Week 2 Homework Assignments: MATLAB Fundamentals

Global Requirements

- All deliverables shall be added, committed, and pushed to your `Week02` folder in your repository.
- At the **top** of each `.m` file, please include: `matlab % Student: Firstname Lastname % Assisted by: first person, second person, etc. clc; clear;`

---

1. Matrix Arithmetic

Instructions

Write a MATLAB script that performs basic matrix and vector arithmetic.

Script Name: `matrixOperations.m`

Objectives:

- Practice element-wise operations, matrix addition, subtraction, and scalar multiplication.
- Use either `disp` or `fprintf` to show your results

Steps:

1. **Initialize a Matrix**:
   - Create a 3x3 matrix `A` where each element is a number between 1 and 9:
     `A = [1, 2, 3; 4, 5, 6; 7, 8, 9];`
   - Create another 3x3 matrix `B` where each element is a number between 9 and 1:
     `B = [9, 8, 7; 6, 5, 4; 3, 2, 1];`
2. **Matrix Addition**:
   - Add matrices `A` and `B` and store the result in a new matrix `C`.
   - Display `C` with a clear label (e.g., `disp('Matrix C:')`, `disp(C)` or use `fprintf`).
3. **Matrix Subtraction**:
   - Subtract `B` from `A` and store the result in a new matrix `D`.
   - Display `D`
4. **Element-wise Multiplication**:
   - Multiply `A` and `B` element by element (use the `.*`) and store the result in `E`.
   - Display `E`
5. **Matrix Scalar Multiplication**:
   - Multiply matrix `A` by a scalar value (for example, 2) and store the result in `F`.
   - Display `F`

Deliverables

1. `matrixOperations.m` containing all of the above steps.
2. Include comments explaining what each part of the code does.
3. Use `disp` or `fprintf` to **clearly** present each result (Do not use unsuppressed MATLAB output)

2: Vector Arithmetic

Instructions

Write a MATLAB script that demonstrates basic vector operations.

Script Name: `vectorOperations.m`

Steps:

1. **Create a Row Vector**:
   - Define a row vector `x` with elements `[1, 3, 5, 7, 9]`.
2. **Create a Column Vector**:
   - Define a column vector `y` with elements `[2; 4; 6; 8; 10]`.
3. **Element-wise Multiplication**:
   - Multiply the `x` by `y` element by element (use `.*`).
4. **Vector Transposition**:
   - Transpose the row vector `x` to a column vector and store it as `xT`.
5. **Vector Summation**:
   - Find the sum of all elements in vector `x` using the `sum` function.
   - Display the sum of x in a clear format (e.g., "The sum of x is...")

Deliverables

1. `vectorOperations.m` containing all vector operations.
2. Add **comments** explaining each step.

3: Simple Data Visualization

Instructions

Write a MATLAB script that creates a basic line plot.

Script Name: `simplePlot.m`

Steps:

1. **Create a Time Vector**:
   - `time = [0, 1, 2, 3, 4, 5];`.
2. **Create a Distance Vector**:
   - `distance = [0, 10, 20, 30, 40, 50];`.
3. **Plot the Data**:
   - Use the `plot` function to plot `time` on the x-axis and `distance` on the y-axis.
4. **Add Labels and Title**:
   - Label the x-axis as "Time (s)" and the y-axis as "Distance (m)".
   - Add a title to the plot: "Time vs Distance".

Deliverables

1. `simplePlot.m` which creates the plot.
2. **Comments** explaining each part of the code.

---

4. Material Properties Calculation

Task

Create a MATLAB script that performs calculations for **stress** and **strain** and then visualizes the results

Instructions

Script Name: `materialProperties.m`

Objectives:

- Calculate stress and strain using **vector** operations.
- Visualize the stress-strain relationship with a plot.

