Temple 3044 Numerical Analysis II Spring 2012

Problem Set 5

(Out Thu 02/16/2012, Due Thu 02/23/2012)

Instructions

- Problems marked with **(T)** are theory problems. Their solutions are to be submitted on paper.
- Problems marked with **(P)** are practical problems, and require the use of the computer. Their solutions are to be submitted on paper, and usually require two parts: (a) a description of the underlying theory; and (b) code segments, printouts of program outputs, plots, and whatever it required to convince the grader that you have understood the theory and addressed all practical challenges appropriately.

Generally, naked numbers are not acceptable. Solutions must include a short write-up describing the problem, your solution technique, and procedural details. To include a computer printout use the cut and paste method for placement of materials in your work. All things must be clearly labeled.

Problem E

(P) Download the Matlab program `temple3044_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) Modify the time integrator to adaptive time stepping (writing your own routine, not using Matlab's ODE integrators), so that the swing-by at jupiter is simulated very accurately, without requiring too small time steps away from the swing-by event.

(c) Run your code on the given test case 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 final position.

(d) Using your accurate code, participate in the following competition: Try to find the smallest initial velocity for the Voyager probe (without changing any other parameters), such that it leaves the solar system (i.e. its distance from the sun is at least 1.5 times jupiter's distance from the sun) before 3000 earth days have passed. Whoever achieves this task with the smallest velocity (and demonstrates that the computation is correct), receives 20 bonus points.