

NuMe - SoSe23 - Homework 3

Instructions:

- Demonstration codes available in moodle can be utilized (with necessary modifications).
- The solution must be typed using LaTeX (a template `homework.tex` is available in moodle). The file can be edited online using the service <https://www.overleaf.com>.
- The submission is due July 14th 2023 at the end of the day.

Problem 1: time integraton schemes.

1. Using the finite difference method, approximate the derivative $\partial q/\partial t$. What order of accuracy does your approximation have?
2. Apply your approximation to the linear system of ODEs

$$\frac{\partial q}{\partial t} = Lq. \tag{1}$$

3. Is your scheme explicit or implicit? What determines that?
4. Write your scheme as an update formula for q^{n+1} .
5. Which operations (i.e., matrix-matrix, matrix-vector, inverse, etc.) are necessary to compute the update?
6. In your case, does the time-step have to be bounded? If so, by which condition? Explain why or why not.

Problem 2: stiffness.

1. There is no concrete definition of a stiff problem. In your own words, write a concise enough definition for stiffness.
2. Compare and contrast the use of explicit vs implicit time integration schemes. *Both in relation to stability/accuracy and relative computation time.*
3. Provide an example of a flow simulation where an explicit scheme is preferable. Explain why.
4. In contrast, provide an example of a flow simulation where an implicit scheme is preferable (or crucial). Explain why.