Date of Approval by Department: November 14, 1990
Mathematics 2706 [39]: Chaos and Structural Stability in one Dimensional Dynamics
3 hours lecture, 2 hours laboratory; 4 credits
Computer and thought experiments will be used to illustrate concepts from one dimensional dynamical systems. Lectures will focus on theoretical concepts explaining the phenomena illustrated in the laboratory assignments. Topics include structural stability, chaos, symbolic dynamics, kneading sequences for folding maps, bifurcation in parameter spaces, periodic points and the Sarkovskii ordering, Cantor sets, and fractional dimension.
Prerequisites: Mathematics **1206 [4.3]**
Frequency of Offering: Once a year
Projected Enrollment: 25 students
Discussion: The material in this course contains current mathematics, yet it is accessible to undergraduates. This is quite unusual. The course should prove informative and exciting for our mathematics majors.

Texts

1. Devaney, Robert L., Chaos Fractals, and Dynamics: Computer Experiments in Modern Mathematics, Boston University Lecture Notes (1998)
2. Devaney, Robert L., An Introduction to Chaotic Dynamical Systems, Addison-Wesley (1987)
3. Wolfram, Stephen, Mathematica, Addison-Wesley (1988)

Topics

1. Structure of dynamical space: orbits and their asymptotic behavior, hyperbolicity.
2. Parameter spaces and normalizations: structural stability, generic phenomena, conjugacy.
3. Examples of real one dimensional systems: maps of the interval and the circle.
4. Combinations: kneading sequences and Sarkovskii's theorem.
5. Symbolic dynamics.
6. Feigenbaum phenomena, renormalization.
7. Fractals. Hausdorff dimension.
8. Brief introduction to complex numbers.
9. Introduction to dynamics in one complex variable.

Labs

1. Introduction to hardware and software, graphing and iterating. Newton's method.
2. Hyperbolic periodic cycles, graphic analysis, expansive maps of the circle.
3. Feigenbaum phenomenon I: periodic doubling and the first chaos point.
4. Feigenbaum phenomenon II: Hausdorff dimensions.
5. Complex dynamics: Julia sets of polynomials.
6. Complex dynamics: Parameter spaces of polynomials.

Grading: based on laboratory reports, class examinations, and final examination.