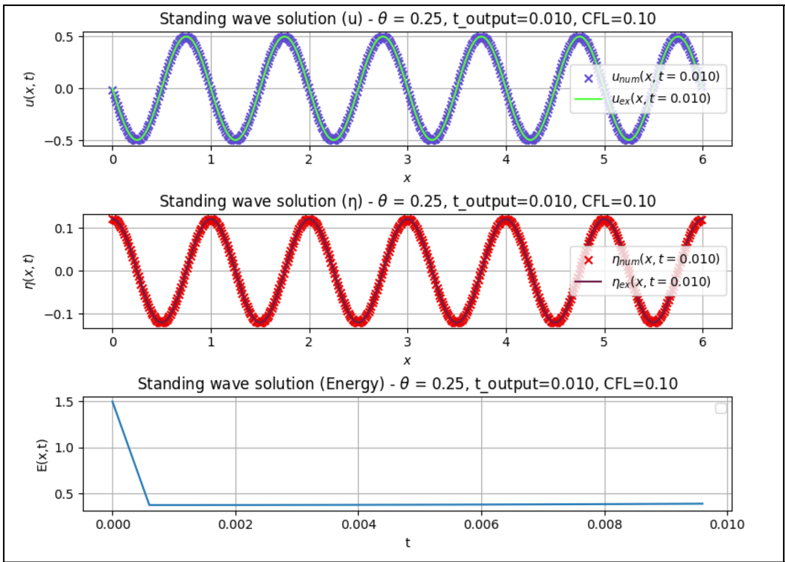
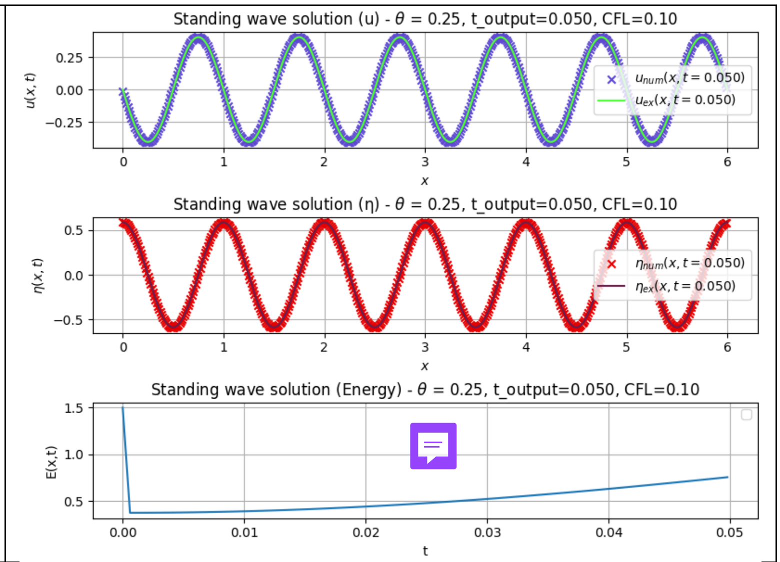
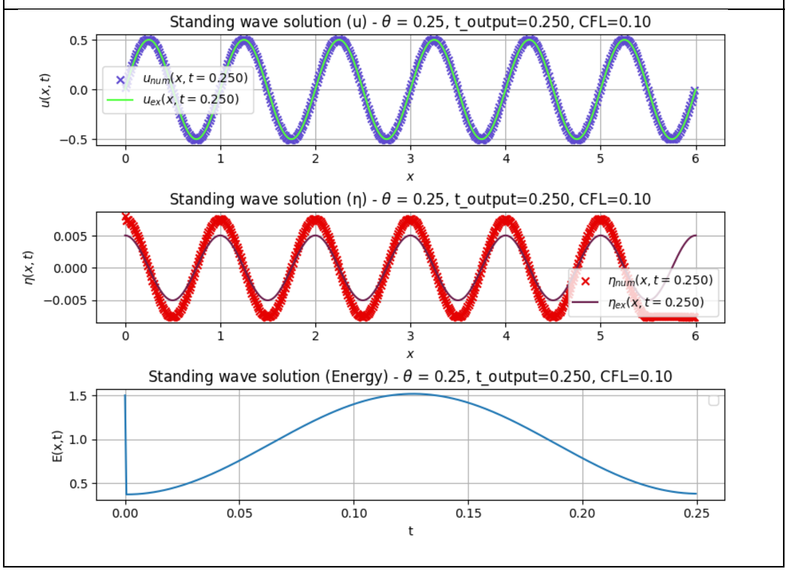
Question 6 and 7 (Exercises 2)

