Syllabus, Dynamical Systems, Math 235. Fall, 2019.

Prof. Richard Montgomery; rmont@ucsc.edu

class : Tu, Th 9:50 to 11:25.

office hours: Tu: 2-4, Th : 5:30 - 6:30

web site: http://people.ucsc.edu/ rmont/classes/DynSys/2019/

Primary Texts. (a) Clarke Robinson, Dynamical Systems.

(b) M Brin and G Stuck, Introduction to Dynamical Systems.

(c) Guckenheimer & Holmes, Nonlinear Oscillations, Dynamical Systems and Bifurcations of Vector Fields

Other highly recommended texts: Hirsch and Smale and Devaney, (1974), Differential Equations, Dynamical Systems, and Linear Algebra, (Academic Press, New York)

Sinai et al, Dynamical Systems II, Encyc of Math. Sciences vol 2, Springer.

Arnold, V. I. (1978). Mathematical Methods of Classical Mechanics. New York, Springer.

Arnol'd , Avez, 'Ergodic Theory'

Halmos, 'Ergodic Theory'.

Moser: Stable and Random Motion.

Not recommended as reading, but good as an encyclopaedia: **an encyclopaedic treatment:** Hasselblatt, B. and A. Katok (2003). A First Course in Dynamics: with a Panorama of Recent Developments. Cambridge, Cambridge Univ. Press.

Evaluations and grades :

50 percent HW, 40 percent in-class presentation, 10 percent class participation.

HW: You are encouraged to work together on homework assignments, however, the final write-up of each problem must be your own.

In-Class Presentations: Each student will give at least one presentation in class. I will post a list of of possible papers and topics for presentations. You can also take topics from any of the above sources or choose your own topic. Get my okay ahead of time.

Bare Bones Calendar.

Sept 26. 1st class. Nov 28. Thanksgiving Holiday. Dec 5. Last class.

Topics covered. *This list is ambitious. As you go further down the list, topics becomes less likely to be covered.* Basic Examples and Definitions. ODEs: Basic theory: "Well-posedness". Straightening lemma. N-body problem. "Oldest problem in dynamical systems". Systems arising from mechanics. From geometry. Fixed points. Periodic orbits. Linear theory. Linearization. Flows vs. Maps. Poincare Return Map. Suspension. Conjugation and semi-conjugation. Normal forms. Circle maps. Rotation number. Hyperbolic Theory. Stable and Unstable Manifolds. Hartman-Grobman. The Smale Horseshoe. How a horseshoe arises from the transversal intersection of stable and unstable manifolds. Bernoulli shifts buried in the horseshoe. Coin flipping. Logistic map. The pendulum. Geodesic Flows. The constant curvature cases. Integrable systems. Perturbations. Of integrable systems. Of constant curvature geodesic flows. Time permitting. Statement of Anosov theorem. Statement of KAM. Relations between topology and dynamics. Index theorems of Poincare-Hopf. Of Lefshetz. Counting orbits. Lyapanov exponents. Entropy. Ergodic theory. Arnol'd conjecture.

By Week.

1. Examples, from basic ODEs. Defintions. ODEs: Basic theory: "Well-posedness". Straightening lemma. Flows. Maps. More examples. Henon. Fixed points and periodic orbits. of ODEs. Linear theory. Linearization.

2. Poincare Return Map. Suspension.

3. Conjugation and semi-conjugation. Circle maps. Rotation number.

3. Hyperbolic Theory. Stable and Unstable Manifolds. Hartman-Grobman.

4. The Smale Horseshoe. How it arises as the intersection of stable and unstable manifolds. Bernoulli shifts and the Horseshoer. Coin flipping. Logistic map. The pendulum, again.

5. Geodesic Flows. The constant curvature cases.

6. Perturbations. Flat: KAM ? Hedlund. Negative curvature: Anosov. Positive curvature : Open Qs, and Contreras.

7. Index theorems of Poincare-Hopf. Of Lefshetz. Counting orbits. Entropy , I.

8. Examples, definitions, measures of chaos. Ergodic Theory. Entropy, II.

9. Ergodic theory.