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| **Team Member Names:** |  |
| **Purdue Logins:** |  |
| **Section Number:** |  |
| **Team Number:** |  |

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| **Submission Instructions:**   1. Rename this answer sheet to be **Project\_M2\_*sss\_tt*.docx**, where ***sss*** is your section number (e.g., 001 for section 001) and ***tt*** is your team number (e.g., 07 for team 7). 2. Compress all deliverables into one zip file named M2\_*sss\_tt*.zip. Submit the zip file to the Blackboard drop box for M2 prior to Class 25. This folder must contain:    * **Project\_M2\_*sss\_tt*.docx**    * **Project\_M2Algorithm1\_*sss*\_*tt*.m**    * **Project\_M2Algorithm2\_*sss*\_*tt*.m**    * **Project\_M2Calibration\_*sss*\_*tt*.m**    * **Project\_M2AlgExec\_*sss*\_*tt*.m**   Notes:   * Only one(1) submission per team * Only the last submission to the M2 Dropbox will be graded.   1. Check to make sure the files can be accessed after uploading to Blackboard. * After submission, distribute the submitted files to all team members*. Ensure all members of the team have copies of the submitted files.* |

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| **Particular Learning Objectives are highlighted throughout the document. However, all LOs that you have encountered throughout the semester may apply where appropriate to your work on the Milestones.** |

**Part 0: M1 Feedback Review**

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| **Learning Objective (LO): 22.00 Reflect on feedback for the purpose of improvement**  ***Evidence of Proficiency Requires*:**   * Feedback summarization is clear and useful * Response plan is clear and practical |

1. In your own words, summarize the feedback you received on project milestone M1 that could lead to improvements in your work.

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| <*insert your answer here*> |

1. Based on your feedback, what do you need to do to improve your parameter identification approaches? (Do not just reword your response to Part A. Do consider how you will incorporate your feedback into your work.)

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| <*insert your answer here*> |

**Part 1: Algorithm Development**

1. In Milestone 1, you developed two approaches for identifying ts and two approaches for identifying . Now, you will create two complete algorithms for full parameter identification (yL, yH, ts, and τ). You will mix and match your best ideas for identifying ts and τ and add your best ideas for identifying yL and yH to make ***two different algorithms***. Then, you will develop a flowchart and a user-defined function for each algorithm.

Each flowchart must:

* be clear and filled with English text (not code)
* clearly indicate inputs and outputs
* provide sufficient details (steps) for computing all four key parameters (yL, yH, ts, and τ) ***with no user intervention***
* provide a means of computing the parameters for ***both heating and cooling data***

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| **Learning Objective (LO): 15.00 Construct and troubleshoot a flowchart using standard symbols and pseudocode (this includes all appropriate sub-LOs)** |

Remember, flowcharts are a thinking tool for developing and organizing your algorithm ***before*** you code. A well-developed flowchart reduces coding frustrations.

It is highly recommended that your produce your flowcharts using a computer tool.

**Algorithm 1 Flowchart:**

<*insert your flowchart here*>

**Algorithm 2 Flowchart:**

<*insert your flowchart here*>

1. Once you have completed the flowcharts, translate your flowcharts into two user-defined functions named **Project\_M2Algorithm1\_*sss*\_*tt*.m** and **Project\_M2Algorithm2\_*sss*\_*tt*.m**.

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| **Learning Objective (LO): 11.00 Create and execute a user-defined function (this includes all appropriate sub-LOs)** |

As you develop your algorithm UDFs, keep in mind that they will be called by an executive function (see Part 2.C). The executive function will load the time-history data that needs to be analyzed, call your two algorithms, and plot the results. As such, you must carefully consider what the input and output arguments need to be for your algorithm UDFs.

**Part 2: Output Comparison**

You will now compare your algorithms, along with a third “calibration” algorithm, using the four provided calibration data sets: ‘clean’ heating, ‘noisy’ heating, ‘clean’ cooling, and ‘noisy’ cooling. In this section, you will determine your algorithms’ parameters, plot data with models, and determine modified SSE values. By the end of this section, you will complete all parts of Tables 1 and 2 below.

Table 1. Heating Comparisons

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| --- | --- | --- | --- | --- | --- | --- |
|  | **HEATING** | | | | | |
| Parameter | M2Calibration | | M2Algorithm1 | | M2Algorithm2 | |
| Clean | Noisy | Clean | Noisy | Clean | Noisy |
|  | 0.00 | -0.70 |  |  |  |  |
|  | 100.00 | 98.90 |  |  |  |  |
|  | 1.50 | 1.50 |  |  |  |  |
|  | 0.31 | 1.65 |  |  |  |  |
| SSEmod |  |  |  |  |  |  |

