DEPARTMENT OF MATHEMATICS
SYLLABUS

Course # & Name: MAT 124: Mathematical Biology

Recommended Text(s) & Price: *Mathematical Models in Biology* by Leah Edelstein-Keshet (SIAM, 2005, $50.00)

Prepared by: Craig Benham UPC Approval Date: Fall 2006

Lecture(s)	Sections	Comments/Topics
1	Linear Difference Equations & Systems: Methods	Exponential solutions; Eigenvalues and qualitative behavior.
1.5	Linear Difference Equations & Systems: Applications	Population dynamics – plant propagation and insect generations; Red blood cell dynamics; Control of respiratory volume.
2	Nonlinear Difference Equations: Methods	Fixed points and their stability; Bifurcations, stable oscillations and period doubling; Graphical methods – cobwebbing.
1	Nonlinear Difference Equations: Applications	Logistic growth; Density-dependent population dynamics.
1	Systems of Nonlinear Difference Equations: Methods	Matrix representations; Fixed points and stability criteria.
1	Systems of Nonlinear Difference Equations: Applications	Host-parasitoid systems; CO_2 and ventilation volume; Population genetics.
2	ODEs and Systems (Linear Equations and Systems): Methods	Fixed points of ODEs and their stability (graphical methods); Matrix methods for linear systems; Eigenvalues and qualitative behavior; Phase plane and analysis.
1.5	ODEs and Systems (Linear Equations and Systems): Applications	Growth in a chemostat; Compartmental models in physiology.
2	ODEs and Systems (Nonlinear Equations and Systems): Methods	Fixed points and analysis of their stability; Nullclines and phase plane methods; Dimensional analysis.
3	ODEs and Systems (Nonlinear Equations and Systems): Applications	1. Enzyme kinetics - Michaelis-Menten; cooperativity; threshold phenomena; chemotherapy models. 2. Population dynamics - Predator prey systems; interspecies competition; mutualism; effects of fishing or hunting. 3. Epidemiology - SIR models, effects of vaccination

2-3	ODEs and Systems (Limit Cycles, Oscillations, and Excitable Systems): Methods	Poincare-Bendixson Theorem - existence of stable cycles; Cubic nullclines; Hopf bifurcation.
2	ODEs and Systems (Limit Cycles, Oscillations, and Excitable Systems): Applications	Transmission of action potentials in neurons - Hodgkin-Huxley equations; Fitzhugh-Nagumo analysis; Oscillations in population biology; Oscillatory chemical and biochemical systems; Circadian rhythms
2	PDEs (Transport Processes): Methods	The diffusion equation; Laminar hydrodynamics.
3	PDEs (Transport Processes): Applications	Diffusion in disease models, Diffusive transport in physiology; Hemodynamics.

Additional Notes:

This is 26 lectures of a total of 29. One will be devoted to the midterm exam, and two are for flexibility.

If time runs out, consider shortening or eliminating lectures on limit cycles, oscillations, and excitable systems.