General Instructions

Due Date: Sunday, August 1st by 11:59pm (submit via Blackboard)

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.

- Phase Diagram Development (Application of Chemical and Mechanical 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 zyBook before the deadline to receive credit.

- Chapter 34.1 MA6: CheckPhase Function
- Chapter 34.2 MA6: 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 **CheckPhase_Solution.p**. This is a content-obscured file which contains a working solution to the CheckPhase function. 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 Brightness function, you are encouraged to instead copy CheckPhase_Solution.p to your working folder and rename it **CheckPhase.p**. Now, when your main script calls the CheckPhase 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: 5 – 10 min

One aspect of materials science is the study of materials' phases. The phase properties for many common materials such as water are well-documented and readily available, but if the material in question is complex or is of an unknown composition, phase properties often must be found by approximation based on experimental values. Phase diagrams, diagrams which show the phases a given material can experience based on its temperature and pressure, are used to find or better understand these phase properties. Some significant phase properties include:

- Triple Point: the temperature and pressure at which a material can exist as all three major phases simultaneously
- Critical Temperature: the temperature at which the material can only be in a gaseous phase (due to superheating)
- Phase Boundaries: the boundaries at which transitioning from one phase to another occur
    - Sublimation Curve: the phase boundary between the solid and gas phases
    - Fusion Curve: the phase boundary between the solid and liquid phases
    - Vaporization Curve: the phase boundary between the liquid and gas phases

You are a chemical engineer trying to determine the phase properties of a chemical mixture provided to you by a coworker. As a first step, you have experimentally determined the pressure of the mixture at certain temperatures along both the fusion and vaporization curves by heating the mixture and analyzing its phase changes. Theses results are provided in the data file **Boundaries.csv** and duplicated below in Table 1. Temperature and pressure measurements for the fusion curve are given in rows 1 and 2, and temperature and pressure measurements for the vaporization curve are given in rows 3 and 4. Assume this data will always have these four rows as shown but may have any number of measurements (columns). You will use this data to develop a phase diagram for the mixture. The phase diagram you will be developing will only be valid between temperatures of 150 – 350 Kelvin and pressures of 0 – 60 atmospheres; you may use these as the bounds of the diagram.

Table 1: Boundaries.csv

Fusion Curve	Temp [K]	220	240	260
	Pressure [atm]	15	30	60
Vaporization Curve	Temp [K]	250	280	310
	Pressure [atm]	15	18	22.5

Tasks: Proficiency Time: 50 – 70 min

TASK 1: (2 – 3 min)

The critical temperature of the mixture is necessary for developing the phase diagram. Prompt the user to enter the critical temperature of the mixture. For this mixture you have determined that the critical temperature is known to exist between 300 and 350 K; if the user enters a value outside this range continue to prompt the user until they enter a valid temperature.

TASK 2: (20 – 27 min)

Create the phase diagram for the mixture by developing curves with the given data. Model the fusion curve as a power equation and model the vaporization curve with an exponential curve using the data from **Boundaries.csv.** Where these two curves intersect will be the triple point of the mixture. Model the sublimation curve as a linear equation using the origin of the phase diagram (T = 150, P = 0) and the triple point.

On the phase diagram, the fusion curve should begin at the triple point and end at the phase diagram upper limit. The vaporization curve should begin at the triple point and end at the critical temperature. The sublimation curve should begin at T = 150, P = 0 and end at the triple point. An additional boundary between the liquid and gas phases should appear as a vertical line at the critical temperature.

Include the following formatting on your phase diagram:

- X-axis label
- Y-axis label
- Title
- Gridlines
- Phase labels
- Blue lines
- Line thickness 3
- Axis limits

TASK 3: (18 – 24 min)
With the phase diagram created, prompt the user to input a point to analyze on the phase diagram. Check that this point is within the phase diagram limits; if not, continue prompting the user until a valid point is entered. Create the function **CheckPhase.m** that checks the phase of the user-inputted point. This function will have six inputs (in order: the test point formatted as a 1x2 vector, function handles containing the fusion curve, vaporization curve and sublimation curve, the critical temperature and the temperature at which the triple point occurs). If the point is exactly on a phase boundary, you may choose which phase the point is classified as. The function should output a string containing the phase of the point and should also add that point to the phase diagram. Call your new function to determine the phase and output to the command window the phase of the entered point.

TASK 4: (2 – 3 min)
Ask the user if they would like to enter another point on the phase diagram. If yes, repeat Task 3. If no, continue to Task 5.

