ECE 6740
Spring 2010
Severance

Course Syllabus
Nonlinear Systems

Professor: Dr. Frank L. Severance
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Office Hours: *To be announced*
Monday:
Tuesday:
Wednesday:
Thursday:
Friday:

Prerequisites:
Graduate student status and ECE 5950 (Linear Systems) or instructor's approval. ECE 5800 is highly recommended.

Text: (Required): *Nonlinear Dynamics and Chaos* (*with Applications to Physics, Biology, Chemistry and Engineering*) by Steven H. Strogatz; Perseus Publishing, 2000.

Grading Procedure:
Grades will be determined by the following criteria:

midterm tests **(2)**:	**30%**
assignments (**6**):	**30%**
Project (**1**):	**15%**
final examination:	**25%**

Final grades will based on over-all class performance.
All assignments and examinations will be announced well in advance.

Course Description:
This is a first course in nonlinear systems. In it you will learn to characterize nonlinear phenomena such as limit cycles and chaotic behavior, both analytically and numerically. We will also delve into the world of strange attractors and fractals. All this will be applied to a number of engineering, mechanical, biological and chemical problems. Specifically will consider the family nonlinear control problems (such as the inverted pendulum) and chaotic communication systems (such as the Cummo and Chua circuits.)

Academic Integrity:
All graded work, including the assignments, is expected to be your own. Failure to observe this rule will result in action by the office of *Student Judicial Affairs* and may result in a failing grade for the course.

Course Topics:

One-dimensional flows
Bifurcations
Zeeman machines
Flows on the circle
Two-dimensional flows
Linear systems
Phase plane analysis
Limit cycles
Poincare-Bendixson Theorem
Weakly nonlinear oscillators
Bifurcations - applications
Chaos
Lorenz equations
One-dimensional maps
Logistic map
Liapunov exponents
Fractals
Strange attractors
Lorentz attractor
Applications to communication systems

Control Systems at Western Michigan University

WMU offers a thorough program of study in control systems at the graduate level. These include the following courses:

ECE 5710: **Advanced Linear Systems -** See above topics.

ECE 6700: **Modern Control Systems** - Topics include canonical forms, observer and controller design, system identification, stochastic systems, Kalman filters and Lyapunov methods.

ECE 6710: **Optimal Control Systems** - Topic include static optimization, Lagrange multipliers, control of discrete time systems, regulator and tracking problems, Riccati and Kalman equations, the calculus of variations, continuous time systems, dynamic programming and Bellman's principle.

ECE 6740: **Nonlinear Systems** - Topics include system flows, bifurcations, Zeeman machines, flows on the circle, two-dimensional flows, phase plane analysis, limit cycles, Poincare-Bendixson theorem, weakly nonlinear oscillators, chaos, Lorenz equations, iterative maps, the logistic map, Lyapunov exponents, fractals and strange attractors.