

Course Offering Proposal:

Araceli Bonifant

1. **ACTION:** Add new course.
2. **COURSE CODE AND NUMBER:** MTH 445
3. **COURSE TITLE:** Introduction to Chaotic Dynamical Systems.
4. **Description for Catalog:** The goal if this course is to introduce students to the study of non-linear dynamical systems on the real line and/or the plane, where such systems exhibit all of the chaotic and interesting behavior that occurs in more general contexts. The course should be accessible to junior and senior majors interested in the study of non-linear dynamical systems, as well as graduate students. (E.g., students majoring in mathematics, physics, chemistry, ecology, economics and neuroscience.)
5. **Prerequisites:** MTH141, MTH142, MTH215, and junior level standing, or permission of the instructor.
6. **Number of Credits:** 3
7. **Type of Credits:** Regular credits.
8. **Grading Method:** 1= A-F grades apply.
9. **Course Term:** I
Term of First Offering: Fall 2008.
10. **Type of Course:** Regular
11. **Method of Instruction:** A=Lecture.
12. **Restriction:** 1=No Restriction.
13. **Other Course Codes used for Cross-Listed Offerings:**
14. **College:** Arts and Sciences.
15. **Department:** Mathematics.
16. **Instructors:** Staff.
17. **Expected Number of Registrants at each Level:** Between 10 or 15 undergraduates and 5 or 8 graduate students.
18. **Additional Information Required** (On a separate page)

18.

1. A)

- (a) The last twenty five years or so have seen an explosion of interest in the study of nonlinear dynamical systems. Scientist in all disciplines have come to realize the power and the beauty of the geometric and qualitative techniques developed during this period. More importantly, they have been able to apply these techniques to a number of important nonlinear problems from physics, chemistry, ecology and economics. The results have been truly exciting: systems which once seemed completely intractable from an analytic point of view can now be understood in a geometric or qualitative sense. Chaotic and random behavior of solutions of deterministic systems is now understood to be an inherent feature of many nonlinear systems.

The objective of this course is to introduce the elements of dynamical systems theory and its applications. Dynamical systems on the real line and/or the plane exhibit all of the chaotic and interesting behavior that occurs in more general contexts. The course should be accessible to junior and senior majors interested in the study of non-linear dynamical systems, as well as graduate students. To be successful on the course all what is needed is to be interested in the subject and a solid calculus foundation and linear algebra background.

- (b) This will be a 400 level course and it can be taught by any faculty member of the mathematics department interested in the field. Among the mathematics department faculty who are interested in teaching this course are: Mark Comerford, Mustafa Kulenovic, Orlando Merino, Lew Pakula and Araceli Bonifant. The course will entail no additional resources from Library or computer facilities.
- (c) This course will not overlap in function with other courses in the mathematics department.
- (d) This course is intended as an elective course.
- (e) No curricula will be affected other than mathematics.

2. B) SAMPLE SYLLABUS

TEXT: An Introduction to Chaotic Dynamical Systems, Second Edition by Robert L. Devaney, Addison-Wesley Publishing Company.

GRADING: Grades will be based on 2 hour exams, a final exam, quizzes, homeworks and projects. After the second exam the students will be asked to develop a project relating what they have learned in the course with the subject in which they are majoring in, or the field that most interest them. The projects chosen by the students will have to be approved by the instructor.

PROPOSED SYLLABUS

Week	Topic	Text Sections
1	Examples of Dynamical Systems. Preliminaries from calculus	1.1, 1.2
2	Preliminaries from calculus. Elementary definitions	1.2, 1.3
3	Hyperbolicity. An Example: The Quadratic Family	1.4, 1.5
4	An Example: The Quadratic Family.	1.5
	Exam I	
5	Symbolic Dynamics. Topological Conjugacy	1.6, 1.7
6	Chaos. Structural Stability	1.8, 1.9
7	Sarkovskii's Theorem	1.10
8	Sarkovskii's Theorem. The Schwarzian Derivative	1.10, 1.11
9	The Schwarzian Derivative.	1.11
	Exam II	
10	Bifurcation Theory	1.12
11	Homoclinic Points and Bifurcations	1.16
12	The Period-Doubling Route to Chaos	1.17
13	The Kneading Theory	1.18
	Final	

LEARNING OUTCOMES:

At the end of the course students should know:

- (a) The concept of a dynamical system.
- (b) Consequences and features of non-linearity for dynamical systems and the kinds of complicated phenomena that appear in such systems.
- (c) How these phenomena arise in applications.

Students should be able to:

- (a) Analyze chaotic systems, using appropriate theoretical techniques.
- (b) Apply the theory to examples.