MATH 2121 **Mathematical Modeling and Simulation** **Spring 2024**

Problem Set 5

(Out Tue 03/12/2024, Due Thu 03/21/2024)

Submissions are to be done by emailing to the course instructor: all requested Matlab files, plus a single file (PDF preferred), called `yourfamilyname_pset5.pdf` that contains all requested explanations.

Problem 5

Modify the Matlab file `temple_abm_traffic_car_following.m` from the course website `http://math.temple.edu/~seibold/teaching/2024_2121/` in the following ways:

(a) Change the initial velocities of vehicles to `v = (1:n)'`. Present the results and explain what this change represents.

(b) Now change the time step `dt` to 0.1, and the number of compute steps per plotting event `np` to 1. This way, the same time passes between plotting events, but now with only one, rather than 10, time steps. Submit your code under the filename `yourfamilyname_problem5b.m` . Running the code should produce a weird behavior. Explain what happens and why.

(c) For the previous code, change the time stepping from Euler's method to Runge-Kutta 4. Submit your code under the filename `yourfamilyname_problem5c.m` , and explain why the new time stepping fixes the problem encountered in (b).

(d) Change your code from part (c) to have `dt = 1e-2` and `np = 10` again, but keep the Runge-Kutte 4 time stepping. With this code, conduct a parameter study how the characteristics of the traffic wave depend on the strength of the optimal velocity term. Specifically, vary the coefficient (which is 0.5 in the original file) in front of the term from 0 to 2, in steps of 0.05. For each choice, obtain the maximum and minimum vehicle velocity, $u_{\max}$ and $u_{\min}$, at the final time. Using these data, plot $u_{\max}$ and $u_{\min}$ as functions of the parameter. Describe your observations and explain the result. Submit your code under the filename `yourfamilyname_problem5d.m` .