Enter only names of Teammates who are present to work on this Milestone.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Teammate FNs:** | Micah | Peter | | | Colin | | Alex |
| **Purdue Logins:** | huffma11 | pswales | | | cjamison | | apieprzy |
| **Section Number:** | 014 | |  | **Team Number:** | | 05 | |

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| **Read these Instructions:**   1. Read through this Milestone before beginning your work so you understand its scope. Also, carefully read the contributions sections so you understand what is expected of each teammate. 2. Save this answer sheet as **M3\_*sss*\_*tt*.docx** where ***sss*** is your section number (07, 14, or 15) and ***tt*** is your team number (e.g., 03 for team 3).    1. Make sure all teammates have copies of all submitted project files all the time. 3. Cite your sources in APA format with (1) an in-text citation where referenced in the body of the text **and** (2) a full citation in the Reference section of this Milestone. As a reminder, it would be an example of **Academic Dishonesty** if you don’t include in-text citations and references. 4. FOR UPLOAD TO Bb prior to Class 28   You MUST submit your PUBLISHED m-files  Compress all deliverables listed into one zip file named M3\_sss\_tt.zip   * + M3\_sss\_tt.docx   + M3Exec\_sss\_tt.m   + M3Alg\_sss\_tt.m (and any additional sub-UDFs you create; save with same file naming convention filename\_sss\_tt.m; sub-UDFs are not required)   + M3Regr\_sss\_tt.m   + M4\_TechBrief\_sss\_tt.docx (Part 1 Section C1 and Part 3)   This zipped file ***must*** contain M3 and M4 ***along with*** your MATLAB m-files  Submit the zipped file to the M3 Drop Box on Bb prior to Class 28.   * Only one submission of the zip file with all documents is required per team. * Only the last submission will be graded; make sure all deliverables are submitted at the same time.  1. BRING A COMPLETE SET OF THESE DOCUMENTS to Class 28   All docs (Milestones **and** Matlab code) should be double-sided printed stapled  For M4 iterations, use ***CAPS BOLD ITALIC*** to identify corrections from your prior version  For .m files, use “format compact” to suppress the display of blank lines  You MUST print your PUBLISHED m-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: M2 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 M2 that could lead to improvements in your work.

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| We neglected to include parallelograms for inputs when making our flowcharts. Although our logic and concepts were sound, they were not worded effectively within milestone 2, resulting in a deduction of points. A few of our metrics for improvement were actually descriptions of the issue, not the improvement itself. |

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. Consider how you will incorporate your feedback into your work.)

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| Going forward we will make sure to double check that all parts of the flowchart are present, such that the flowchart can be easily translated into MATLAB code from start to finish. We will also clarify our parameter improvement descriptions and metrics to ensure that they clearly describe how we plan to improve the given metric instead of simply describing the problem. |

Consult the M3 memo from FOS, Inc. for the details concerning your task. Respond to each of the prompts below in the space provided.

**Part 1: Flowchart & Coding**

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| **Learning Objective (LO): 21.04 Create a mathematical model that addresses the complexity of problem** |
| **Learning Objective (LO): 15.00 Construct and troubleshoot a flowchart using standard symbols and pseudocode (this includes all appropriate sub-LOs)** |

1. Your goal is to create an executive function to analyze the 100 time histories provided by FOS, Inc. in a *fully automated* way, and identify the four relevant first-order system parameters (yL, yH, ts, and τ) from each time history. ***Note:*** *The 100 time histories provided to you represent two different test conditions: (i) 50 of the time histories are for heating experiments, and (ii) the other 50 are for cooling experiments. They also represent 5 different FOS thermocouple designs*. Your executive function should call one user-defined function to process each time history provided by FOS. This one user-defined function uses the better-performing elements of your two algorithms from M2 by incorporating the improvements you recommended in M2. In the space below, draw a flowchart for your executive function. ***Note:*** This flowchart need only focus on the time-history parameter identification process, not the other steps the executive function will need to accomplish as described in later parts of this document.

ExecFlowChart.png

1. Once you have completed the flowchart, translate your flowchart into an executive function named **M3Exec\_*sss*\_*tt*.m,** and name your parameter identification algorithm (from M2) **M3Alg\_*sss*\_*tt*.m**. The algorithm user-defined function must be called by the executive function with appropriate inputs and outputs being passed between the functions.

