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

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| **Submission Instructions:**   * Rename this answer sheet to be **Project\_M4\_*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). * **BE SURE** to indicate in your MATLAB M-file, using as many comments as necessary, the specific details of your refinements. Please label them “Category 1”, “Category 2”, and “Category 3”, and use comments to briefly describe the nature of the refinements. * Compress all deliverables into one zip file named **M4\_*sss\_tt*.zip**. Submit the zip file to the Blackboard drop box for M4 prior to Class 30.   Update all MATLAB m-file names to M4 and name the algorithm files as explained in this document. You will be submitting ***three*** m-files, the answer sheet, and the technical brief as part of this assignment:   * 1. **Project\_M4Exec\_sss\_tt.m**   2. **Project\_M4Algorithm\_sss\_tt.m**   3. **Project\_M4Regression\_sss\_tt.m**   4. **Project\_M4\_*sss*\_*tt*.docx**   5. **Project\_M4TechnicalBrief\_*sss.tt*.docx**   6. **As needed, any additional m files required to achieve M4 goals.**   Notes:   * Only one(1) submission per team * Only the last submission to the M4 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: M3 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 M3 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: Refinements Preview**

Consult the M4 memo from FOS, Inc. for the details concerning your task. Respond to each of the prompts below in the space provided. Your goal is to introduce ***three refinements*** to your original algorithm, and these refinements must improve your solution to the FOS parameter identification problem. ***Read the rest of this document*** ***carefully*** ***before you begin your work on this milestone***.

**Definition of “refinement”**

In this milestone, a refinement will fall into one of the following categories:

* **Refinement Category 1: Parameter Identification:** an improvement that changes the way you are doing parameter identification, and that improves your parameter identification results.
* **Refinement Category 2: Algorithm Efficiency:** an improvement that improves the efficiency of your code by (for example) removing un-needed looping structures, streamlining data handling, or otherwise reducing the execution time of your code.
* **Refinement Category 3: Algorithm Insight:** an improvement that involves analysis of your code and its limitations. For example, if you use any kind of thresholding in your code, you could determine the sensitivity of the solution to changes in that threshold parameter, and report how those changes affect your parameter identification and/or regression results.

In this milestone, you are ***REQUIRED*** to implement ***three*** total refinements, one from each of the above categories.

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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 |

Briefly describe, in words (not code), the nature of the refinements you will implement in your MATLAB code. Provide a brief, but thoughtful, description of your refinement, *using evidence-based rationales for why the refinement is necessary and should improve your solution*.

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| **Refinement 1. Category 1: Parameter(s) Targeted: \_\_**<*declare parameter(s) here*>**\_\_\_** |
| Description  <*insert your answer here*> |
| Rationale for Refinement  <*insert your answer here*> |

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| **Refinement 2. Category 2: Algorithm Efficiency** |
| Description  <*insert your answer here*> |
| Rationale for Refinement  <*insert your answer here*> |

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| **Refinement 3. Category 3: Algorithm Insight** |
| Description  <*insert your answer here*> |
| Rationale for Refinement  <*insert your answer here*> |

**Part 2: Refinements**

Resave all M3 files as **Project\_M4Exec\_*sss*\_*tt*.m**, **Project\_M4Algorithm\_*sss*\_*tt*.m**, and **Project\_M4Regression\_*sss*\_*tt*.m** before starting to make refinements.

**Refinement Category 1: Parameter Identification (*Required*)**

Making all necessary refinements to your M3 algorithm in your **Project\_M4Algorithm\_sss\_tt.m** file.Refinements must be clearly commented in your code with the text “Category 1” AND an adequate description.Then evaluatethe improvement in your refined parameter identification algorithm. Use the clean and noisy calibration data from M2 and compare the parameters identified from the calibration data using the algorithm you submitted as your solution for M3 and your refined algorithm for M4. Report your results in Tables 1 and 2. Take care with units and decimal places when presenting results.

**Table 1. Algorithm performance comparison to HEATING calibration parameters**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **HEATING** | | | | | |
| Parameter | M2Calibration | | M3Algorithm | | M4Algorithm | |
| Clean | Noisy | Clean | Noisy | Clean | Noisy |
|  | 0.00 | -0.70 |  |  |  |  |
|  | 100.00 | 98.90 |  |  |  |  |
|  | 1.50 | 1.50 |  |  |  |  |
|  | 0.31 | 1.65 |  |  |  |  |
| SSEmod |  |  |  |  |  |  |
| *Note:* Verify your SSEmod calculation. Heating Actual Clean SSEmod should be 0.00 degF2.  Heating Actual Noisy SSEmod should be 0.85 degF2. | | | | | | |