Table 2. Cooling Comparisons

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| --- | --- | --- | --- | --- | --- | --- |
|  | **COOLING** | | | | | |
| Parameter | M2Calibration | | M2Algorithm1 | | M2Algorithm2 | |
| Clean | Noisy | Clean | Noisy | Clean | Noisy |
|  | 100.00 | 98.91 |  |  |  |  |
|  | 0.96 | -0.67 |  |  |  |  |
|  | 1.50 | 1.50 |  |  |  |  |
|  | 1.82 | 1.12 |  |  |  |  |
| SSEmod |  |  |  |  |  |  |

1. Use your algorithms, Project\_M2Algorithm1\_*sss*\_*tt*.m and Project\_M2Algorithm2\_*sss*\_*tt*.m,to process the four calibration datasets. Report the parameters identified by your algorithms in Tables 1 and 2. **Be sure to manage decimal places throughout the table**.
2. In Tables 1 and 2, you are given calibration parameter values for both heating and cooling. Create a user-defined function called **Project\_M2Calibration\_*sss*\_*tt*.m**, which will examine how well those values, when plugged into the piecewise equations (1) and (2) from the project introduction document, model the ‘clean’ and ‘noisy’ datasets for both heating and cooling.

The function should generate two figures that contain 2 x 1 subplots in MATLAB that are suitable for technical presentation.

Figure 1:

* 1. Upper: plot the ‘clean’ HEATING calibration data and overlay the piecewise model generated using equation (1) from the project description document with the actual parameter values for the ‘clean’ heating calibration dataset. Use different line styles and colors with no data markers for the ‘clean’ data and the model.
  2. Lower: plot the ‘noisy’ HEATING calibration data and overlay the piecewise model generated from using equation (1) from the project description document with the actual parameter values for the ‘noisy’ calibration dataset. Use different line styles and colors with no data markers for the ‘noisy’ data and the model.

Figure 2:

* 1. Upper: plot the ‘clean’ COOLING calibration data and overlay the piecewise model generated using equation (2) from the project description document with the actual parameter values for the ‘clean’ cooling calibration dataset. Use different line styles and colors with no data markers for the ‘clean’ data and the model.
  2. Lower: plot the ‘noisy COOLING calibration data and overlay the piecewise model generated using equation (2) from the project description document with the actual parameter values for the ‘noisy cooling calibration dataset. Use different line styles and colors with no data markers for the ‘noisy data and the model.

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| **Learning Objective (LO): 07.00 Create and evaluate x-y plots suitable for technical presentation (this includes all appropriate sub-LOs)** |

<*insert Figure 1 here*>

<*insert Figure 2 here*>

* 1. To get a feel for a possible target for the error between time histories and their models, compute a ‘modified’ SSE for the ‘clean’ and ‘noisy’ heating and cooling datasets and place the values in the Calibration section of the SSEmod row in Tables 1 and 2 above.

The ‘modified’ SSE calculation normalizes (i.e., divides) the SSE calculation you saw when we studied regression by the number of data points *n*, yielding an average error per data point:

In this case, the *yi* are the data points from the ‘clean’ or ‘noisy’ dataset, and the *f*(*x*) is the piecewise equation that defines a first-order response [heating or cooling; equations (1) and (2) from the project description document] using the parameters given in the table for the calibration data sets.

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| **Learning Objective (LO): 12.03 Manually compute the SSE (noting the SSEmod is a bit different as described above)** |

1. In a separate user-defined function, **Project\_M2AlgExec\_*sss*\_*tt*.m**, examine how well **your** parameter values for the calibration datasets, when plugged into the piecewise equations (1) and (2) from the project description document, model the ‘clean’ and ‘noisy’ heating and cooling calibration datasets. This function must load the data, call your two algorithms, calculate SSEmod (either directly or by calling a standalone function), and plot the results.
   1. Repeat the plotting steps (steps 1-4) of part B above using the parameters identified by your algorithms.

**Algorithm 1 Plots:**

<*insert your Figure 1 & 2 here*>

**Algorithm 2 Plots:**

<*insert your Figure 1 & 2 here*>

* 1. For each algorithm, consider the ‘clean’ calibration dataset plots (both heating and cooling) generated using the parameters that you identified. In the box below, describe similarities and differences in the shapes of the ‘clean’ dataset and your model for the two ranges of the piecewise function: t<ts and t≥ts.

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| **Algorithm 1 ‘clean’ dataset plot observations of heating and cooling**  For t<ts  <*insert your answer here*>  For t≥ts  <*insert your answer here*> |

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| **Algorithm 2 ‘clean’ dataset plot observations of heating and cooling**  For t<ts  <*insert your answer here*>  For t≥ts  <*insert your answer here*> |

* 1. For each algorithm, consider the ‘noisy’ calibration dataset plots (both heating and cooling) generated using the parameters that you identified. Do you notice any differences in the shapes of the ‘clean’ dataset and your model? Briefly explain what you see in the box below.

