# Course 28451: Optimizing Plantwide Operation

## Example : Linearisation of dynamic models: Predator–Prey Model of lynx and hare populations

Population dynamics includes the effects of competing populations, where one species may feed on another. This situation is referred to as the predator–prey problem that describes some of the features of historical records of lynx and hare populations.

In what follows a dynamic predator prey model is given. Let H(t) represent the number of hares

(prey) and let L(t) represent the number of lynxes (predator). The dynamics of the

system are modeled as:



In the first equation, *r* represents the growth rate of the hares, *k* represents the maximum population of the hares (in the absence of lynxes), *a* represents the interaction term that describes how the hares are diminished as a function of the lynx population and *c* controls the prey consumption rate for low hare population. In the second equation, *b* represents the growth coefficient of the lynxes and *d* represents the mortality rate of the lynxes. Note that the hare dynamics include a term that resembles the logistic growth model.

In this example, the following are solved:

1. Implement the system in Matlab Simulink and simulate the dynamic system. Use the following parameter values a = 3.2, b = 0.6, c = 50, d = 0.56, k = 125 and r = 1.6 and the initial conditions for hares and lynxes are given as [15 20]. You may use a time period of 100 years. Interpret and discuss the results.
2. Find the steady-state solution**(s)** of the dynamic model for hare and lynx populations. (either obtain algebraic solution or use matlab or matlab-simulink commands to this end). Linearize the system around steady-state solution (equilbrium point). Simulate the system behaviour at equilbeium point using the linear and nonlinear models. Compare ansd explain the simulation results. What are the differences?
3. Are the predictions of the linear model is valid at initial conditions different than equilbrium? (assume the predictions of the nonlinear model is correct).