

Responses to Reviewers

Response to Reviewer 1 Comments

1. Summary

We sincerely thank you for taking the time to review our final report. After reading the feedback, we realized that the original report mainly described the hardware design, but did not fully explain how the system was evaluated. To address these issues, we revised the report and prepared a supplementary document.

2. Questions for General Evaluation

| | Reviewer's Evaluation |
|-------------------------------------|-----------------------|
| Purpose | Yes |
| Functionality | Yes |
| Subsystem Overview | Yes |
| Equations & Simulations | Yes |
| Design Alternatives | Must be improved |
| Design Description & Justification | Yes |
| Subsystem Diagrams & Schematics | Must be improved |
| Cost | Yes |
| Schedule | Must be improved |
| Completeness of Requirements | Must be improved |
| Appropriate Verification Procedures | Must be improved |
| Quantitative Results | Must be improved |
| Accomplishments | Can be improved |
| Uncertainties | Can be improved |
| Future Work / Alternatives | Yes |
| Ethical Considerations | Yes |

3. Point-by-point response to Comments and Suggestions for Authors

Comments 1: There is no discussion of design alternatives anywhere in the report, such as considering different op-amps and rejecting them with reasons, alternative architectures considered, or other approaches that were tried and discarded. The appendix shows an “initial principle design” but does not compare it as an alternative — it is just the predecessor of the same design.

Response 1: Thank you for pointing this out. The original report focused too much on the final PCB design and did not explain why we chose this design over other options.

We have added a new **Design Alternatives** section. In this section, we compare the final analog solver with several other choices, including using the STM32 as a digital solver, using different op-amps, using a single-supply circuit, and building the system on a breadboard.

[Added text: A digital STM32-based solver was considered, but it would make the project a software-based numerical solver instead of a continuous-time analog solver. The LM358 was

selected because it is low-cost and sufficient for low-frequency demonstration. A single-supply design was also considered, but the dual-supply design makes the waveform easier to observe around ground. We also considered building the circuit on a breadboard at the beginning. However, during early testing, we found that the wiring was easy to disconnect.]

Comments 2: Figures 2 and 6 are very small and have hard-to-read component labels. Please produce an updated version that is easier to read. Seek to achieve the same font size as Figure 5, for example.

Response 2: We agree that Figures 2 and 6 were not clear enough in the original report. We have replaced these figures with larger and clearer versions.

Comments 3: No high-level requirements are stated with tolerances. In Section 1.1, you mention wanting to “reduce computational latency” but no quantifiable target is given. Please develop requirements with quantifiable metrics. You might try to recreate the analytic solution to an ODE with specific coefficients and assess the error of the solver against that solution.

Response 3: This is a fair comment. The original report described the goal of the project, but it did not give clear numerical requirements. We have added a requirements section with measurable targets.

[Added text: For the second-order ODE mode, the main waveform behavior should stay within 15% of the analytic prediction. The output should remain stable under stable coefficient settings, and the waveform should be observable continuously on the oscilloscope without visible delay.]

Comments 4: Likewise, no verification procedures are given. Section 2.6.2 mentions using an oscilloscope to “verify the real-time response” but does not describe any test protocol or report any measurement. Can you export the oscilloscope measurements and compare with an analytic solution in MATLAB or Excel? Come up with an approach and describe it.

Response 4: We added a Verification section to make the test method clearer. The verification is based on a simple comparison between the theoretical waveform in MATLAB and the actual oscilloscope waveform.

In the revised procedure, a second-order ODE model is first built in MATLAB. Sine, triangle, and square wave inputs are applied separately to obtain the theoretical output waveforms. Then the same types of input waveforms are applied to the actual hardware, and the output is observed on the oscilloscope. During measurement, the oscilloscope cursor is used to read several basic parameters.

[Added text: For sine and triangle wave inputs, the main comparison items are output peak-to-peak voltage and frequency. For square-wave input, the main comparison items are the high level, the low level, and the frequency. These values can be read directly using the oscilloscope cursor and compared with the MATLAB theoretical waveform.]

Comments 5: No measured quantitative results from the hardware appear anywhere in the report.

Response 5: We agree that the original report did not include enough quantitative hardware results. The report mainly described the circuit structure and waveform observation, but did not compare measured values with theoretical results.

To improve this part, we added a Verification section. This section uses theoretical results from MATLAB and oscilloscope cursor readings for comparison.

