Topics in Applied Analysis (MATH 429) Course Syllabus

Instructor: Paul J. Hurtado (phurtado (at unr.edu)) **Spring 2018**

Lectures: MW 4:00 - 5:15PM in DMSC 315.

Office: 220 DMSC. **Phone:** 775-784-4655 (Math Office: 775-784-6773)
Office hours are as listed on the course website, or by appointment in 220 DMSC.

Text: Strogatz, Steven H. *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering*, 2nd ed. Additional supplements will be provided.

Websites: http://www.pauljhurtado.com/teaching/SP18/MATH429/ is the main website. Students are also responsible for checking Web Campus (wcl.unr.edu) and their email, and are assumed to be aware of all information posted to these sources prior to each meeting.

Description: This course introduces stability analysis and bifurcation phenomena in dynamical systems, primarily Ordinary Differential Equations and Discrete Maps. Students will get hands-on experience using analytical and computational methods to analyze such models. Possible additional topics include resonance and synchronization, chaos, fractals, and advanced methods useful in applications.

Course Pre-requisites: None, but MATH 283 (Calc III), MATH 330 (Linear Algebra) or equivalent are highly recommended.

Course content: This course is an advanced introduction to the analysis of nonlinear dynamical systems models. We will cover most of the material addressed in the textbook. This includes equilibrium and stability analysis, bifurcation analysis, Poincaré maps, and related computational tools. Time permitting, students will also get a brief introduction to more advanced topics that build on this material.

Course Objectives: Students will obtain familiarity with concepts and methods in the field of dynamical systems, apply those concepts and methods to analyze dynamic models analytically and computationally, and will learn how to interpret and critically evaluate the results of those analyses.

Student Learning Outcomes: Upon successful course completion, a student will be able to:

- Demonstrate understanding of the concepts that underly the study of dynamical systems.
- Use the analytical and computational methods covered in this course to analyze dynamical systems models.
- Critically evaluate and discuss the results of these analyses in an applied/scientific context.

General Rules: I (the instructor) come to class to help you learn, and I expect you will come to class to learn **and help others learn**. Everyone in class, myself included, is expected to be respectful to one another. Disruptions during class will not be well tolerated, and are to be kept to a minimum.

Homework: Homework will be approximately weekly, and in some cases may be graded upon completion only. Please write your homework solutions legibly or (preferably) type them. I may award zero credit for problems I cannot easily read. Your solutions should show all relevant work, and be a clear explanation of your reasoning (the same applies for all written work submitted to the instructor). Supplementary electronic files (e.g. R scripts) are to be emailed to the instructor (as a single attachment, or if needed as a single zip file) using the naming convention: **SURNAME-HWX.ext**.

Exams: There will be two or three mid-terms, and no final exam.

Project: Each student will complete a project and submit a term paper at the end of the course. The instructor will help students identify a good topic, and will consult closely with them during the semester.

Computing Resources: This course requires the use of mathematical software, all of which is either free or available to use through UNR. Students are assumed to have access to a computer with, e.g., Matlab,

the free software R (www.r-project.org) or similar software (e.g., Python). Students using R are strongly encouraged to use the front-end RStudio (www.rstudio.com). Additional software (e.g., XPP/Auto) may be used as well.

Course Topics: Below is a tentative list topics for the course. See the course website for an updated schedule of topics.

1. Dynamics of linear systems
2. Equilibrium stability analysis
3. Bifurcations in 1- and 2-dimensions
4. Bifurcations in higher dimensions
5. Normal forms
6. Center manifolds
7. Poincaré maps
8. Computational tools for model simulation and bifurcation analysis

Final Grades: Your grade for the course will be determined as follows: 40% Assignments, 35% Exams, 25% Project.

The grading scale that will be used may be curved, and the cutoffs will be no higher than the those given below (i.e., for a given final score, letter grades will be as follows or better):

A	A-	B+	B	B-	C+	C	D	F
≥93%	≥90%	≥87%	≥83%	≥80%	≥77%	≥70%	≥55%	55%>

Makeup, Late Policy: Late homework will not be graded, unless you had previously notified the instructor. There will be no early or make-up exams. If you need to miss an exam due to participation in official university activities, you must make arrangements with the instructor at least two weeks prior to the exam.

Academic Dishonesty: Cheating, plagiarism or otherwise obtaining grades under false pretenses constitute academic dishonesty according to the Student Code of Conduct. Students are assumed to know what plagiarism is (for a definition, see wpacouncil.org/positions/WPAplagiarism.pdf) and how to avoid it. Academic dishonesty will not be tolerated and penalties can include canceling a student's enrollment without a grade or receiving an F for the course or assignment. For more details, see the UNR General Catalog.

Disability Services: Any student with a disability needing academic adjustments or accommodations is requested to speak with the Disability Resource Center (Thompson Building, Suite 101) and then me, as soon as possible, to arrange for appropriate accommodations.

Academic Success Services: A common habit among successful students is to seek help outside of the classroom. Your student fees cover use of the Math Center (784-4433 or www.unr.edu/mathcenter), Tutoring Center (784-6801 or www.unr.edu/tutoring-center), and University Writing Center (784-6030 or www.unr.edu/writing-center). These centers support your classroom learning; it is your responsibility to take advantage of their services.

Statement on Audio and Video Recording: Written permission of the instructor is required to video or audio recorded class lectures. In order to accommodate students with disabilities, some students may have been allowed to record class lectures and discussions. Therefore, your comments and actions during class may be recorded. Surreptitious or covert video-taping of class or unauthorized audio recording of class is prohibited by law and by Board of Regents policy.