

# MEC6215 - Numerical Methods in Engineering

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#### Feedback on Duty A

by [Sebastien Leclaire](#), Friday October 15th, 2021, 01:16 PM

Hello,

In general, your work is of excellent quality and what differentiates the marks between your homework is not necessarily very significant, but I had to decide in some places.

On the other hand, for Issue 3, some teams did not use ArrayFire to resolve the issue. One of my objectives with this course is the fact that I want to learn to master this library in order to train you in the use of modern computational architecture (eg GPUs) in the application of numerical methods. Please, for future assignments use the ArrayFire API unless otherwise specified. No one was penalized for this for Duty A.

Here are the criteria I used to assess Assignment A:

*General appreciation of the work*

*Respect of the statement*

*Problem 1 - Demonstrate an understanding of Lobatto quadrature*

*Problem 2- Demonstrates an understanding of explicit ODE solvers*

*Problem 3 - Demonstrates an understanding of the method of shooting*

*Quality of presentation*

*Problem 2 - Compare and discuss the results against the analytical solution*

*Problem 2 - Compare and discuss the performance and accuracy of each of the implementations*

*Problem 3 - The error is well commented as well as the results.*

*Accuracy of results and code*

*Depth of analyzes*

*Comment the code well*



Here are some comments in relation to these points:

### Respect of the statement

Make sure you answer all of the items requested. Sometimes people forgot to discuss certain items that were requested. If you are not sure, you can write to me and ask me. For example, if I ask to put a specific table in the report, please put it. You will automatically lose points if you don't.

**Problem 1 - Demonstrates an understanding of Lobatto quadrature**

**Problem 2 - Demonstrates an understanding of explicit ODE solvers**

**Problem 3 - Demonstrates an understanding of the firing method**

Almost everyone has correctly understood these three elements above.

### Quality of presentation

Generally speaking, I was not very harsh on this part, as most of the elements I mentioned in the first report have been taken into account, but I will increase my demands here for your next reports. Please take the following into account to further improve the presentation.

- Pagination - Double numbering, Roman numeral or other type of numbering before the first "relevant" page (usually the first relevant page is the introduction).
- Pay attention to the size of the characters so that it is uniform between your sections.
- After the table of contents for the different sections, it is also good when there is a list of tables and figures, but it does not matter if there is not.
- Make sure the title of your document is correct!
- Number all your equations. There is a different "school" of thought here, but I think it's better to number them all. The reason is that when the report is to be shared between different people, it is sometimes necessary to refer to an equation during discussion and exchange and it is better when there is a number. Imagine saying to someone the following sentence: "Go see the equation just after the paragraph that ends with such and such a sentence ..." This is much more fair saying, go see equation number X ". I hope my explanation is still understandable. Roughly speaking, the numbering of the equations facilitates future discussions and exchanges. You will notice that in scientific papers, generally all the equations are numbered.
- Make sure that once converted to PDF, the quality of your figures and equations remains good. This was not the case for everyone.
- Make sure your graphics are understandable when in black and white. You can print your work in "black and white PDF" format to check and be sure.
- Make sure your graphics are legible. It does not help much to present a graphic which is difficult to interpret because you cannot discern the symbols.
- Have a consistent scoring in the report. For example, sometimes some people used for problem 2 the quantity "h" for the step and interchangeable for "dt" in other places. We can even go further and try to have a consistent notation also between the code and the report, so that your report can easily be used to understand a code and the report therefore serves as a reference.

### Problem 2 - Compare and discuss the results against the analytical solution.

All the teams (except one!) Did not explicitly address this requested point. Before starting the assessment, I had weighted this point at 8% of the total mark. In fact, I don't really know how it would have been possible to answer this point without presenting and discussing at least the analytical solution. So be careful to respond to the elements I ask. If you are unsure of what you can do for a given topic, drop me a line so I can provide some additional material to enlighten you and maybe even give you some ideas if you are really stuck. For example, the team which treated this point presented the analytical solution and well explained the expected behavior of this solution. She then compared and discussed the numerical results obtained with respect to the analytical solution using the solution for an example particle. There was even a graph that plotted the analytical vs numerical solution for each of the methods. It was a good way to illustrate and respond to this point.

### Problem 2 - Compare and discuss the performance and accuracy of each of the implementations

Regarding the precision of the implementations, all the teams addressed it. The table to be filled in allowed this comparison and discussion.

In relation to performance, some teams looked at the total time required to run the algorithm and other teams looked at the performance of the algorithms based on the number of iterations. These are interesting elements, but they don't always give a clear conclusion. All the same, some teams have carried out interesting analyzes, even talking about "memory used".

On this subject and concerning the evaluation of the performance of EDOs resolvers, I think that a correct and robust way to proceed is to first fix the target error that we want to obtain ( $E_{cible}$ ) and then calculate the time required for resolvers to achieve this precision. This is a kind of problem where you have to find the zero of a function so the error  $E$  which respects the function  $F(t^i) = E(t^i) - E_{cible} = 0$  where the index "i" corresponds to the method used and  $t^i$  is the time taken by method "i". The quantity  $t^i$  is also the variable that we seek to find to respect the target error  $F(t^i) = 0$ . Some people have made comments that come close to this and understand that RK4 performs better for this problem to achieve similar accuracy. Next,

No one has done this type of performance study, but that's okay, I'm giving these comments to enrich your personal science culture.

#### Accuracy of results and code

When the results you get are "strange" and do not conform to the expected theory. It is important to draw a visual graph to try to understand what is happening (eg graph of the analytical solution vs numerical solution). This at least helps to show so visually if the results are still good.

Note, inside a main computation loop, you should never use `scalar <T> ()` to transfer one scalar at a time from "device" to "host". A call of this type is blocking and very slow. This is a method that exists in the library only for "debugging" or when it is obvious that it will not cause a performance problem.

#### Depth of analyzes

Often this part is confused with reporting and commenting on the results in general. The analysis is above all the part where you explain the results obtained, explaining the results with key theoretical elements. This is an important part of a report where you demonstrate your expertise in understanding the topic.

One way to explain your results is to find explanations through the scientific literature and what has been seen in class and then refer to to explain your own results. Of course, you have to make sure that the conditions for comparisons are reasonably the same or you have to be clear when making an assumption that is not the same as a statement.

#### Comment the code well

As I specified in a forum post, this aspect was actually "given" points for people who bothered to do it.

If you have any questions about your report, you can contact me.

Hope you enjoy this feedback, thank you and good luck,

Sebastien leclaire

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