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

**Part 2: Descriptive Statistics**

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| **Learning Objective (LO): 08.00 Compute basic descriptive statistics of values stored in arrays using appropriate commands** |
| **Learning Objective (LO): 12.03 Manually compute the SSE (recall SSEmod is a bit different)** |

Complete Table 1 with results from executing your MATLAB user-defined functions. Calculate the mean and standard deviation of time constants across all 20 time histories for each of the five thermocouple designs. Then, as you did in M2, calculate SSEmod for each time history and determine a mean SSEmod for each thermocouple design. Report these values in Table 1; be sure to include appropriate units and number of decimal places for all values in Table 1.

**Table 1**

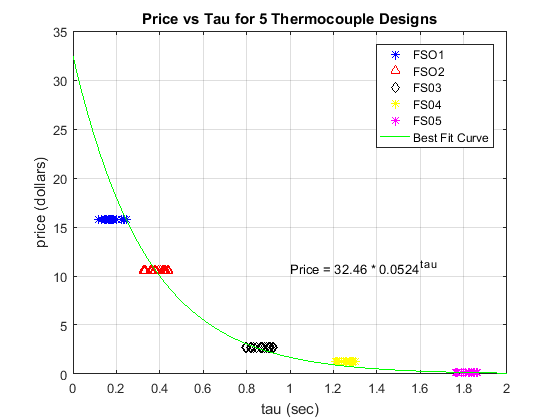
|  |  |  |  |
| --- | --- | --- | --- |
| **Model Number** | **τ Characteristics** | | **Mean SSEmod** |
| **Mean** | **Standard Deviation** |
| FOS-1 | 0.1822 sec | 0.0399 | 2.2443 |
| FOS-2 | 0.3826 sec | 0.0375 | 1.3680 |
| FOS-3 | 0.8665 sec | 0.0407 | 1.0563 |
| FOS-4 | 1.2595 sec | 0.0302 | 1.0342 |
| FOS-5 | 1.8171 sec | 0.0330 | 1.2678 |

**Part 3: Regression Analysis for τ**

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| **Learning Objective (LO): 12.00 Perform linear regression** |
| **Learning Objective (LO): 13.00 Perform function discovery and data transformations** |

1. Write a user-defined function called **M3Regr\_*sss*\_*tt*.m** that determines the regression model for price as a function of time constant (τ); consult the M3 company memo for price data. The regression user-defined function must be called by the executive function with appropriate inputs and outputs being passed between the functions. You will need to carefully consider the shape of the relationship between price and the time constant. What function type best models this relationship?
2. The regression user-defined function must generate a plot showing the results of this analysis: plot price versus the time constants for all 100 points (not simply the mean values), and overlay your regression model on the same figure. The regression equation must be displayed on the plot in a suitable location.

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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)** |



1. Report the metrics (with appropriate units) for your regression model in Table 2.

**Table 2**

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| --- | --- |
| **Parameter** | **Value** |
| SSE | 0.8883 |
| SST | 35.2168 |
| r2 | 0.9748 |

**Part 4: Observations & Improvements**

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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   + 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 * External research is accompanied by an in-text citation and full reference |

In M2, you were asked to generate ideas about how to improve your algorithm for first-order system parameter identification. In M3, you have improved your algorithm and applied your algorithm to 100 different time histories, and observed its performance across all that data. You have also created a regression model to characterize trends in your data. Based upon your work on M3, again consider potentially useful improvements and provide **two** specific ways you can **improve your parameter identification model**. Provide the details of each suggestion in the spaces below. You do not need to code these refinements right now (you will do this later in the project), but it would be beneficial to think through now how you will implement these recommendations!

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 to clarify your improvement),
* describe the 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?
  + method for making the improvement is a good idea?
  + metric is a good idea?

**Algorithm Improvements**

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| **Improvement 1. Parameter(s) Targeted:** time step |
| Description  As of now, the time step is calculated using a moving average of data points until that average deviates grossly from the previous averages. The range in which our program evaluates the average is currently hardcoded, so it is not ideal for every data set. Moving forward, we plan on determining the range for the average specifically for each data set based on the error or ‘nosiness’ of the data set. |
| Graphic to Clarify Improvement    The above graphics show data points before the time step for two different trials of the same first order system for heating. The scales of each graph are exactly the same, but as you can see, the ‘noise’ of each data set differs slightly. While data A (left) appears to have a temperature range between -3 and 2 °C, data B (right) appears to have a temperature range between -3 and 4 °C. As such, the hardcoded value, whatever it may be currently set to, will not work ideally for both data sets, so it would make our algorithm more accurate by specifying the range for the moving average for the time step based on the individualized error or ‘noise’ in each data set. |
| Metrics to Determine Improvement  The mean SSE mod for each FOS will be our metric for improvement. As our time step improves in accuracy, our SSE for each FOS should become smaller in magnitude. |
| Rationale for Improvement and Metrics  By making our algorithm specific for each FOS data set, the time step will become more accurate, and the more accurate the time step value is for each data set, the more accurately our algorithm will represent the data as a whole, causing our SSE to decrease in magnitude. |

