Temple Math 5044 **Introduction to Numerical Analysis II** **Spring 2019**

Problem Set 4

(Out Mon 02/11/2019, Due Wed 02/20/2019)

Problem 4

Download the Matlab program `temple5044_voyager.m` from the course web site, and run it.

(a) Describe in your own words what the program does, and what it shows.

(b) Find out how to use Matlab's `ode45.m`, and apply the solver to the given test case, using a relative tolerance of 10^{-9}.

(c) Modify the system's initial conditions correctly, so that the `ode45.m` solution matches the true Voyager 1 trajectory towards and past jupiter. Use online resources to find the true trajectory. Note that Voyager 1 swang by jupiter 546 days after its start.

(d) Now modify the `temple5044_voyager.m` code to incorporate *your own* adaptive time integrator. Use the `ode45.m` reference solution to verify that your numerical solution is reasonably accurate.

(e) On your developed test case (of a realistic swing-by), run your own adaptive integrator with three choices of tolerances TOL, as follows: (i) TOL is too large, so the solution is inaccurate; (ii) TOL is sufficiently small, so that the numerical solution is satisfactory in the "eye-norm"; and (iii) TOL is one tenth of the choice in (ii). For all three cases, plot the path of the voyager probe, and its position after 1,164 days. Where should it be, and where does it end up in the numerical solutions?

Instructions

For each problem set, you need to submit one document, either in class or via email to the course instructor, that contains plots and explanations (hand-written or typed). If you decide to email the document, name it `yourfamilyname_problemset1.pdf`, where 1 stands for the number of the problem set.

In addition, for each programming task, email your respective program to the course instructor, under the filename `yourfamilyname_problem1a.m`, where `1` stands for the problem number and `a` for the sub-problem letter.