Group Work 9: Nonlinear systems of differential equations

For each of the following systems of nonlinear differential equations:

a) Write it in the form $\frac{dv}{dt} = \mathbf{A}v + q(v) + r$, and specify what v, $\mathbf{A}$, $q(v)$, and r are.

b) Solve it using a suitable numerical integration method on the time domain $0 \leq t \leq 20$.

c) Find the steady-state solution $\frac{dv}{dt} = 0$ using Newton's method (if a steady-state exists).

1. Two organisms competing for the same resource.

$$\frac{dx}{dt} = Ax - Px^2 - Qxy$$

$$\frac{dy}{dt} = By - Rxy - Sy^2$$

Given: $A = B = P = Q = R = S = 1$, $(x_0, y_0) = (1, 1/2)$.

2. (Extra credit): A predator-prey model.

predator: $\frac{dx}{dt} = (Py - C)x$

prey: $\frac{dy}{dt} = (D - Qx)y$

Given: $D = C = P = Q = 1$, $(x_0, y_0) = (2, 10)$