# *Computational Methods in Physics*: Simulation Project

## Description

This document describes the second project for *PHYS 351: Computational Methods in Physics*.

## Instructions for Submission

**<u>Project Requirements</u>**

(1) Define and clearly summarize a physical system that you would like to model in *Mathematica*. You may either select a pre-approved simulation problem or suggest an original of your own design. (No projectile problems will be accepted.) The system does not have to be overly complex, but it should involve approximately three or more adjustable parameters that the user controls. As a good source of ideas, see either the Wolfram Demonstration Projects (www.demonstrations.wolfram.com), the challenge problems from an introductory, calculus-based physics text, or problems from an upper division textbook.

(2) Produce a flowchart for the final version of your computer simulation. It's expected that you a use flowchart to aid in the design of the program. Your flowchart will evolve as you write your program, so only your final flowchart is required as part of your submission.

(3) Write a pseudocode for your simulation. Similar to the flowchart discussion above, only the final pseudocode is required.

(4) Write a *Mathematica* computer simulation that models your physical system. The code does not necessarily need to produce a graphical result. It should include lots of comments so a human can read your code and understand what it's doing without actually executing the code. A copy of the code should be included as an appendix in your write-up, and the Mathematica notebook should be uploaded along with your writeup for verification purposes.

(5) Describe the verification and validation process for your code.

(6) By the start of class on **Thursday, October 25** either identify your selected Simulation problem or submit a proposed problem to the instructor. Submit your proposals by email to [redacted]

(7) The final writeup is due by **Friday November 9 at 12:00**.

## Expectations for the Paper

In the write-up for your project it's expected that the paper includes the following items,

(a) Title

(b) Author

(c) An introductory section that includes

- relevant background information
- a description of why the current work is relevant
- a clear and concise statement of the hypothesis
- a brief statement of the main findings

(d) A section describing the theory

(e) A section describing the procedure and analysis methods

As part of this section you should address what assumptions your simulation uses and what are its limitations. This is also the appropriate section to include the required flowchart and pseudocode.

(f) A section that critically analyzes the results

This section is where you should include a discussion on verification and validation (ie, how did you test your code and did it work as expected).

(g) A concluding section that summarizes the work by restating the purpose and the main conclusion, along with placing the results in context

(h) An appendix that includes a copy of the commented code.

The written grade will be based on the following nine categories:

(a) Format

(1) *Purpose*: Identify a problem to be solved

(2) *Presentation*: Report should be logically sequenced and includes all the necessary components: title, author, introduction, theory, methodology, analysis, and conclusion

(3) *Style*: The writing must be presented in a clear manner, including the use of sections, accurate grammar, and proper labels on graphs

(b) Reproducibility

(4) *Design*: Describe the experimental procedure clearly and completely

(5) *Data*: All data is recorded and clearly presented

(6) *Verification*: Ensure that the implementation of the physical model is correct

(c) Analysis

(7) Analysis: The data is carefully and accurately analyzed

(8) Validation: Assess the results by considering face validity and/or comparisons to independent methods

(9) Conclusion: Make and justify a reasonable conclusion

The full rubric, which explains how each of the above items are evaluated, is included at the end of this document.

**Submission**

Once your report is typed up, submit two files through the Workshop tool in Moodle. File 1: A pdf version of your report. Title your report,

Simulation Project LastName

Do not use the "Submission content" area. All of your report should be included in the writeup file.

File 2: The Mathematica notebook for your project. Title your notebook

Simulation Project Code LastName

## Instructions for Assessment

Each student must assess three other reports using the *Written Report Rubric*. The rubric is available both as a pdf on the Moodle page and as a part of the assessment process. It is highly suggested that you have a hardcopy of the rubric in hand as they assess their peers. The version of the rubric in Moodle can be difficulty to read in sections.

After completely reading a single project, you will be asked to identify which level of compliance the paper corresponds to in each of the nine categories. Students must also provide an summative statement in order to complete the assessment. The summative statement need not be long but it should highlight the key complimentary points, and identify areas that could have been better presented.

## Conclusion

Your final grade for this laboratory report is a combination of how your peers assessed your work and how you assess your peers. Eighty percent of your final grade comes from the average of your peers assessment of your report. The remaining twenty percent is based on your participation in assess others. The participation grade is calculated by Moodle and is based on how similar your grade is to the other peer assessments.

