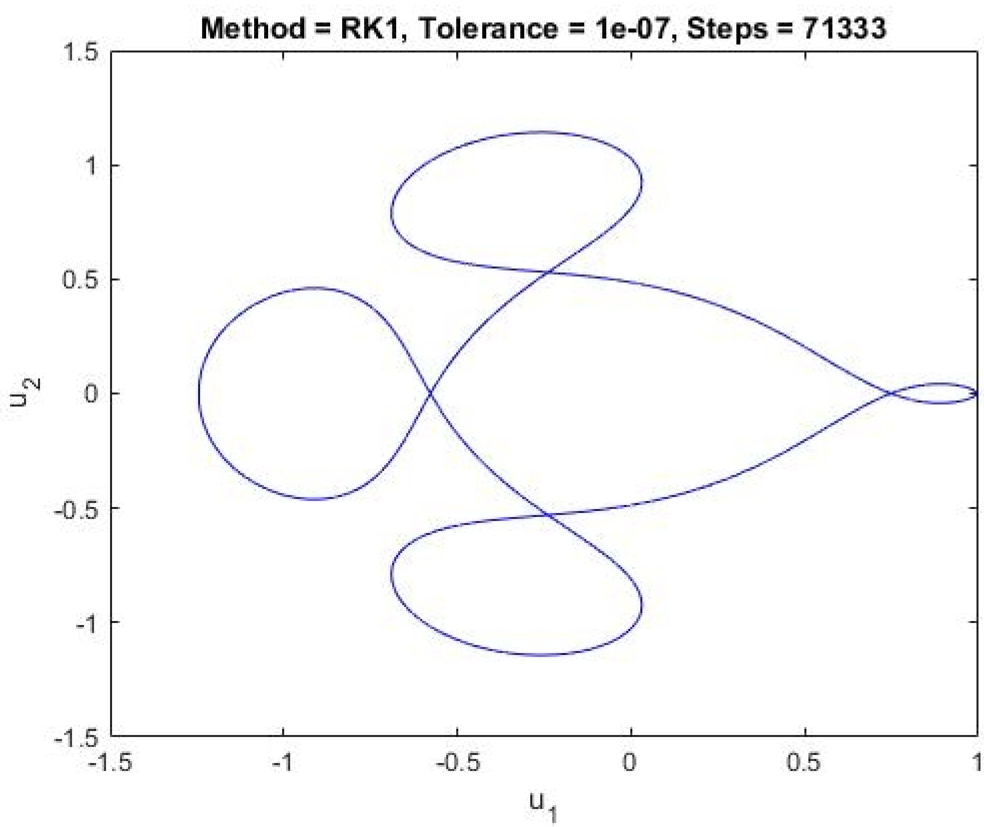
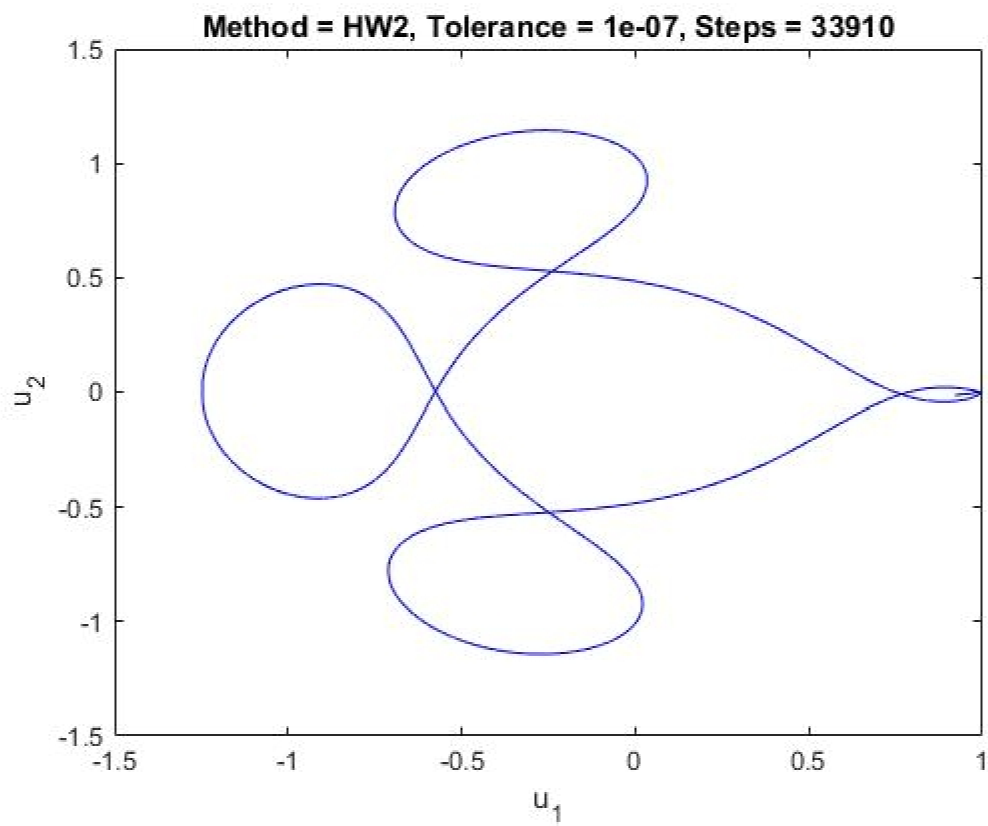