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| **Improvement 2. Parameter(s) Targeted:** tau |
| Description  To calculate tau, we used an arbitrary value to determine the data points that are used to find tau. This value was not chosen based on the data and was just assigned to be 0.4 because it provided the greatest average accuracy among all given data sets. The value determines how far the temperature of a data point has to be from the temperature of tau in order to be accounted for in calculating tau. We could improve the code by making this value vary with the data in order to provide a better correlation between each data set and its tau value. |
| Graphic to Clarify Improvement    The above graphics show data points between the point in time where the time step and maximum temperature occur from two different trials of the same first order system for heating. The scale used for the x axis (time) of each graph are not the same. Although the ‘noise’ or temperature deviation for data set A (left) and data set B (right) appear to be the same, there are still slight discrepancies. It would maximize the accuracy of our algorithm, therefore, if we were to specify the arbitrary value used to determine the temperature data used in calculating tau based on the individualized error or ‘noise’ in each data set. |
| Metrics to Determine Improvement  The mean SSE mod for each FOS will be our metric for improvement. As our value for tau improves in accuracy, our SSE for each FOS should become smaller in magnitude. |
| Rationale for Improvement and Metrics  By making the value of error (0.4) dependent on the data, you increase the accuracy of the calculated tau by avoiding a hard coded value. This would improve the values of tau for the varying data sets, as the data on either extreme of variance and tau would require different values to accurately manipulate the data. |

**REFERENCES (written in APA format – see Word>reference>manage sources>new tab)**

List your References used in evidence-based rationales for this Milestone. Also, copy and paste them into your M4 Tech Brief Reference Section. Each of your References requires n in-text citation!

|  |
| --- |
| Example (reference for an internet source):  Author Last, X. (year). Title xxxx xxx xxxx. Retrieved from http://www.url.xxx/xxxx/xxxx |
| No external sources used |

**M4 TECHNICAL BRIEF**

Open your Technical Brief document, ***M4\_TechBrief\_sss\_tt*.docx**, and review the instructions, components, and requirements of this document. Once you complete M3, reread Part 1 Section B and Part 2 and make corrections in ***CAPS BOLD ITALIC***. You will always make correction in ***CAPS BOLD ITALIC***. Then write Part 1 Section C1 and Part 3. Resave your M4\_TechBrief with your same document name, ***M4\_TechBrief\_sss\_tt*.docx**.

**INDIVIDUAL CONTRIBUTIONS on PROJECT**

**Part 1: Rate Self on Specific Criteria**

Write each teammate’s name in a separate column. Each teammate must **score** just your *own* behaviors during *this* Milestone. Indicate the extent to which he/she agrees with the statement on the left using a scale of 1-4 (0=did not attend or do; 1=strongly disagree; 2=disagree; 3=agree; 4=strongly agree). Each teammate totals the numbers in his/her own column. As a reminder, it would be an example of **Academic Dishonesty** if you record a false evaluation of your work or attendance for this Milestone.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Teammates Names:  Evaluation Criteria: | TM1:  Micah | TM2:  Alex | TM3:  Peter | TM4:  Colin |
| Came to classes prepared to work on current Milestone. | 3 | 3 | 3 | 3 |
| Was not distracted any time during class (phone, text, other hw, etc). (ONLY a 1 or 4) | 4 | 4 | 4 | 4 |
| Contributed meaningfully to team discussions and coding progress in class. | 3 | 3 | 3 | 3 |
| Demonstrated a cooperative and supportive attitude in class. | 4 | 4 | 4 | 3 |
| Attended team meeting(s). (ONLY a 0 or 4) | 4 | 4 | 4 | 4 |
| Arrived to team meeting on time.  (ONLY a 0 or 4) | 4 | 4 | 4 | 4 |
| Came to team meeting prepared with assigned work completed and gave 100% during meeting. | 3 | 3 | 3 | 3 |
| Contributed meaningfully to team discussions and coding during team meeting. | 3 | 3 | 3 | 3 |
| Was not distracted any time during meeting (phone, text, other hw, etc). (ONLY a 1 or 4) | 4 | 4 | 4 | 4 |
| Demonstrated a cooperative and supportive attitude during team meeting. | 4 | 4 | 4 | 3 |
| Provided assigned code and answers to this Milestone on time and in a quality manner. | 4 | 4 | 3 | 3 |
| List specific range of lines of code you wrote *on your own*. Remember to write your name in the comments of your program. | M3Regr  ln 1-47  M3Calib  ln 1 - 40 | M3Alg2 ln 1,53,55  M3Alg  ln 1 - 50 | M3Alg2 ln68-75  M3Alg  ln 50 - end | M3Regr  ln 49 - end  M3Calib  ln 40 - end |
| Completed equal portion of this week’s Milestone. | 4 | 4 | 3 | 3 |
| If corrections were made to the code, added 2nd teammate’s name in the comments of edits made to original coder’s lines of code. (ONLY a 1 or 4 or N/A) | N/A | 4 | N/A | N/A |
| **TOTALS** | 44 | 48 | 42 | 40 |

