DISTANCE CALCULUS @ Suffolk UNIVERSITY

Ordinary Differential Equations
Detailed Syllabus

Mathematics

- Features of an exponential functions: percentage versus average growth rate, instantaneous growth rate, and steady growth versus steady percentage growth. These ideas lead directly into an analysis of several exponential models: y'[x] = r y[x] (Exponential Differential Equation) y'[x] = r y[x] (1 - y[x]/b) (Logistic Differential Equation)
- Sometimes called the "controlled exponential growth", the Logistic Differential Equation has many similarities to the Exponential Differential Equation under certain initial conditions while diverging greatly in the global scale.
- Great emphasis on graphs of solutions and FlowPlots: {(1, y'[t])}.
- Visual inspection guides intuition and conceptual understanding of sensitive dependence on initial values, end behavior, equilibrium, families of solutions, and the phase line.
- Euler's method of approximation.
- Interaction of processes through systems of linear differential equations.
- Graphical and analytic examination of autonomous and non-autonomous differential equations.
- Gradient as a tool to investigate f[t,y] = y'[t].
- Phase lines, Bifurcation plots, and how these graphs indicate sensitivity and general solution behavior.
- Oscillators.
- Damped, undamped, Van der Pol's oscillators.
- Systems of linear equations and their connection to higher order equations such as oscillators.
- Boundary problems, integrating factors, and separating variables.

Science and Math Experience

- Exponential and Logistic modeling to determine decay involving radioactive half-life, carbon dating, inflation, and pharamcokineticist's investigations.
- Logistic Harvesting.
- Predator-Prey models.
- Lanchester's war models.
- Targeting.
- E coli growth models.
- Newton's law of cooling.
- Falling bodies and terminal velocity.
- Leaky buckets.
- Pot holes and Heartbeats.

Mathematics

- Graphical and analytical aspects of linear systems are explored.
- The Coefficient Matrix and its eigenvalues and eigenvectors are analyzed to establish connections between the formulas and the Flow plots.
- How do the features of the eigenvalues and eigenvectors signal sinks, sources, and swirling and their relative strengths?
- The value of Linearization.
- Linearizing non-linear Differential Systems.
- Investigating the most useful and trustworthy places to linearize and how to interpret the results.
- Lyapunov's rules.
- The Jacobian. Van der Pol oscillators.
- Gradient systems.

- Hamiltonian systems.
- Lorenz's chaotic 3D oscillator.
- Pendulum Oscillators.
- Their amplitudes, frequencies, forcing, damping.
- Transient and Steady states.
- Convolution integrals, DIrac delta functions, and Step functions as they relate to the examination of systems.

Science and Math Experience

- Electrical circuits.
- Chemical reactions.
- Drug metabolization.
- Pollution models: Predator Prey.
- Sensitivity to initial conditions as well as long term behavior.
- Resonance.
- Beats.
- Impulse, constant, and ramp-forced systems.
- Forcing the Van der Pol oscillator as well as the Duffing nonlinear oscillator.
- Targeting or specified outcomes.
- Long-range weather forecasting, hydrodynamic flows and the Lorenz chaotic differential equation system.

All Distance Calculus courses are offered via the Computer Science and Mathematics Department
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