**Table 2. Algorithm performance comparison to COOLING calibration parameters**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **COOLING** | | | | | |
| Parameter | M2Calibration | | M3Algorithm | | M4Algorithm | |
| Clean | Noisy | Clean | Noisy | Clean | Noisy |
|  | 100.00 | 98.91 |  |  |  |  |
|  | 0.96 | -0.67 |  |  |  |  |
|  | 1.50 | 1.50 |  |  |  |  |
|  | 1.82 | 1.12 |  |  |  |  |
| SSEmod |  |  |  |  |  |  |
| *Note:* Verify your SSEmod calculation. Cooling Actual Clean SSEmod should be 0.54 degF2.  Cooling Actual Noisy SSEmod should be 1.04 degF2. | | | | | | |

Using your M4 algorithm, analyze the 100 time histories provided by FOS, Inc. to identify the four relevant first-order system parameters (yL, yH, ts, and τ) from each time history. In Table 3, copy your results from M3 for the M3 algorithm, and record your results for your M4 algorithm. Take care with units and decimal places when presenting results.

**Table 3. Algorithm performance comparison for FOS designs**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Model Number** | **M3 Algorithm** | | | **M4 Algorithm** | | |
| ** Characteristics** | | **Mean SSEmod**  **(degF2)** | ** Characteristics** | | **Mean SSEmod**  **(degF2)** |
| **Mean**  **(sec)** | **Standard Deviation**  **(sec)** | **Mean**  **(sec)** | **Standard Deviation**  **(sec)** |
| FOS-1 |  |  |  |  |  |  |
| FOS-2 |  |  |  |  |  |  |
| FOS-3 |  |  |  |  |  |  |
| FOS-4 |  |  |  |  |  |  |
| FOS-5 |  |  |  |  |  |  |

As necessary, make improvements to your price versus time constant (τ) regression model in **Project\_M4Regression\_sss\_tt.m**. Complete the price versus tau regression analysis on the 100 data sets using your M3 algorithm and your M4 algorithm. Generate a regression plot for your M3 algorithm and your M4 algorithm. Report the results of each model in Table 4.

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| **Learning Objective (LO): 12.00 Perform linear regression** |
| **Learning Objective (LO): 13.00 Perform function discovery and data transformations** |
| **Learning Objective (LO): 07.00 Create and evaluate x-y plots suitable for technical presentation (this includes all appropriate sub-LOs)** |

<*insert your M3 algorithm regression plot here*>

<*insert your refined M4 algorithm regression plot here*>

**Table 4. Algorithm performance comparison for**

**price versus time constant regression models**

|  |  |  |
| --- | --- | --- |
| **Regression Result** | **M3 Algorithm** | **M4 Algorithm** |
| General Equation |  |  |
| SSE ($2) |  |  |
| SST ($2) |  |  |
| r2 |  |  |

**Refinement Category 2: Algorithm Efficiency (*Required*)**

***After refining the efficiency of your code***, complete Table 5 below to show the effects of your refinements. Use the MATLAB built-in functions **tic** and **toc** to measure how long it takes your code to execute. *Efficiency refinements must be clearly commented in your code with the text Category 2 AND adequate description.**Do not remove code; comment out unnecessary code and comment on the change. New code must be designated as such.*

**Table 5. Efficiency measurement results.**

|  |  |
| --- | --- |
| **Algorithm** | **Execution Time (sec)** |
| **M3 Algorithm** |  |
| **M4 Algorithm** |  |

**Refinement Category 3: Algorithm Insight (*Required*)**

***After refining the robustness and performance of your algorithm*** in light of changes in a thresholding or other variable hardcoded in your algorithm, create one or more plots that illustrate the insights you have gained. The plot(s) should be suitable for technical presentation and clearly illustrate the effect of changes on the parameter identification and/or regression results. Write a paragraph that complements the plot(s). This paragraph must clearly describe changes to the thresholding or other variables hardcoded in your algorithm and the insights you gained. *The variables used in this analysis must be clearly commented in your code with the text Category 3 AND adequate description.*

*If you need guidance or other suggestions about how to execute this refinement, be sure to ask the teaching team*.

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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 your ‘insight’ plot(s) here*>

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| **Learning Objective (LO): 21.02 Communicate ideas clearly and concisely** |

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| **Description of Insights Gained**  <*write description here*> |

**Technical Brief Draft**

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| **Learning Objective (LO): 21.02 Communicate ideas clearly and concisely** |
| **Learning Objective (LO): 21.03 Evaluate model or algorithm development (e.g. ideas, work, functionality) using evidence-based rationales** |
| **Learning Objective (LO): 07.00 Create and evaluate x-y plots suitable for technical presentation (this includes all appropriate sub-LOs)** |

Resave ENGR132\_Sp17\_FOS-Project\_M4\_TechnicalBrief\_Template.docx as **Project\_M4TechnicalBrief\_*sss.tt*.docx**. Use this template to respond to the M4 FOS memo. You may find the original M1 FOS memo and project introduction materials useful when composing your technical brief.

M4 References Used in Evidence-Based Rationales

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