MA #1 Guide

Overall Goal: Determine how much energy must be removed to cool various pieces of metal. Then, determine how much cooling liquid is required to achieve the desired cooling. You will practice your knowledge of variables, vectors, matrices, indexing, menus, and plotting while completing this MA.

The proficiency times on the MA assignment is the amount of time it should take you to complete the task *after* you are an expert. Use these as target goal times when you are reviewing the material. The first time completing the MA it will likely take you longer.

MA Requirements:

Algorithm: Submitted to Blackboard
MATLAB Code: Submitted to Zybooks

Task 1: Main Script – Load data and analyze based on user inputs

- Load the data in the file: CoolingLiquid.csv
- Prompt the user to enter information about a part that needs to be cooled:
  - Prompt for a material name
  - Prompt the user to enter a specific heat in units of $\left[\frac{J}{g\cdot ℃}\right]$
  - Prompt the user to enter the mass in units of $[g]$
- Based on the user entries calculate the heat that must be removed (Q) **and** the cooling liquid volume in **gallons** that is needed to cool the part from 300 ℃ to 50 ℃. Pay attention to units!
  - HINT: Thermal energy equation: $Q = mC_p\Delta T$
  - HINT: The density equation ($density = \frac{mass}{volume}$) allows you to convert between mass and volume. Remember how to use specific gravity from class!
  - HINT: The thermal energy (Q) lost by the cooling rod = thermal energy gained by the cooling liquid
  - HINT: The information you need about the cooling liquid to calculate Q is located in the data you loaded. To avoid hardcoding, you must **index** the appropriate values.
- Output the value for Q (absolute value) **and** cooling liquid volume to the command window

Task 2: Main Script – Load data and analyze a data set

- Load the variables contained in MA1_data.mat
- Using a similar approach to Task 1, calculate the thermal energy (Q) that must be removed to cool each of the metals in the table from 300 ℃ to 50 ℃ **and** the required cooling liquid volume
  - HINT: Use your knowledge of matrix and vector operations to complete the necessary calculations for all the metals at once!
- Create a matrix that summarizes your calculations. The matrix should be organized as shown below **and** include the data from Task 1 as the last row. Check your work with the sample output!

Heat capacity	Mass	Thermal energy	Volume of cooling liquid

- Add the material name from Task 1 to the end of the Materials string array
- Export the updated Materials string array **and** your data matrix in **MA1_Task2.mat**.
- Output to the command window the total number of materials in the Materials variable.

Task 3: Main Script – Analyze a part made of two materials

- You are now analyzing the cooling of a part that is made of two materials (an alloy)
- Use a menu to prompt the user to select the first material
- Delete the user selection from the menu and the data so they cannot re-select the same material
    - Warning: You will need the data about the first material later in the task!
- Use a menu to prompt the user to select the second material.
- Based on the user entries output to the command window the Cp of the alloy **and** the required cooling liquid volume
    - The Cp of the alloy is the **average** Cp of the selected materials
    - The required volume is the **sum** of the individual volumes for each material found in Task 2

Task 4: Main Script – Plotting

- Plot your results from Task 2. Your plots must include: title, axis labels gridlines, and data as individual points
- Plot 1: **x-axis:** Mass; **y-axis:** Thermal Energy
- Plot 2: **x-axis:** Mass; **y-axis:** Cooling Liquid Volume

Task 4: Main Script – Plot and determine where user-inputted data would fall on the stress-strain curve

- Prompt the user to enter how many test measurements will be entered
- Prompt the user to enter [stress, strain] data for each measurement. HINT: *while* loop or *for* loop? *Why?*
    - The number of times you prompt the user should equal the number of measurements that are being entered
    - Each prompt should include the measurement # (see MA sample output for reference)
    - Each measurement should be saved
- Plot the new data points as individual measurements
- Determine and **create a table** displaying:
    - If the material is in the **plastic** or **elastic** region of the plot
      If the measurement is to the left of the yield strength, the sample is in the elastic region. Otherwise, it is in the plastic region.

    - If it is **Irregular** or **Nominal** quality according to the following criteria:
      If the measurement falls between (theoretical stress + 5%) or (theoretical stress – 5%) for the same x-value, the sample is nominal. Otherwise, it is irregular.

        - HINT: If a test measurement on the line (boundary), the sample is the first of the two options given. For example, a sample with a test measurement at the yield strength is considered elastic.
    - HINT: A video tutorial for creating a table is posted to Blackboard in the MA #6 Folder where you downloaded this guide.

```
Stress [MPa]   Strain [%]   Region     Quality
1.50           0.25         Elastic    Irregular
2.00           0.50         Elastic    Nominal
3.00           1.50         Plastic    Irregular
3.00           3.00         Plastic    Nominal
3.00           7.00         Plastic    Nominal>>
```