Math 538: Discrete Dynamical Systems and Chaos
Fall 2017

- Instructor: Chris Curtis
- Office: GMCS 591
- Office Hours: TBA
- Meeting Time: MW, 14:00-15:15
- Email: ccurtis@mail.sdsu.edu
- Office Phone: (619) 594-5962

Text: Chaos: An Introduction to Dynamical Systems, K.T. Alligood, T.D. Sauer, and J.A. Yorke

Prerequisites: Minimum grade of C in MATH 151, MATH 254 or 342A; or 342 B.

Official Course Description: One-and two-dimensional maps, equilibria and their stability, sensitive dependence on initial conditions, Lyupanov exponents, horseshoe maps, period doubling, chaotic attractors, Poincare maps, stable/unstable manifolds, bifurcations. Applications in biology, chemistry, physics, engineering, and other sciences.

Learning Outcomes:

1. **The Analysis of Nonlinear Maps:** You will learn how to linearize non-linear maps in one and two dimensions. You will learn how to compute eigenvalues of two-dimensional Jacobians. You will learn how to make predictions about nonlinear dynamics based on these computations.
2. **Chaos:** You will learn how to define identify chaotic dynamical systems in one and two dimensions. An introduction to symbolic dynamics will be presented to motivate sensitivity to initial conditions. You will learn how to compute Lyupanov exponents to further quantify

this sensitivity. You will learn how to build fractals, and how they characterize strange attractors in chaotic dynamical systems. You will learn how to compute and interpret horseshoe maps.

3. **Global Dynamics:** You will learn the defintion of stable, unstable, and center manifolds.

4. **Bifurcations:** You will learn the definition of bifurcations, and you will learn how to identify them for one dimensional maps. You will learn how to compute saddle/node, pitchfork, and transcritical bifurcations.

5. **Visualization in Matlab:** An important part of the course will be learning how to use Matlab to visualize results in dynamical systems.

Grading Policy: Your final score will consist of homework (45%), two midterms (15% each), and a final project (25 %). Homework is roughly due every week, though please pay attention to the schedule since there are exceptions to this (and every) rule.

Homework Policy: Any work you submit should be turned in via a Python notebook. Late work is not accepted unless you make arrangements with me in advance.

Exam Policy: Each exam will be take home and due a week after it is assigned. The exams should be worked out in great detail and with an emphasis on clarity. Graphs should be printed and clearly labeled.

Students with Disabilities: If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact Student Disability Services at (619) 594-6473. To avoid any delay in the receipt of your accommodations, you should contact Student Disability Services as soon as possible. Please note that accommodations are not retroactive, and that accommodations based upon disability cannot be provided until you have presented your instructor with an accommodation letter from Student Disability Services. Your cooperation is appreciated.

Week	Date	Sections
Week 1	08/28	Basic calculus facts and a little analysis
	08/30	Basic calculus facts and a little analysis
Week 2	09/04	Labor Day,
	09/06	1.1-1.2, HMWK 1 Due
Week 3	09/11	1.3-1.4
	09/13	1.3-1.4, HMWK 2 Due
Week 4	09/18	1.4-1.8
	09/20	1.4-1.8, HMWK 3 Due
Week 5	09/25	3.1-3.4
	09/27	3.1-3.4, HMWK 4 Due
Week 6	10/02	3.5, 6.1
	10/04	4.1, HMWK 5 Due
Week 7	10/09	2.1-2.4
	10/11	2.1-2.4, Midterm I Assigned
Week 8	10/16	2.4-2.6
	10/18	2.4-2.6, 10.1 Midterm I Due
Week 9	10/23	11.1-11.2
	10/25	4.5,4.6, HMWK 6 Due
Week 10	10/30	5.1-5.4
	11/01	5.1-5.4, HMWK 7 Due
Week 11	11/06	5.5-5.6
	11/08	5.5-5.6, 10.2 HMWK 8 Due
Week 12	11/13	11.3 - 11.4
	11/15	11.3 - 11.4, Midterm 2 Assigned
Week 13	11/20	2^{∞}-map
	11/22	No Lecture, Midterm 2 Due
Week 14	11/27	Measure Theory
	11/29	Measure Theory HMWK 9 Due
Week 15	12/04	Ergodic Maps, Recurrence
	12/06	Ergodic Dynamics, 6.6, HMWK 10 Due
Week 16	12/11	Presentations
	12/13	Presentations
Week 17		Final report is due, Merry Christmas