Steps:

1. **Variable Initialization**:
   - Define a vector `forces = [100, 200, 300, 400, 500];` (in Newtons).
   - Define a scalar `crossSectionArea = 50;` (in mm^2).
   - Define a vector `displacements = [0.1, 0.2, 0.3, 0.4, 0.5];` (in mm).
   - Define a scalar `originalLength = 100;` (in mm).
2. **Stress Calculation**:
   - Calculate the stress using the formula

     $$\text{stress} = \frac{\text{force}}{\text{crossSectionArea}}$$

     for each force value.
   - Store the results in `stress`. Use element-wise calculations where needed.
3. **Strain Calculation**:
   - Calculate the strain using

     $$\text{strain} = \frac{\text{displacement}}{\text{originalLength}}$$

     for each displacement value.
   - Store the results in `strain`. Use element-wise calculations where needed.
4. **Plot the Stress-Strain Curve**:
   - Plot the stress-strain curve using the calculated values.
   - Label the x-axis as "Strain" and the y-axis as "Stress (N/mm^2)".
   - Add a title "Stress-Strain Curve".

Deliverables

1. `materialProperties.m` containing all calculations and the plot.
2. Comments explaining each calculation and the final purpose of the plot.

---

5. Projectile Motion Simulation

Task

Simulate the vertical motion of a projectile under gravity, and visualize the results.

Instructions

Script Name: `projectileMotion.m`

Objectives:

- Compute the projectile's height at different times using vectorized operations.
- Visualize the motion using time vs. height.

Steps:

1. **Variable Initialization**:
   - Define constants: `gravity = 9.81;` (m/s^2) and `initialVelocity = 50;` (m/s).
   - Create a time vector `time = 0:0.1:10;` (representing 0 to 10 seconds).
2. **Height Calculation**:
   - Calculate the height of the projectile at each time point using

     $$y = \text{initialVelocity} \times \text{time} - \frac{1}{2} \times \text{gravity} \times \text{time}^2$$

   - Store the results in a vector `height`.

3. **Plotting the Trajectory**:
    - Use `plot(time, height);` to create the plot.
    - Label the x-axis as "Time (s)" and the y-axis as "Height (m)".
    - Add a title "Projectile Motion Under Gravity".

Deliverables

1. `projectileMotion.m` with calculations and the plot.
2. Comments explaining each calculation and the purpose of the final plot.

---

6. Bug Hunt Challenge

Task

Identify and fix errors in a MATLAB script that calculates the total cost of items in a grocery list and displays the result.

Instructions

1. Copy the provided buggy MATLAB code to a script file named `buggyScript2.m`.
2. Open the script in the MATLAB Editor and try running it. Observe the errors or unexpected behaviors.
3. Identify and fix the bugs in the script. The bugs could include syntax errors, incorrect operations, or function misuse.
    - Pay attention to how arrays and variables are used and manipulated.
4. Use comments to explain each fix you make and describe the original error.

Example Buggy Script (buggyScript2.m)

```
% Task: Calculate the total cost of items in a grocery list

itemPrices = [2.5, 3.0, 4.5, 5]; % Prices of 4 items
itemQuantities = [2, 1, 3]; % Quantities of each item bought

% Calculate the total cost for each item
totalCost = itemPrices * itemQuantities;

% Display the total cost (using sum to get the overall cost)
fprintf('The total cost of the grocery items is: %.2f\n', sum(totalCost));
```

Deliverables

1. Submit the corrected script file (`fixedScript2.m`).
    - Ensure that all calculations and logic work as intended.
    - Include comments explaining each error you found and how you fixed it.
2. Write a short report (`debuggingReport2.txt`) containing the following:
    - Summarize the errors you encountered.
    - Explain how you found the solution to fix them.
    - Explain what you learned from the debugging process.

Definition of Done

1. You shall have a GitHub Repository set up with gberl001 invited as a collaborator.
2. Your `Week02` Folder shall have the following files:

- matrixOperations.m
- vectorOperations.m
- simplePlot.m
- materialProperties.m
- projectileMotion.m
- buggyScript2.m
- fixedScript2.m
- debuggingReport2.txt