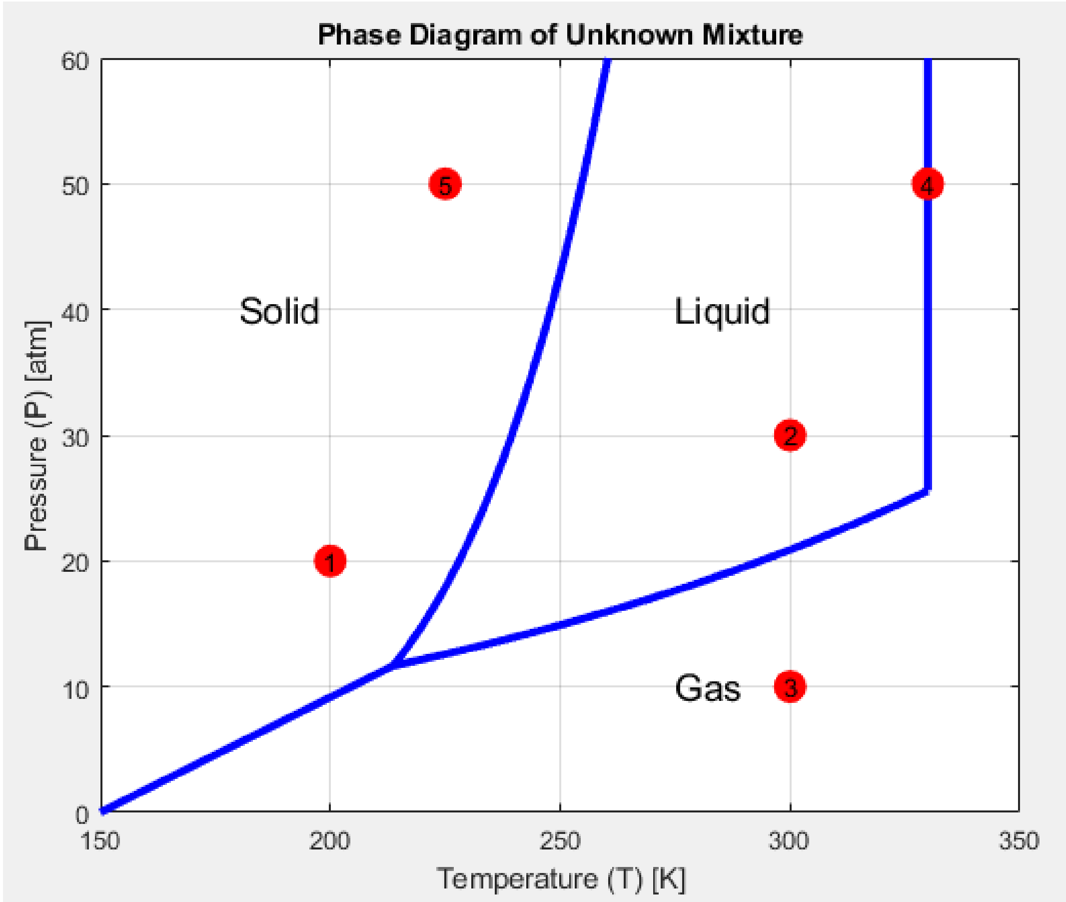
TASK 5: (5 – 8 min)
Output to the command window a table of the points inputted by the user and their corresponding phases. This table should include headers stating what each column represents. See sample output.
For Task 5, you cannot use cell2table() or equivalent functions.

TASK 6: (3 – 5 min)
Find the percentage of the phase diagram that is in the gas phase. Output the percentage of the diagram in the gas phase to the command window.

Sample Output

Command Window

```
Enter the critical temperature of the mixture [K]: 275
Enter the critical temperature of the mixture [K]: 351
Enter the critical temperature of the mixture [K]: 330
Enter a test point on the phase diagram [T, P]: [200 20]
The point (200, 20) is in the solid phase.

Enter a test point on the phase diagram [T, P]: [300 30]
The point (300, 30) is in the liquid phase.

Enter a test point on the phase diagram [T, P]: [300 -10]
Enter a test point on the phase diagram [T, P]: [149 10]
Enter a test point on the phase diagram [T, P]: [300 10]
The point (300, 10) is in the gas phase.

Enter a test point on the phase diagram [T, P]: [330 50]
The point (330, 50) is in the gas phase.

Enter a test point on the phase diagram [T, P]: [225 50]
The point (225, 50) is in the solid phase.

Temperature [K] Pressure [atm]  State
    200             20          solid
    300             30          liquid
    300             10          gas
    330             50          gas
    225             50          solid

The gas phase is 30.27% of the phase diagram.
```



Note: The numbers shown inside each point are for illustration purposes only and are not required. Adding a number to each point is left as an optional exercise.