

Here are 10 Differential equations (2 systems) that model phenomena we have studied. You should be able to see why they are appropriate, add some variants, have an idea what their qualitative behavior is, and perhaps consider limitations of these models.

Differential equation	Dynamical system it models	What it says
$y'' = -g$	Equation of motion due to gravity, ignore friction	
$y' = c y$	Population growth, continuous compounding $c > 0$ Exponential decay $c < 0$	
$y' = c y - a$	Annuity/fees problems	
$y' = c y (1 - y/N)$	Logistic growth	
$y' = c y (1 - y/N) - h$	Logistic growth with harvesting $h > 0$	
$y'' = -k y$	Harmonic oscillator	
$T' = k (S - T) \quad k > 0$	Newton's law of cooling (similar to memory models and RC circuit)	
$S' = A_{in} - A_{out} S$	Simple mixing	
$x' = a x - b xy$ $y' = -cy + d xy$	Lotka-Volterra predator prey	
$y' = v$ $v' = c y$	Another way to write a harmonic oscillator	