MTH-326 MATH MODELING SPRING 2024
Homework 2 Due Friday 02/14/2025

1. Reconsider the pig problem of Example 1.1, but now assume that the price for pigs is starting to level off. Let

$$p = 0.65 - 0.01t + 0.00004t^2 \tag{1}$$

represent the price for pigs (cents/lb) after t days.

(a) Use MATLAB or MAPLE to graph eqn. (1) along with our original price equation.

(b) Find the best time to sell the pig.

(c) The parameter 0.00004 represents the rate at which price is leveling off. Conduct a sensitivity analysis on this parameter. Consider both the optimal time to sell and the resulting profit.

(d) Compare the results of part (b) to the optimal solution contained in the text. Comment on the robustness of our assumptions about price.

2. It is estimated that the growth rate of the fin whale population (per year) is $rx(1 - x/K)$, where $r = 0.08$ is the intrinsic growth rate, $K = 400,000$ is the maximum sustainable population, and x is the current population, now around $70,000$. It is further estimated that the number of whales harvested per year is about $0.00001\,Ex$, where E is the level of fishing effort in boat-days. Given a fixed level of effort, population will eventually stabilize at the level where growth rate equals harvest rate.

(a) What level of effort will maximize the sustained harvest rate? Model as a one-variable optimization problem using the five-step method.

(b) Examine the sensitivity to the intrinsic growth rate. Consider both the optimum level of effort and the resulting population level.

(c) Examine the sensitivity to the maximum sustainable population. Consider both the optimum level of effort and the resulting population level.