# Question 8

=) The same code as Q7 is utilized in a new copy labelled "gulana - q8. py"

=) Choi et. al, 2024 stated that as the value of epsilon becomes very small, the presence of a boundary layer arises, characterized by thin gradients near the boundary. This leads to instability in the system and prevents the system from converging.

=) To test this, a smaller value of dx is utilised of $dx = 0.02$ ($T = 100$) to properly observe these changes.

=) Because I did not utilize scipy.sparse, my simulations at very fine grids take an

extremely long time to run, and only two cases were observed.

The graphs plotted for varying $\epsilon$ values can be found in

1) "gulana-98_epsilon_0.0001_dx=0.02.jpeg"

2) "gulana-98_epsilon_1e-05_dx=0.02.jpeg"

3) "gulana-98_epsilon_1e-06_dx=0.02.jpeg"

⇒ As the value of epsilon decreases, the width of the boundary layer tends to decrease. We can see this as a steeper gradient at $t=0.250s$ for $\epsilon = 10^{-4}$, and a less steep gradient for $\epsilon = 10^{-5}, 10^{-6}$.

⇒ To reproduce the graphs, simply run the code as is.