If you feel that the peer assessment grade does not accurately reflect your work you may appeal their peer score. After a written appeal request is received, the instructor will assess the report and the final grade is based on the instructor's scoring. With an appeal to the instructor's score the grade is final even if the instructor's assessment is lower than the peer assessment.

## Written Report Rubric

| | **Unsatisfactory** — 0 points — | **Requires Improvement** — 1 point — | **Satisfactory** — 2 points — | **Exceptional** — 3 points — |
|---|---|---|---|---|
| **Purpose:** *Identify a problem to be solve* | No mention is made of the problem to be solved or the problem identified is too simple. | An attempt is made to identify the problem to be solved but it's described in a confusing manner. | The problem to be solved is described but there are minor omissions or vague details. | The problem to be solved is clearly stated. |
| **Presentation:** *Report should be logically sequenced and includes all the necessary discussions: title, author, introduction, theory, methodology, analysis, and conclusion* | More than two sections are missing or out of sequence. | Not more than two sections are missing or out of sequence. | Not more than one section is missing or out of sequence. | The report is logically sequenced; it includes an introduction; sections on the theory, methodology, and analysis; and a relevant conclusion. |
| **Style:** *The writing must be presented in a clear manner, including the use of sections, accurate grammar, and proper labels on graphs* | Sections are not labeled; English is poor; figures/graphs are not titled nor labeled. | Sections are labeled; frequent errors in grammar; figures/graphs labeled but contain errors in units, axes or headings. | Sections are labeled; English is generally correct; figures/graphs correctly labeled but not titled. | Sections are labeled; grammatically correct English; figures/graphs correctly titled & labeled. |
| **Design:** *Describe the experimental procedure clearly and completely* | An experimental procedure is missing or extremely vague and/or necessary supporting diagrams are missing. | An experimental procedure is present but important details are missing. It takes a lot of effort to comprehend and/or diagrams are present but unclear. | An experimental procedure is present but with minor omissions or vague details. The procedure takes some effort to comprehend. Diagrams are present but contain minor errors. | The experimental procedure and diagrams are present, clear, and complete. |
| **Data:** *All data is recorded and clearly presented* | Data is not presented. | Some data is included but without reference or explanation to its source; data is presented in a confusing way. | Most data is included with reference or explanation to its source; data is presented in a clear way. | All data is included with reference or explanation to its source; data is presented in a clear way. |

## Written Report Rubric

| | **Unsatisfactory**<br>— 0 points — | **Requires Improvement**<br>— 1 point — | **Satisfactory**<br>— 2 points — | **Exceptional**<br>— 3 points — |
|---|---|---|---|---|
| **Verification:** *Ensure that the implementation of the physical model is correct* | Mathematical procedure is either missing, or the equations written down are irrelevant to the design. | A mathematical procedure is described, but it's incorrect or incomplete, due to which the final answer cannot be calculated; or units are inconsistent. | A correct and complete mathematical procedure is described but an error is made in the calculations. All units are consistent. | Mathematical procedure is fully consistent with the design. All quantities are calculated correctly with proper units. Final answer is meaningful. |
| **Analysis:** *The data is carefully and accurately analyzed* | Dimensional analysis is not used. Math not shown. Figures display data incorrectly. | Calculations contain substantial errors in dimensional analysis or math. Figures are incorrect. No labels or legends are present. | Calculations contain some errors in dimensional analysis or math. Figures are correct but variables unlabeled. | Calculations clearly laid out. Dimensional analysis and math are correct. Figures display data correctly, all variables labeled. |
| **Validation:** *Assess the results by considering face validity and/or comparisons to independent methods* | No attempt is made to evaluate the consistency of the result using an independent method. | An independent method is used to validate the results. However, the independent method is not properly referenced or there is little or no discussion about the differences in the results due to the two methods. | An independent method is used and properly referenced to validate the results. The results of the two methods are compared correctly using experimental uncertainties. But there is little or no discussion of the possible reasons for the differences when the results are different. | An independent method is used and properly referenced to validate the results and the evaluation is correctly done within the experimental uncertainties. The discrepancy between the results of the two methods, and possible reasons are discussed. |
| **Conclusion:** *Make and justify a reasonable conclusion* | No attempt is made to state or justify a conclusion | A conclusion is stated, but its justification is either absent, missing major steps, or contains major mistakes. | A conclusion is stated and justified, but it's inconsistent with the results of the analysis, or it's incomplete. | A conclusion is stated and justified, and it's consistent with the results of the analysis. |