Introduction to Nonlinear Dynamics –Physics 429
Fall 2017
SUNY College at Cortland
Physics Department

Description

Often physics courses focus on developing general laws (e.g. Newton's laws), applying them to a physical process (e.g. a block sliding down an inclined plane) to model that proces yielding a prediction of future behavior. In this course we will frequently take the model as a given. Instead our task is to understand the *kinds of behavior* that are possible in the model, and how one kind of behavior switches to another.

At the end of this course you will be able to find and analyze fixed points, limit cycles, chaos, and bifurcation points in continuous flows and maps. You will also understand what a fractal is and be able to charactorize one. Furthermore you must be able to apply your knowledge from this course to a project of your own choosing. (2 cr. hr.)

Required Texts

Nonlinear Dynamics and Chaos, 2nd Ed. by Steve Strogatz

Instructor Information

Instructor: Douglas Armstead
Office: 127 Bowers (607) 753-2919
Office Hours: MTW 2-3pm and by appointment.
Email: douglas.armstead@cortland.edu
Course Website: http://facultyweb.cortland.edu/douglas.armstead/F17/ND.html
Lecture meets: MW 11:30am-12:20pm in Bowers 0139.

Expectations

What you should expect from me:

- Explanations of physical concepts that include concrete examples and demonstrations.
- In-class examples that help you to develop the level of reasoning that is necessary to do the problems you will encounter in the homework and on exams.

- Careful and respectful consideration of your questions.
- An open door policy–if my office door is open you should feel free to come in and talk about physics. This is in addition to my regularly scheduled office hours listed above.

What I expect of you:

- Your presence in class, both physical and mental, for the entire class period.
- Prepare for class, read the text at a level that you arrive with questions in hand.
- When you have a question, ask it. Your fellow classmates will thank you–if you are unclear on something, chances are your neighbor is too.
- Submit work that is your own. If you copy from another student or source and submit it for a grade, then you risk earning an F in this course.

Grades

The final score for the class has the following break down:

$$score = \frac{H + P + E_1 + E_2}{4} \tag{1}$$

where H = Homework average, P = Final Project, $E_i = i$th exam. Each Element is out of 100.

The homework is a vehicle for your mastering the concepts, techniques, and thought processes relevant to Nonlinear Dynamics and for communicating this in a way that leads from beginning to end using a clear, methodical plan. There are a number of aids at your disposal: the book, the instructor, in and out of class; and your classmates. But in the end nothing beats quiet concentration and gradually sorting things out for yourself.

Some homework will involve simulation by numerical integration and you should think of those simulations as an important part of the solution but that a full solution includes an explanation of your results.

Homework will typically be assigned online, due once a week, and then solutions will be provided. Allowing late homework is not really in your best interest and will generally not be accepted.

The projects will have you explore some particular aspect of nonlinear dynamics that interests you in some detail. Projects can take the form of an in depth analytical analysis of a system, simulating a system numerically and analyzing the motion using the techniques learned in this class, building a chaotic system and analyzing its motion, or doing a review of the scientific literature on a topic touched on in class. This is not an exhaustive list but rather an aid to get you thinking about a project.

Make-up exams will only be administered for "Excused Absences" (see University Catalog for details). Supporting documentation to excuse your absence will be required.

Final %	Grade
90-100	As
80-89	Bs
70-79	Cs etc.

Improvement and class participation may be used raise a border line grade.

Academic Integrity

You are expected to observe the University's statements and procedures on Academic Integrity in the college handbook, Chapter 340. Ask me if you have any uncertainty about what it means to cheat or the distinction between proper collaboration and plagerism.

Students with a Disability

If you are a student with a disability and wish to request accomodations, please contact the office of Student Disability Services located in VanHoesen B-1 or call (607) 753-2066 for an appointment. Information regarding your disability will be treated in a confidential manner. Because requests for accommodation take time to review and many accommodations require early planning, requests for accommodations should be made as early as possible.

Class Schedule

This class has three main parts: 1-D flows, 2-D flows and chaos. A rough time line follows.

Week starting	Chapter(s)	Topic
Aug. 28	1 and 2	Intro and Flows on the line
Sept. 4	2	Flows on the line.
		Labor Day is Sept. 4, no class.
Sept. 11	3	Bifurcations.
Sept. 18	4	Flows on the circle.
Sept. 25	5	Start 2-D flows–Linear systems.
		Test:Ch 1-4 on Wed. Sept. 27.
Oct. 2	6	Phase Plane.
Oct. 9	7	Limit Cycles.
Oct. 16	8	Bifurcations revisited.
		Fall Break on Oct. 16, no class.
Oct. 23	9	Start Chaos–Lorenz equations.
Oct. 30	9	Chaos.
Nov. 6	10	1-D maps.
		Test: Ch 5-8 on Mon. Nov. 6
Nov. 13	11	Fractals.
Nov. 20	11	Fractals.
		Project proposals due Mon. Nov. 20.
		Thanksgiving break starts Nov. 22
Nov. 30	12	Strange Attractors.
Dec. 4		Project.

Final Exam Tuesday Dec. 12 at 11am-1pm.