

**MA573 - Fall 2022 Homework 2 - Due September 16th**

**Hirsh-Smale-Devaney Problems**

*Chapter 1: 2(c),2(d), 3(b),(c), 5,11,12,*

**Additional Problem(s):**

**Problem 1:** *We wish to test the Euler method on the simple initial value problem  $x' = x$ ,  $x(0) = 1$ .*

- (i) Find the solution analytically, and calculate the exact value of  $x(1)$ .*
- (ii) Write up Euler's method for this equation in the coding language of your choice. With step size  $\Delta t = 1$ , estimate  $x(1)$  numerically; call it  $\tilde{x}_0(1)$ . Repeat using the step-sizes  $\Delta t = 10^{-n}$  to obtain new approximations  $\tilde{x}_n(1)$ , of  $x(1)$  for  $n = 1, 2, 3, 4, 5$*
- (iii) Plot the error,  $E = |\tilde{x}_n(1) - x(1)|$ , between approximate and actual solution as function of the step-size  $\Delta t$ . Now plot  $\log E$  vrs.  $\log t$  and explain the results.*
- (iv) Repeat parts (ii) - (iii) for the Improved Euler's method and the Runge-Kutta method, comparing all three methods.*
- (v) (optional, but will be useful later on) Also try using one of MATLAB's built in solver packages such as "ode45" (which is a fancier version of the Runge-Kutta method) or "ode15s."*

*Provide all of your codes at the end of your write-up.*