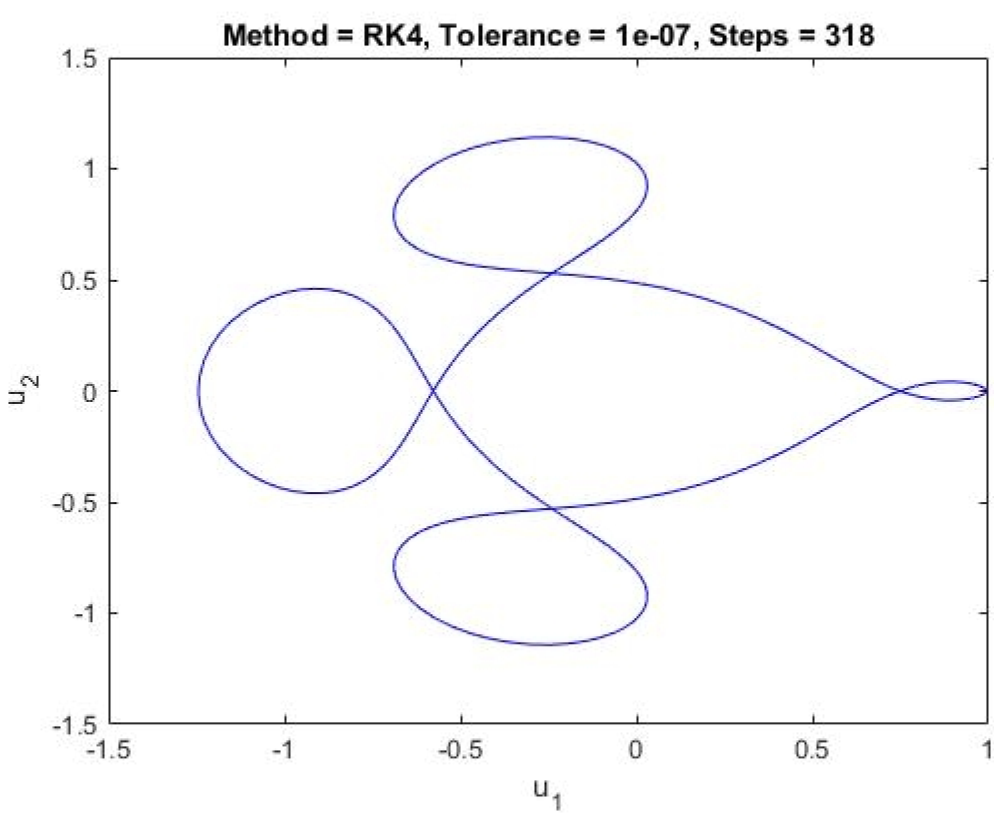
Andrew Alferman
MTH 552
Homework #4
Due Wed, Feb 15, 2017