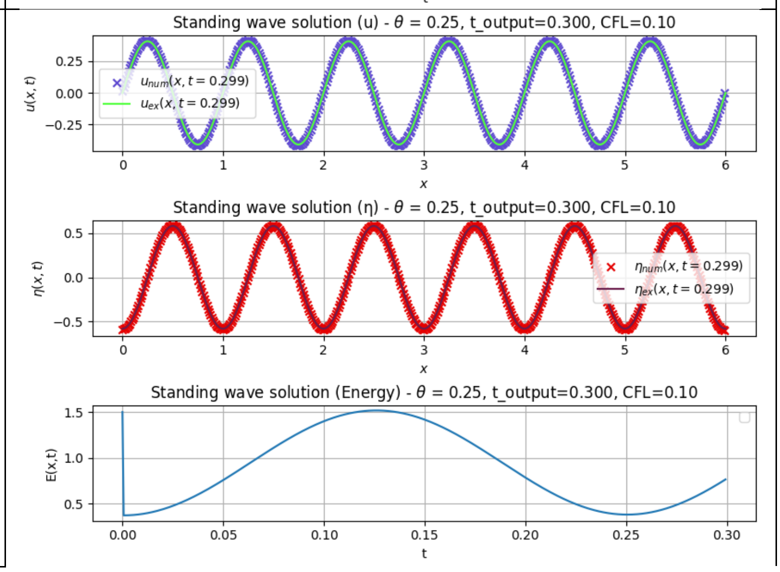
My code Ex2Q67codeadapted.py was used to produce the following. This is built on my code for Qu4 and uses the provided code SWE_DG0.py as a reference for initial conditions and exact solutions (adapted for u, η). I have used H_0 here (instead of H(x) in the middle of each cell – I don't know how to implement this). The time periods used here are quite small as for whatever reason, my code for this question and Qu4 gives numerical solutions equal zero when the period for t, t_output, is over 0.5. I have used CFL=0.1 as it gives good convergence to the exact solution and my code doesn't like CFL values over, say, 0.5 for some reason.

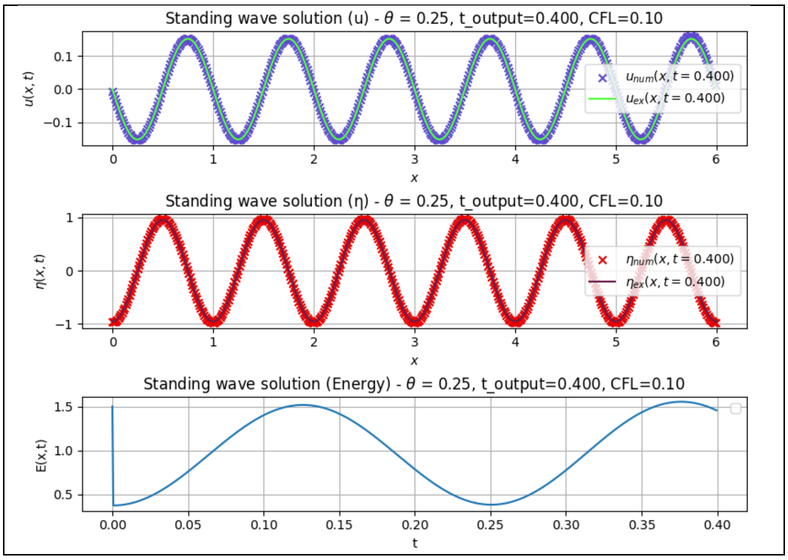
The below shows the solutions over a few values of t_output, from t_output = 0.01 to t_output=0.4.