Exceptions:

* If you feel your teammate's scoring is not accurate or a teammate contributed extremely little or a lot more to this milestone, please talk to your Instructor/GTA in class or send an email to your Instructor so we can help resolve any issues or imbalanced workload.

**Part 2: Describe Specific Contributions**

**Individually**, also **write** just your *own* specific task-oriented and detailed description of what you contributed to *this* Milestone. As a reminder, it would be an example of **Academic Dishonesty** if you write false contributions of your work for this Milestone or if you write the contributions for another Teammate, so only write your own contributions. Sign your name in your cell verifying true authorship of your work.

Teammate name Contributions (described in **DETAIL**)

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| --- | --- |
| TM1 Name  **Micah Huffman** | Organized team meetings and kept the team on schedule to complete milestone by the deadline. Assisted in development of parameters and metrics for improvement. Created graphics and wrote explanation for improvements. Responsible in part for M3Regr\_014\_05 function. |
| TM2 Name  **Colin Jamison** | worked on improvements from previous milestone. Contributed to executive code. Inputted data to milestone from functions including SSE, tau, and standard deviation. |
| TM3 Name  **Peter Swales** | Coded and revised parts of M3Alg2 and wrote improvements that can still be made to the code. Helped to work on M3\_Alg as well to find errors and improve code. |
| TM4 Name  **Alex Pieprzycki** | Helped with logic for program writing. Responsible in part for M3\_Alg\_014\_05 and improvements on M3\_Alg2. Created metrics to test programs. Made flowcharts for programs. Assisted other teammates with their programs |

Exceptions:

* If a teammate did not contribute in class or at a team meeting, then the space next to that teammate’s name should be left blank and an appropriate grade will be assigned.
* If a teammate does not write anything, then that will represent having not contributed to the milestone and an appropriate grade will be assigned.
* If you feel your teammate's description is not accurate or a teammate contributed extremely little or a lot more to this milestone, please talk to your Instructor/GTA in class or send an email to your Instructor so we can help resolve any issues or imbalanced workload.

**DELIVERABLES BY CLASS 28**

**ELECTRONIC – upload to M3 Dropbox on Bb by Class 28**

You MUST PUBLISH your m-files

In the same submission, upload a zipped file that contains:

* M3\_*sss\_tt*.docx
* M3Exec\_*sss*\_*tt*.m
* M3Alg\_*sss*\_*tt*.m
* M3Regr\_*sss*\_*tt*.m
* M4\_TechBrief\_*sss\_tt*.docx (update Part 1 Section B and Part 2 (if necessary); and complete Part 1 Section C1 and Part 3)

**HARD COPIES – bring a set of these documents to Class 28**

All docs (Milestones **and** Matlab code) should be double-sided printed stapled

For M4 iterations, use ***CAPS BOLD ITALIC*** to identify corrections from your prior version

For .m files, use “format compact” to suppress the display of blank lines

You MUST print your PUBLISHED m-files

* M3\_*sss\_tt*.docx
* M3Exec\_*sss*\_*tt*.m
* M3Alg\_*sss*\_*tt*.m
* M3Regr\_*sss*\_*tt*.m
* M4\_TechBrief\_*sss\_tt*.docx (update Part 1 Section B and Part 2 (if necessary); and complete Part 1 Section C1 and Part 3)

These documents will be graded **in** **Class 28** and returned to you with feedback on Sunday afternoon. Dr. Strutz will post on Bb that you may come by ARMS 1335 to pick up your graded Milestone. You may also pick it up from Carlene on Monday in ARMS 1300 from 8am-5pm.