

THE UNIVERSITY OF TEXAS AT EL PASO
Department of Electrical and Computer Engineering
EE5390 SPECIAL TOPIC: CHAOTIC SIGNALS AND SYSTEMS
Fall 2024

Instructor

Benjamin C. Flores, Ph.D.
Engineering Annex 336
bflores@utep.edu
915 747-6961

Office Hours

On-line or by appointment right after class. I will be glad to answer questions or address issues and concerns during office hours. Please make an appointment to see me individually or in groups.

Course Description

This course is an introduction to chaotic electronic systems and the signals they generate. We will cover fundamental concepts and definitions, one-dimensional and two-dimensional maps, characterization of chaotic systems, strange attractors and fractals. The prerequisite knowledge for this course is an understanding of Matrix Algebra and Differential Equations.

Required Book

This course is based on the following textbook:

Chaos and Time-Series Analysis
Julien Clinton Sprott
Oxford University Press, 2003

Additional Reading

1. Flores, B. C., & Erives, H. (2024). *Implementation of non-linear oscillators using analog computers for the study of chaotic oscillators*. Paper presented at 2024 ASEE-GSW, Canyon, TX. <https://peer.asee.org/45385>
2. Flores, B., & Ochoa, H., & Pappu, C. (2022, August), *Adapting Chaos Theory for Undergraduate Electrical Engineers* Paper presented at 2022 ASEE Annual Conference & Exposition, Minneapolis, MN. <https://peer.asee.org/40835>

Topics

The main topics we will cover in this course are:

1. Introduction to Chaos: Somewhere between determinism and randomness
2. One-Dimensional Maps: Logistic, Bernoulli, Gauss
3. Time-Frequency Signal Characterization
 - a. Harmonic Oscillator: Simulation and Electronic Implementation
4. 2D Linear and Nonlinear Systems (differential equations, eigenvalues, stability, simulations)
 - a. Van der Pol Oscillator: Simulation and Electronic Implementation

THE UNIVERSITY OF TEXAS AT EL PASO
Department of Electrical and Computer Engineering

5. Chaotic Flows: Initial Conditions, Exponential Separation
 - a. Lorenz Oscillator: Simulation and Electronic Implementation
6. Chaotic Flow Characterization: Lyapunov Exponents

Course Outcomes

By the end of this course, you will be able to:

1. Explain chaotic system behavior
2. Simulate and implement nonlinear systems that display deterministic chaos
3. Characterize chaotic signals and systems

Class Attendance

Attendance is an essential component of this course. You are expected to come to all the sessions. If you are unable to attend, please let me know in advance.

Software

Load MATLAB on the computer. We may use it in class.

Grade

Your final score will be determined as follows:

Quizzes	25 points
MATLAB assignments	25 points
Hardware projects:	
Harmonic oscillator	10 points
Van der Pol oscillator	10 points
Lorenz oscillator	10 points
Final exam	<u>20 points</u>
Total	100 points

Study Groups

I encourage you to form study pairs. You may get together to discuss assignments. At the same time, I expect a truly individual effort to be reflected in all your work.

Course Participation and Etiquette

- Ask questions. The only bad question is the one that is never voiced.
- Attend class regularly.
- Participate in class.
- Treat e-mail correspondence as a professional exchange of information.
- Show up on time. Habitual lateness will be noted.
- Turn in homework assignments on time.
- Turn off cell phones during the class period.

THE UNIVERSITY OF TEXAS AT EL PASO
Department of Electrical and Computer Engineering

Academic Honesty

I expect you to act responsibly and to turn in only work that is honorably acquired and developed. In other words, the work you submit must be a fair representation of your actual ability, knowledge, and skills. It is the official policy of the university that all suspected cases or acts of alleged scholastic dishonesty must be referred to the Dean of Students for investigation and appropriate disposition. Any student who commits an act of scholastic dishonesty is subject to discipline.

Privacy

I respect your right to privacy. I will not disclose your information (including grades) to anyone else unless I have your written authorization. If you share your grades with someone else, that is your choice.

Disabled Students Services

If you have any specific needs, please let us know during the first week of classes. The UTEP Disabled Student Services Office was established to provide appropriate and reasonable accommodations as mandated in Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act (ADA). Additional information is available on the CASS center website.

Discrimination

All humans are created equal. UTEP does not discriminate discrimination based on age, gender, color of skin, ethnicity, national origin, religion, disability, sex, or sexual orientation.

Teaching Philosophy

I will organize the class in small collaborative groups and encourage you to take responsibility for your group. Typically, I will direct groups to work examples and then introduce you to small problems to emphasize principles. As the course progresses, I will increase the complexity of the problems by adding components that make them more realistic. I have found that this progression strongly motivates students to stay on task as they gain expertise and take ownership of the process. Thus, in this role I facilitate learning rather than pretend to be an infinite fountain of knowledge.

Welcome to my class!

Fall 2024

RESPIRATORY ILLNESS PRECAUTION STATEMENT

Please stay home if you have a cool, influenza, or COVID-19.