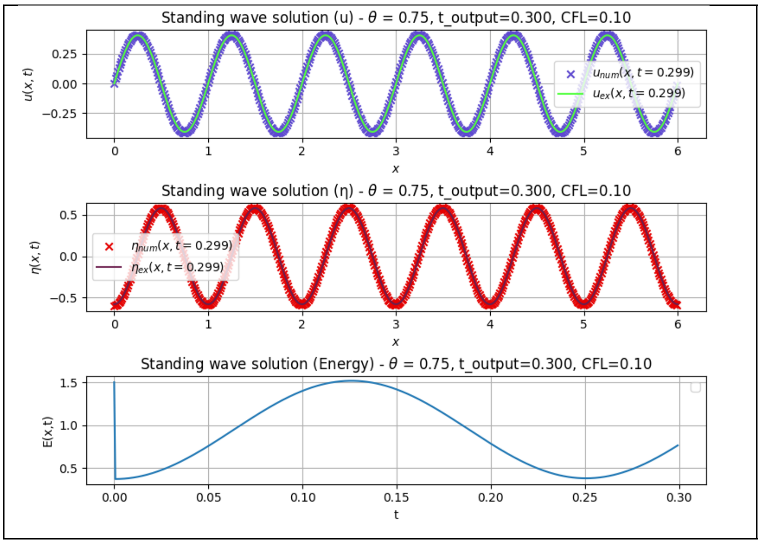


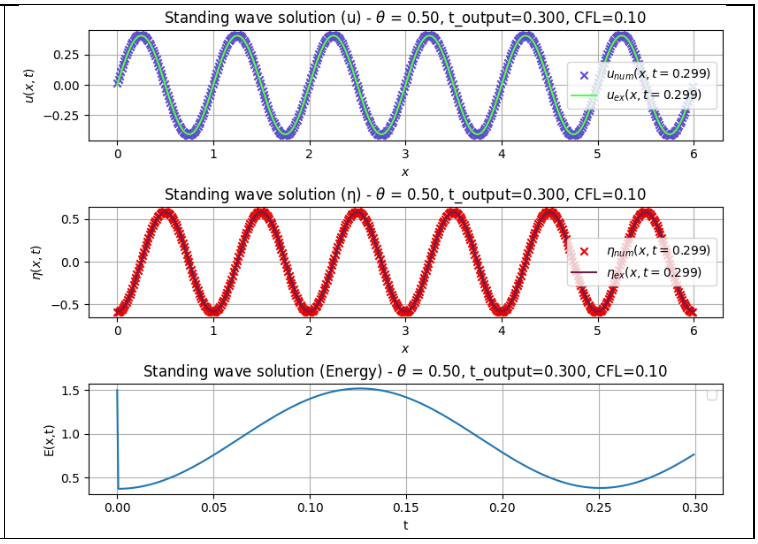


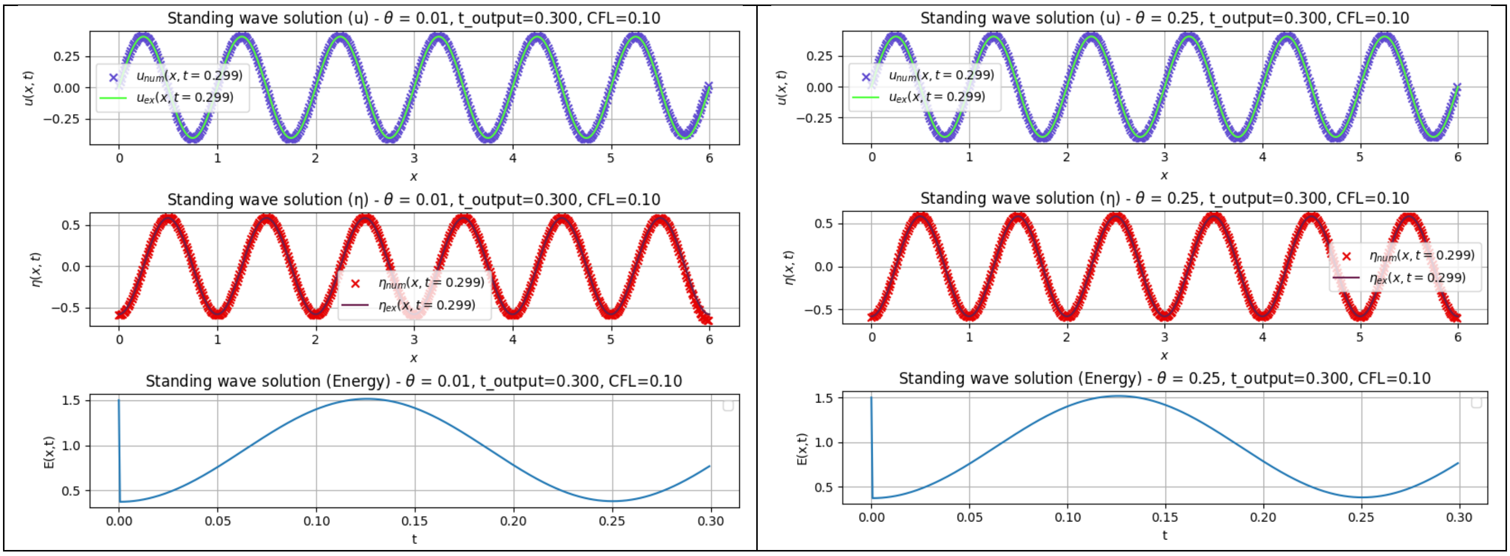


We can see that η ie wave amplitude increases with time, which is sufficient to show that discrete energy is conserved. We can see that the actual E value is periodic and does not decay with x or t, as expected. It is interesting that the numerical solution for η diverges from the exact solution for t=0.25, but does not do this for any other value – I suspect this is a rounding error or similar.

The below shows different values for θ (t_output =0.4, CFL = 0.1).







Changing θ has no apparent effect, which is what we are after.

Note: I'm a bit worried about the exact solutions, as there is no divergence between the exact solutions and numerical solutions at all. To rigorously test this, I have ran random integer values for the fluxes and calculated the exact values from "fresh" x and t values. These showed that the numerical solution is not dependent on the exact values/calculated solely from the ICs and visa versa. The convergence is accurate.