Methods:

For part (a) of this task, the dynamics of the numerical solution for different values of delay were analyzed by running the difference scheme equation: for 2000 steps. The initial value is defined on , meaning all with were set to . The *PopGrowDelay.m* function runs the delay growth model over 2000 steps. It takes following parameters: Initial value , Growth rate , Step size , Carrying capacity , delay , and Number of steps. The results were then visualized and interpreted regarding the population size, the relationship between oscillatory peaks, period and the delay term.

The next three parts analyzed the differential equations of the 2D representation of the parasite/food system. The systems is defined on the time span [0, 20] with fixed birth rate = 1, and death rate . We performed multiple parameter sweep processes to analyze the effect of rate of food growth , food decay , and food consumption :

Parameters that do not satisfy following conditions will be ignored:

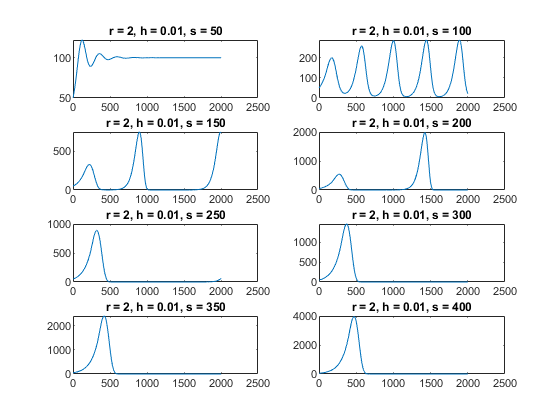
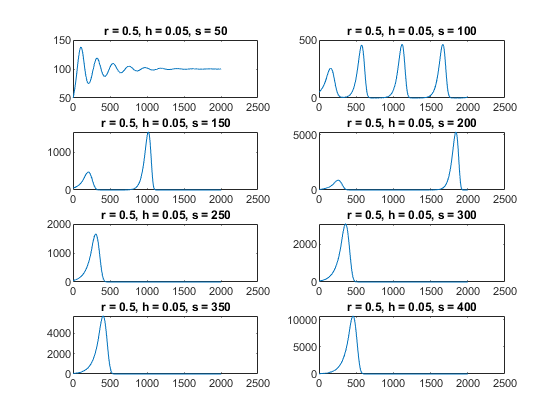
* The population is non-negative at all time.
* The system tend to enter a stable state of either or with and .

MATLAB ODE45 built-in function was used with the *ParasiteGrowthModel.m* function to solve the differential equations of and . The results then are then applied through the above conditions to determine successful parameters. Three parameter sweeps function *SweepK3.m, SweepK3K4.m,* and *SweepK4K5.m* are used for task b, c, and d respectively.

Results:

a) Delay Growth Model

After introduce the delay term into the equation, we plotted the population size against steps to see the dynamics of the system [**Figure 1**].



**Figure 1**: Population growth with delay term (s)

For both cases of growth rate *r* and stepsize *h*, with a small delay term (, the population temporarily oscillates and approach the stable point of carrying capacity . As s increases into 100, we observed permanent oscillations around the carrying capacity with a larger period. However, after reaching a threshold of s, the population goes extinct because the degree of the delay is so violent.