Math 457/557, Discrete Dynamical Systems, Spring 2009

Class Time: MWF 2-2:50p.m. in 117 Fenton
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Office Hours: 11-12 Mon., Wed., Fri. or by appointment
Textbook: A first course in chaotic dynamical systems, by R. Devaney.

1. Background and Goals. The aim of this course is to introduce students to discrete dynamical systems, which is a fancy term for the study of what can happen when one iterates a function. Topics covered include orbits, fixed and periodic points, bifurcations, symbolic dynamics, chaotic systems, Sarkovskii’s theorem, Cantor’s set, fractals, and the Mandelbrot set. For the in-class computer demonstrations we will use Mathematica, a powerful computer program for symbolic and numerical mathematical computations. The course will cover most of the chapters 2–11 and selected topics from the chapters 16–17 of the textbook.

2. Exams. There will be a midterm in-class exam on Wed. of week 6 and a final exam.

3. Homework. Homework problems will be assigned every week and are due in class on Wednesday on the material of the previous week. No late homework will be accepted.

4. Grading. The grading distribution will be as follows:
   
   Homework: 25%
   Midterm Exam: 25%
   Final Exam: 50%
Tentative Weekly Schedule

Week 1. *Examples of dynamical systems, Newton’s method, orbits, iterations.*
Read §2–3. Problems: §3: 2, 3, 7abd, 10, 11cde, 12, 15, 18.
Using Mathematica, compute the first 20 iterations of $P_{n+1} = \lambda(1 - P_n)P_n$ with $P_0 = 0.5$, when $\lambda = 1, 1.2, 2, 3.1$, and $3.5$. What do you observe?

Week 2. *Graphical analysis, attracting and repelling fixed points, periodic points.*
Read §4–5. Problems §4: 1abfg, 2abc, 4ef, 5, 6. §5: 1acefgh, 2abc, 4acfgij, 5, 7.

Week 3. *Bifurcations, period doubling.*
Read §6. Problems §6: 1adgi, 2, 3, 5, 10, 11, 12, 13, 16.

Week 4. *Dynamics of quadratic functions for $c \leq -2$, Cantor set, transition to chaos.*
Read §7–8. Problems: §7: 2, 3, 5, 7, 9, 10, 11, 12, 14, 21. §8: 3, 4, 5, 6, 7.

Week 5. *Symbolic dynamics.*

Read §10. Problems: §10: 3, 4, 5, 6, 7, 8, 9, 10, 15, 16, 20, 25, 26.

Week 7. *Sharkovskii’s theorem.*
Read §11. Problems: §11: 1, 2, 3, 4, 6, 7, 8.

Week 8. *Complex functions, dynamical systems in the plane.*
Read §15. Problems: §15: 1ade, 2, 3acd, 5abe, 7abcef, 8abf, 9.

Week 9. *The Julia set, the Mandelbrot set.*
Read §16, §17. Problems: §16: 1, 2, 3. §17: 1, 2.

Week 10. Final exam review.

Problems are due the Wednesday of the week after they are assigned.