MATH 488 – Ordinary Differential Equations and Dynamical Systems

Course Description from Bulletin: Boundary-value problems and Sturm-Liouville theory; linear system theory via eigenvalues and eigenvectors; Floquet theory; nonlinear systems: critical points, linearization, stability concepts, index theory, phase portrait analysis, limit cycles, and stable and unstable manifolds; bifurcation; and chaotic dynamics. (3-0-3)

Enrollment: Elective for AM and other majors

Textbook(s): S. Strogatz, *Nonlinear Dynamics and Chaos*, Perseus Publishing

Other required material:

Prerequisites: MATH 251, MATH 252

Objectives:

1. Students will learn nonlinear differential equations in the context of mathematical modeling.
2. Students will learn basic concepts in nonlinear dynamical systems, i.e., equilibrium solutions, linearization, limit cycles, stability, bifurcation, phase portraits and chaos.
3. Students will learn basic techniques and methods for analyzing nonlinear dynamics, i.e., Liapunov stability, index theory, Hopf bifurcation, Poincare-Bendixson theorem, stable/unstable/center manifolds and chaotic behavior.
4. Students will learn how to simulate nonlinear dynamics in Matlab.

Lecture schedule: 3 50 minute (or 2 75 minute) lectures per week

Course Outline:	Hours
1. Examples of differential equations as mathematical models; equilibrium solutions; existence and uniqueness theorem; boundary value problems; Sturm-Liouville theory	16
2. Linearization, linear stability, asymptotic stability, Poincare stability, Liapunov stability; Periodic solutions, limit cycles, and Floquet theory; phase portraits	12
3. Bifurcations and invariant manifolds: Saddle node, pitchfork, Hopf, period-doubling, homoclinic and heteroclinic bifurcations	12
4. Sensitive dependence on initial conditions and chaos	4
5. Applications to various problems in engineering and science	4

Assessment:		
	Homework	10-30%
	Computer Programs/Project	10-20%
	Quizzes/Tests	20-50%
	Final Exam	30-50%

Syllabus prepared by: Jeffrey Duan and Xiaofan Li
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