MATH 420 Homework #4 Due: Friday, 4 May 2018

Instructions: A printed copy of your homework should be handed in at **the start of class** the day it is due. If you have any supplementary electronic files you wish to turn in (e.g. R scripts or wxMaxima files) email them to the instructor prior to class with file name format: `Lastname-hwX.ext`. Each part of each exercise is worth 10 points unless stated otherwise.

Exercise 1: Look up a bifurcation not discussed in lecture (i.e., not a Saddle-Node, Transcritical, Pitch-fork, or Hopf bifurcation) and describe it. Include a bifurcation diagram or similar graphical illustration of the bifurcation, and discuss at least one application in which the bifurcation is relevant.

For each of the following, use a for loop to construct a plot of asymptotic states (e.g. equilibria, min and max of limit cycles, etc.) as a function of a single parameter value varied over some "interesting" range of values. For any bifurcations, provide some discussion of what type of bifurcation is involved, and what dynamics are observed on either side of the bifurcation (see `RM.R` on the course website).

Exercise 2: Consider an interval of r values that includes 0 for

$$\dot{x} = r - x^2.$$

Hint: You should be able to do this analytically to check your simulations (and deal with the solutions for $r < 0$ running off to $-\infty$) by finding the equlibrium points and sketching the stable point(s) them as a function of parameter r.

Exercise 3: Consider an interval of r values that includes 0 for

$$\dot{x} = r\,x - x^2.$$

Exercise 4: Another set of equations of your choice (e.g. SIR type model, Lorenz equations, etc.).