Using the θ-method to solve ODEs: List of Corrections

MMSC Cohort 2026–27

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The numbers in the list below correspond to the handwritten numbers in circles on the marked up scan of the "badly written document". Here is the list of errors we found in class.

1. No need for an apostrophe in ODE's.
2. It's is a contraction of it is. Here the meaning was belonging to it which is written its.
3. Typo — should have been "achieved"
4. The derivative in (1) should have been written

$$\frac{\mathrm{d}u}{\mathrm{d}t} = f(t,u)$$

   with a Roman font for the d in the numerator and denominator. Similarly a Roman font should be used for the d in an integral, e.g.

$$I = \int_0^1 x^2 \mathrm{d}x$$

   The Roman font can be achieved in LaTeX using `{\rm d}`.
5. f(t,u) should have been in maths font (e.g. using $ $) and written as $f(t,u)$. Maths in text should always have a maths font.
6. Again a maths font was needed but the point here was that the order of the arguments in a function should be consistent.
7. The correct spelling is "spatial".
8. The domain should have been written as $(-1,1) \times (0,T]$. Use `\times` in LaTeX to get the $\times$.
9. Avoid abbreviations. It is better to write do not, rather than don't, in formal written reports.
10. Ref. [1] is probably fine, but Reference [1], or just [1], would also be ok.
11. A hyphen is missing in θ-method.
12. The brackets are missing from around the equation number (remember to use `\eqref`).
13. We should have U_{n+1} rather than $U_n + 1$. Use `U_{n+1}` rather than `U_n+1`.
14. No need for a capital letter, we are not starting a new sentence. "where θ is between 0 and 1" is ambiguous (does it include the end points or not?). It might be better to say "where $\theta \in [0,1]$" which is more consistent with notation on page 1.

15. As a rule sentences should not start with a symbol or number. Here, writing "Three" would solve the problem, otherwise sentences should be reordered.
16. Leave a space between a word and a (. Open quotation marks correctly. LaTeX has a nasty habit of making them all look like closing quotation marks. Use `` and '' (i.e. two single quotes). First two items in list need a semi-colon (;) at the end.
17. Crank-Nicolson usually has a hyphen (remember to be consistent with this).
18. Follow the order section, subsection, subsubsection. Here the subsection was missing giving the weird subsubsection number 2.0.1. This should have been a subsection.
19. There is no need for indentation after (2). This has occurred because of a blank line after the equation in LaTeX. Avoid these!
20. The inline equation should not be split over multiple lines if possible. There's an argument that this should have just been a standard equation. The term $1/2\Delta t$ is unnecessarily confusing. It is not clear if we mean $1/(2\Delta t)$ or $\Delta t/2$ (of course it is the latter). Using brackets if there are multiple terms in the denominator, or reordering terms helps remove ambiguity.
21. Punctuate the equation. It ends the sentence so put a full stop at the end.
22. Punctuate the equation. It ends the sentence so put a full stop at the end.
23. No need for a colon before the equation.
24. Having lots of brackets all the same size makes it really hard to see which brackets pair up. Use `\left(` and `\right)` to get variable sized brackets. A neater version of the equation is

$$\begin{aligned} T_n &= \frac{1}{\Delta t}\left\{\left(u(t_{n+1/2}) + \frac{\Delta t}{2}u'(t_{n+1/2}) + \frac{1}{2}\left(\frac{\Delta t}{2}\right)^2 u''(t_{n+1/2})\right)\right. \\ &\quad \left. - \left(u(t_{n+1/2}) - \frac{\Delta t}{2}u'(t_{n+1/2}) + \frac{1}{2}\left(\frac{\Delta t}{2}\right)^2 u''(t_{n+1/2})\right)\right\} \\ &\quad -\theta\left(u'(t_{n+1/2}) + \frac{\Delta t}{2}u''(t_{n+1/2})\right) - (1-\theta)\left(u'(t_{n+1/2}) - \frac{\Delta t}{2}u''(t_{n+1/2})\right) + \mathcal{O}(\Delta t^2)\,. \end{aligned}$$

25. The last line of the equation is too long and overwrites the equation number. Also the font for $O(\Delta t^2)$ is wrong. It should be $\mathcal{O}(\Delta t^2)$ (use `\mathcal{O}`). Or perhaps even better $\mathcal{O}((\Delta t)^2)$ (but this change should be made consistently throughout the document).
26. Typo — too many "the"s. (Very easy to overlook!)
27. *theta* should be θ (remember the backslash in LaTeX).
28. (??) should have been sorted out — the cross referencing here was to an equation label which did not exist.
29. Re-arrange should be rearrange.
30. The first two equations should have been lined up so that the equals signs were one below the other.

31. Avoid using the $\Longrightarrow$ sign. Generally there should be words to explain what is going on. So after Equation (6) we could have:

    Subtracting (5) from (6), taking the modulus and applying the triangle inequality gives

$$\begin{aligned} |u_{n+1} - U_{n+1}| \;\leq\; & |u_n - U_n| + \theta\Delta t |f(t_{n+1}, u_{n+1}) - f(t_{n+1}, U_{n+1})| \\ & + (1-\theta)\Delta t |f(t_n, u_n) - f(t_n, U_n)| + \Delta t |T_n| \; . \end{aligned}$$

32. Put commas around $f(t, u)$.
33. No colon needed at the end of the line.
34. Ω was never defined.
35. Use `\ll` in LaTeX to get better spacing. The spacing of $\ll$ (using `\ll`) is better than $<<$ (using `<<`).
36. Use `\max` to get the correct font and a better subscript, as in

$$T_{\max} = \max_{0 \leq n \leq N} |T_n|$$

    (Similarly remember `\sin`, `\exp`, `\log` etc.)
37. There is extra space before the equation caused by a blank line in the .tex file.
38. Use `\log`. While $\log\log(4+u^2)$ is much easier to read, perhaps $\log(\log(4+u^2))$ is even clearer.
39. There is no need for brackets around figure numbers.
40. Figure 1 is far too small. The legend would have been better in the top left or bottom right, i.e. not overlapping the curves. There should also be details of the numerics so that someone could reproduce the results. For example what is Δt? What is the tolerance for Newton's method?
41. Figure 2 is also too small but the new error here is that it is not discussed in the text. All figures should be discussed in the text so that the reader knows when to look at them and what to learn from them. It could be argued that this solution should have been on Figure 1, or that these figures could be next to each other.
42. The caption for Figure 2 needs to be more descriptive and the quotation marks need sorting out.
43. Need to be consistent about capitalisation in title, section titles etc. Either capitalise all words (except for articles and prepositions) or just the first word of the title and proper nouns. Mostly the document has capitalised everything so we need "Convergence Results". [Same holds in the title of the document.]
44. Never refer to just "the figure" or "the figure below". Refer to each figure specifically by its number.
45. The second occurrence of implicit Euler should have been Crank–Nicolson.
46. Using yellow as a colour for a line on a graph is not a good idea. It can be very hard to see.
47. There is a lack of consistency between the legend and caption of Figure 3 — use either $1/N$ or Δt.

48. Avoid using `\frac` in text. It is better to write 1/2.
49. Typo — order is spelt wrongly.
50. The references are inconsistent and incomplete. In particular:

    - Use "and" rather than & in the second reference;
    - Make the ordering of names consistent between references (i.e. always initials then surname or vice versa);
    - Capitalise all words in the title of the second reference.
    - The second reference needs a publisher and date.

    Optional extras are ISBN/doi. As well as authors and title, journal articles should always have the name of the journal, the volume (and number if appropriate), pages and year. Webpages should have the URL and date accessed.