1)

Which matches our stencil from previous exercises.

2)

3)

Rearranging:

Two first order coupled differential equations.

4)

One row is times the other.

One row is multiplied by the other

Doing a quick check:

5)

Or

Make the Ansatz

They are “wiggulating” solutions, i.e. they are complex exponential/superposition of sine and cosine.

6)

a)

b) 0.0402

7)

b)

c)

8)

a)

The approximate solution was not accurate, it quickly became unstable and oscillated around the exact solution at greater and greater amplitudes. This is most likely due to the fact that we are approximating a sinusoidal solution with a linear approximation.

b)

While increasing the number of nodes helped approximate the solution close to the initial condition, it then rapidly picking up amplitudes as it oscillated around the solution. The increase in nodes did not help particularly, and a Fourier approximation would be a better solution.

Optional:

A particularly interesting initial value problem that I’m using at the moment is the Schrodinger Equation for stationary state solutions:

Where the solution can be found as:

is some vector of functions with only spatial variables.

is a vector containing the functions describing the state of the system

is Plankt’s constant normalized by it has units of momentum

is the Hamiltonian operators, which has eigenvalues of Energy in the energy Eigen state. It can take different forms for different systems.