Math 457/557, Discrete Dynamical Systems, Spring 2009

Class Time:	MWF 2-2:50p.m. in 117 Fenton
Instructor:	Dr. Marcin Bownik
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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, 4acfghij, 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 Read §9. Problems §8: 9, 11. §9: 1, 3, 5, 7, 9.

Week 6. *Chaotic dynamical systems.* **Midterm exam**.
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.