1) The attached MATLAB code wasen modified as directed. The code allows for either fixed stepsize or automatic stepsize to be selected, depending if the value assigned to “autostep” is true or false. The “method” variable represents the numerical method to be used; 'RK1' and 'ExplicitEuler' represent the Euler method, 'RK4' represents the RK method from problem 2 of Assignment 2, and 'HW2' represents the RK method from problem 2 of Assignment 2. The “steps” variable counts how often the function f is being evaluated.

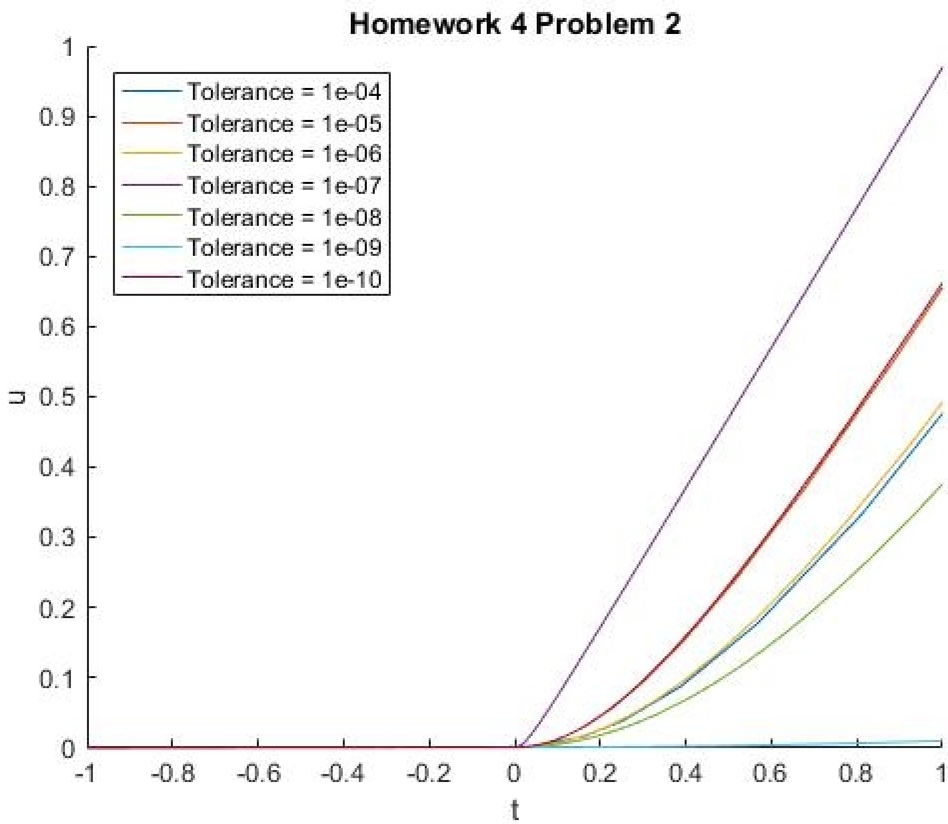
   A tolerance of $1x10^{-7}$ was selected because it yielded a visually correct plot of u_1 versus u_2 for all three methods evaluated. A tolerance value of $2x10^{-7}$ with the HW2 method yielded a plot that was noticeably distorted, while the Euler method and RK4 methods yielded acceptable plots at that tolerance value. The code output the figures below. The number of steps can be found on each graph. All three methods came up with comparable plots, however the RK4 method was much faster than the other two methods. Although the HW2 method used fewer steps than the Euler method (RK1), the computation time was similar due to the larger number of computations needed for each step.