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| **Algorithm 1 ‘noisy’ dataset plot observations of heating and cooling**  For t<ts  <*insert your answer here*>  For t≥ts  <*insert your answer here*> |

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| **Algorithm 2 ‘noisy’ dataset plot observations of heating and cooling**  For t<ts  <*insert your answer here*>  For t≥ts  <*insert your answer here*> |

* 1. For each algorithm, compute the SSEmod values for the ‘clean’ and ‘noisy’ calibration datasets, and insert those values in the tables above.

**Part 3: Observations and Improvements**

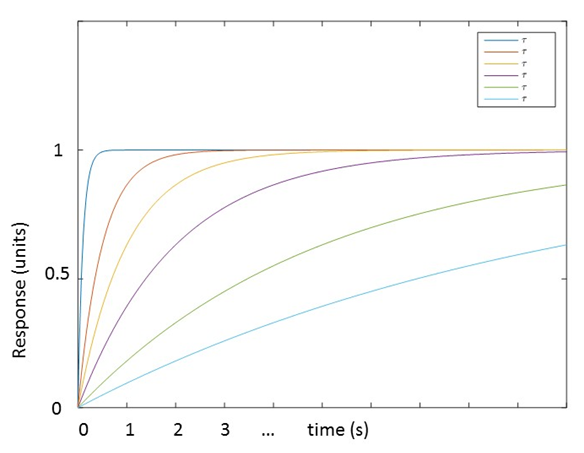
Based upon your observations of your plots and the SSEmod results for your models, suggest at least two ways you believe each algorithm could be improved. Briefly explain each suggestion below. You do not need to code these changes; at this point, simply describe changes you think might be useful.

Be sure to:

* explain which parameter(s) your improvement will target,
* explain the improvement with a level of detail that can be understood by others (provide sketches or flowcharts as necessary to clarify your improvement),
* describe the performance metrics you will use to determine whether your proposed improvement really does improve your solution, and
* provide evidence-based rationales for each proposed improvement and the metrics selected. Your rationales should answer the questions:
  + What is your evidence that this improvement is necessary?
  + Why is this method for making the improvement a good idea - what is your evidence?
  + Why is this metric a good idea - what is your evidence?

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| **Learning Objective (LO): 21.02 Communicate ideas clearly and concisely**  ***Evidence of Proficiency Requires:***   * Purpose of communication is clear * Improvements are fully but concisely described   + All steps are included   + Each step is complete   + Assumptions are stated   + Appropriate technical language is used   + Clarifying images (e.g., sketches, graphs and/flow charts) are provided (as necessary) * External research is accompanied by an in-text citation and full reference |
| **Learning Objective (LO): 21.03 Evaluate model or algorithm development (e.g. ideas, work, functionality) using evidence-based rationales**  ***Evidence of Proficiency Requires:***   * Assumptions, claims, and critical decisions are clearly stated * An appropriate source of evidence is used to support assumptions, claims, and critical decisions * The evidence is clearly articulated * The quality of evidence should be acknowledged when it is insufficient to support assumptions, claims, and critical decisions (especially when sources available are lower than available data or external research when available data is suspect) * External research is accompanied by an in-text citation and full reference |

***Handle improvement that resolve issues that your current algorithms have.*** *BUT if, based on your calibration analysis, you feel that you do not need to make changes to your algorithm*, you should start thinking ahead to the data sets you will work with in M3. What if it takes a long time to research the new steady state as in the figure below (i.e., purple, green, and blue lines)? What if steady state was never reached during data collection (i.e., green and blue lines)?



**Algorithm 1 Improvements** (add additional Improvement blocks as needed)

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| **Improvement 1. Parameter(s) Targeted: \_\_**<*declare parameter(s) here*>**\_\_\_** |
| Description  <*insert your answer here*> |
| Metrics To Determine Improvement  <*insert your answer here*> |
| Rationale for Improvement and Metrics  <*insert your answer here*> |

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| **Improvement 2. Parameter(s) Targeted: \_\_**<*declare parameter(s) here*>**\_\_\_** |
| Description  <*insert your answer here*> |
| Metrics To Determine Improvement  <*insert your answer here*> |
| Rationale for Improvement and Metrics  <*insert your answer here*> |

**Algorithm 2 Improvements** (add additional Improvement blocks as needed)

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| **Improvement 1. Parameter(s) Targeted: \_\_**<*declare parameter(s) here*>**\_\_\_** |
| Description  <*insert your answer here*> |
| Metrics To Determine Improvement  <*insert your answer here*> |
| Rationale for Improvement and Metrics  <*insert your answer here*> |

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| **Improvement 2. Parameter(s) Targeted: \_\_**<*declare parameter(s) here*>**\_\_\_** |
| Description  <*insert your answer here*> |
| Metrics To Determine Improvement  <*insert your answer here*> |
| Rationale for Improvement and Metrics  <*insert your answer here*> |

References Used in Evidence-Based Rationales

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| <*insert your citations here; verify your in-text citations*> |