1. Solve the IVP: \( \frac{dx}{dt} = 10x - x^2, \ x(0) = 1 \)

2. The time rate of change of a rabbit population \( P \) is proportional to the square root of \( P \). At time \( t = 0 \) (t measured in months) the population numbers 100 rabbits and is increasing at the rate of 20 rabbits per month. How many rabbits will there be one year later?
3. The time rate of change of an alligator population $P$ in a swamp is proportional to the square of $P$. The swamp contained a dozen alligators in 1998, two dozen in 2008. When will there be four dozen alligators in the swamp?

4. Suppose that the population $P(t)$ of a country satisfies the differential equation $\frac{dP}{dt} = kP(200 - P)$ with $k$ constant. Its population in 1950 was 100 million and was then growing at a rate of 1 million per year. Predict this country’s population for the year 2010.
5. Consider an animal population \( P(t) \) with constant death rate \( \delta = 0.01 \) (deaths per animal per month) and with birth rate \( \beta \) proportional to \( P \). Suppose that \( P(0) = 200 \) and \( P'(0) = 2 \).
   
a. When is \( P = 1000 \)?

b. When does doomsday occur?

6. Plot a slope field of \( \frac{dx}{dt} = x(x^2 - 4) \) by hand or with a computer and plot enough solution curves to indicate stability or instability of each critical point of this differential equation.
7. Suppose that a car starts from rest, its engine providing an acceleration of 10 ft/s², while the air resistance provides 0.1 ft/s² of deceleration for each foot per second of the car’s velocity.
   a. Find the car’s maximum possible (limiting) velocity.
   b. Find how long it takes the car to attain 90% of its limiting velocity, and how far it travels while doing so.

8. A motorboat weighs 32,000 lb and its motor provides a thrust of 5000 lb assume that the water resistance is 100 pounds for each foot per second of the speed \( v \) of the boat. Then
   \[
   1000 \frac{dv}{dt} = 5000 - 100v
   \]
   If the boat starts from rest, what is the maximum velocity it can attain?
9. (extra credit) According to a newspaper account, a paratrooper survived a training jump from 1200 ft when his parachute failed to open but provided some resistance by flapping unopened in the wind. Allegedly he hit the ground at 100 mi/hr after falling for 8 sec. Test the accuracy of this account. (hint: find $\rho$ in equation $\frac{dv}{dt} = -\rho v - g$ by assuming a terminal velocity of 100 mi/hr. Then calculate the time required to fall 1200 ft.)