## Math 33B Homework 5 Due Thursday, July 28, 2022

Do the following problems from each section of the textbook:

- 9.6: 14,26,34
- 9.8: 14,22,28
- 9.9: 4,12

Do the following additional problems:

1. The system

$$\frac{dR}{dt} = R(1 - R + \frac{1}{2}S) \\ \frac{dS}{dt} = S(\frac{5}{2} - \frac{3}{2}S + \frac{1}{4}R)$$

is a *cooperative* species model. This means the presence of the other population is beneficial for both parties (think bees and flowers!)

- (a) Perform a global analysis of this system: find all the equilibrium points, and sketch a phase plot by hand, making sure to draw the *R* and *S*-nullclines.
- (b) Suppose that the R and S populations are initially 3 each. Describe the long term behavior of these populations.
- 2. The system

$$\frac{dR}{dt} = R(-R - S + 70)$$
$$\frac{dS}{dt} = S(-2R - S + a)$$

is a competing species model, where  $\frac{dS}{dt}$  depends on some parameter  $a \ge 0$ .

- (a) Find the two non-zero bifurcation values of a. (*Hint: these occur when the number of equilibrium points change.*)
- (b) Describe the fates of the R and S populations before and after each of these bifurcations. Make sure your answers are justified mathematically by performing any necessary qualitative analyses of the model.