
12	32
13	35
14	50
15	52
16	60
17	65

	1	2	3	4	5	6
1	2.1467	2.1867	1.8600	2.0933	3.0800	2.2733
2	2.9333	0.2133	2.6000	1.4600	1.2533	1.6920
3	2.1200	3.0600	0.7933	2.5133	1.8467	2.0667
4	1.8000	1.7400	0.3133	0.0333	0.4067	0.8587
5	2.2467	2.3200	1.0600	1.5067	2.2067	1.8680
6	0.2800	2.4200	0.7667	2.3933	0.2933	1.2307
7	0.7333	0.3533	0.9400	0.2733	1.1733	0.6947
8	2.8067	2.2667	1.3200	2.6200	0.0933	1.8213
9	2.1867	1.9467	2.3733	1.9133	2.3133	2.1467
10	1.7067	1.3267	3.3333	1.0467	0.6600	1.6147
11	1.5800	0.6667	1.4467	0.4600	3.0200	1.4347
12	2.0867	3.1467	2.9733	2.1133	3.1200	2.6880
13	2.0267	0.1933	2.2667	2.7000	2.0333	1.8440
14	3.0333	1.6333	2.5133	3.2067	2.1400	2.5053
15	1.1200	1.8533	1.1467	1.8533	0.2200	1.2387
16	0.3133	2.0533	1.7267	0.2800	0.0800	0.8907
17	0.6650	1.8530	1.1570	0.6890	0.2450	1.6800

MA2_Task4.csv: (note that only the last row should differ from the exported matrix in Task 2)

14	3.0333	1.6333	2.5133	3.2067	2.1400	2.5053
15	1.1200	1.8533	1.1467	1.8533	0.2200	1.2387
16	0.3133	2.0533	1.7267	0.2800	0.0800	0.8907
17	0.6650	1.8530	1.1570	0.6890	0.2450	1.6800
18	0.4323	1.2045	0.7521	0.4478	0.1593	1.0920