Comments 6: Please develop the necessary quantitative requirements, perform them, show the results, write a discussion of them. Include a discussion of the uncertainties. Then rewrite the accomplishments of the project.

Response 6: We also added an uncertainty discussion. Since the system is built with real analog components, the actual waveform cannot perfectly match the MATLAB theoretical result. Possible error sources include resistor and capacitor tolerance, potentiometer adjustment, and oscilloscope cursor reading error.

Response to Reviewer 2 Comments

1. Summary

We sincerely thank the instructor for the detailed evaluation and helpful comments on our final report. The comments helped us identify several important weaknesses in the original submission, especially the unclear figure readability, insufficient verification results, and the need to clarify the current limitation of the project. In response, we have revised the report to make the project scope more accurate, improve the presentation of the figures, and strengthen the verification section with more specific testing methods and measurable evaluation criteria.

2. Questions for General Evaluation

Reviewer's Evaluation.

Does the introduction provide sufficient background and include all relevant references?

Yes

Is the research design appropriate?

Can be improved.

Are the methods adequately described?

Yes

Are the results clearly presented?

Can be improved.

Are the conclusions supported by the results?

Can be improved.

Are all figures and tables clear and well-presented?

Can be improved.

3. Point-by-point response to Comments and Suggestions for Authors

Comments 1: The project can only show the shape of waves and get some qualitative assessment of the output. There is no accurate setting of parameters and it is not of too much application with this limited function at this stage.

Response 1: We sincerely appreciate the important suggestion made by the instructor. We agree that the initial report may have overstated the actual capabilities of the system. In the current hardware implementation, the system is mainly a demonstration platform for showing the behavior of simple dynamic systems rather than a high-precision simulation calculation instrument.

To address this issue, we revised the report to clarify the current scope and limitations of the project. Now, the OLED display is described as a qualitative waveform preview interface, while the oscilloscope is emphasized as the main device for waveform measurement. This is consistent with the design of the system, where the OLED is mainly used for displaying selected waveform types and basic previews, rather than for accurate amplitude, frequency, phase or transient response measurements. The oscilloscope is used for more reliable real-time waveform observation and verification. The final report has separated the qualitative preview of the OLED from the measurement based on the oscilloscope, and this viewpoint has been further emphasized in the revised discussion.

Additionally, we adjusted the expression "precise solution of differential equations", and the revised expression is: This project demonstrates a low-latency analog method for visualizing the responses of first-order and second-order differential equations. We also added a limitation note to explain that the current parameter settings are adjusted through potentiometers and resistor-capacitor networks, so the coefficient values are approximations and are affected by component tolerances, the non-ideal behavior of operational amplifiers, and measurement uncertainties. This is consistent with future work discussions in the report, where component tolerances and the limited bandwidth of the operational amplifier are recognized as sources of error.

[The current system should be understood as a hardware demonstration platform for low-latency analog ODE visualization. It can show the qualitative waveform behavior of first-order and second-order dynamic systems, such as rise, decay, oscillation, and damping. However, because the coefficients are adjusted by potentiometers and passive components, the parameter settings are not yet calibrated with high numerical accuracy. Therefore, the current implementation is more suitable for educational demonstration and waveform-based analysis than for precise engineering computation.]

Comments 2: Increase fonts in Figure 1 and Figure 3. Too small to be seen.

Response 2: Thank you for pointing this out. We agree that the original Figure 1 and Figure 3 were difficult to read because the text labels inside the block diagrams were too small. In the revised report, both figures have been redesigned with larger fonts, clearer module labels, and simplified internal descriptions.

Comments 3: Requirements and Verification: not sufficient verification results.

Response 3: We sincerely appreciate the suggestions made by the instructor. We agree that the original report failed to provide sufficient verification results to fully support the system requirements. Although the report described the oscilloscope as the main measuring device, the original version did not include sufficient measurement data, comparison standards, or verification tables.

To address this issue, we revised the discussion content in the "Requirements and Verification" section, adding a more complete verification plan and clearer expected results. The revised report now qualitatively distinguishes between verification and quantitative oscilloscope verification. OLED is used to verify the normal operation of waveform selection and user interface functions, while the oscilloscope is used to verify the actual analog output waveforms. This distinction is very important because OLED can only provide a simplified

preview, while the oscilloscope can measure amplitude, frequency, phase difference, rise time, overshoot, damping behavior, and stabilization time.