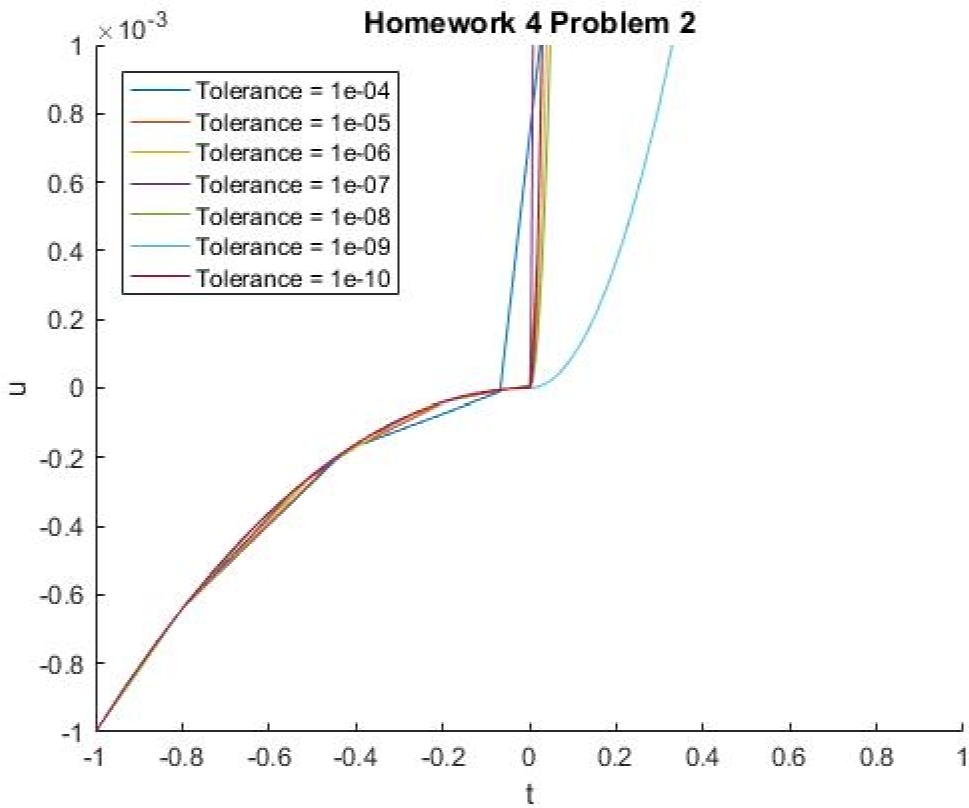

Method = HW2, Tolerance = 1e-07, Steps = 33910
1.5
1
0.5
0
-0.5
-1
-1.5
u_2
-1.5
-1
-0.5
0
0.5
1
u_1


Method = RK4, Tolerance = 1e-07, Steps = 318
1.5
1
0.5
0
-0.5
-1
-1.5
u_2
-1.5
-1
-0.5
0
0.5
1
u_1

2) The attached code has been modified was modified as directed. At first, it appears as if the solution to the IVP is completely flat for $-1 \leq t \leq 0$, while each of the curves for $0 < t \leq 1$ are different for each of the tolerances that were evaluated. This result is illustrated below:



Upon closer inspection, by limiting the y axis to $-0.001 \leq u \leq 0.001$ it can be seen that the IVP converges from $-1 \leq t \leq 0$, and the solution blows up when $t > 0$. The results do not converge when $t > 0$, and therefore the RK4 method may be unstable in this range.


Homework 4 Problem 2
×10^-3
Tolerance = 1e-04
Tolerance = 1e-05
Tolerance = 1e-06
Tolerance = 1e-07
Tolerance = 1e-08
Tolerance = 1e-09
Tolerance = 1e-10
u
t
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1