

SIOC 216A Introduction to the Physics of Complex Systems

Winter Quarter 2025 Tu/Th 1100AM -1220PM OAR 150 @ the SIO Campus

Office Hours (tentative)

Mondays Tuesdays/Thursdays 100-200PM (Mandeville Cafe on the main campus) and online by appointment.

Instructor

bt werner -- Professor of Environmental Physics and Complex Systems, SIO; Teaching Professor, Critical Gender Studies; Faculty Affiliate, Ethnic Studies and UCSD Labor Center bwerner@ucsd.edu

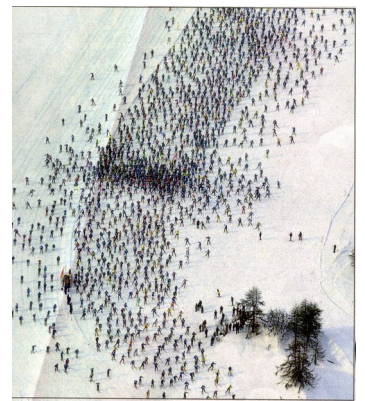
20 Class Meetings

- ~Weekly Homework problems in Octave (open source matlab)/Matlab/Python and/or qualitative problem solving using complexity (5-6 assignments over the quarter)
 - ~30 min presentation plus 15 min questions at end of quarter on a topic related to complex systems
- Graded S/U (except by exception - if you need a grade to satisfy a requirement)

Web Site: <https://courses.complex-systems-laboratory.org/sioc216a> check it out!

Goals of SIOC 216A

- acquire a solid understanding of the concepts and framework of the study of complex systems
- learn the practical methods used to model and analyze complex systems
- discuss modeling, measurement and data analysis strategies for complex systems
- survey some of the ways that complexity is applied in the physical, biological and social sciences.



Who should take SIOC 216A?

The course emphasizes concepts and basic methodologies. It is directed both towards quantitatively oriented students in the physical, biological and social sciences with a research or general educational interest in ways to conceptualize, formulate and solve problems involving complicated systems AND towards students interested in more qualitative analysis approaches in the humanities and social sciences (some of the material on quantitative approaches to dynamics might be challenging for these students, though).

Course Policies

Respect for all participants in SIO 216a and their varying backgrounds, knowledge and life experience is required. SIO 216a is a safe zone for BIPOC, womxn, queers, alternately abled folks, economically disadvantaged people, youth, elders, those who have experienced violence, undocumented people, religious minorities and anyone, individually or as a group, who has been oppressed.

Ground Rules: The number one ground rule which we will all follow is to engage in respectful and considerate debate and discussion in the classroom. Follow the step up/step back rule.

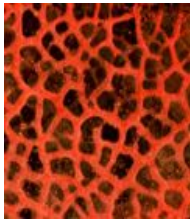
Broad Perspectives: All participants in this class benefit from a broad range of perspectives, and the instructor of this course highly values these perspectives.

Accommodations: If you need any accommodations for disability, illness, or other reason please see bt so they can create an accommodation plan for your success. If you have a disability/alternate ability or condition that compromises your ability to complete the requirements of this course, please inform bt as soon as possible of your needs. We will come up with a plan so that you can participate in and thrive in SIO 216A.

English-language Learning Needs: Some students will need to utilize office hours for extra background/direction on the material. ELL students are encouraged to consult resources at the OASIS center (858-534-3760).

Cheating, Plagiarism and AI: Cheating and/or plagiarism are not tolerated behaviors in SIOC 216A. Use of AI for your work in SIOC 216A is plagiarism. We will discuss the complexity and dynamics of AI in Week ~ 8.





Class Discussions: Everyone is encouraged to commit to and participate fully in class discussions (either by attending class or through discussion forums before and after class) and group projects, and to honor, respect and make space for the disparate intellectual perspectives that might emerge. If you find that you are participating a lot, please step back to allow others to contribute; if you find you aren't participating as much as others, please consider stepping up and contributing more, either verbally or write down what you wish to say and pass it to bt. The topics we discuss sample a broad range of the physical, biological and social world we inhabit, spanning from the beautiful to the very very ugly and violent. You may find some of these topics or examples uncomfortable, difficult or triggering. Your instructor and your fellow classmates are here to support you, but if this support is inadequate and you need to step out of the classroom, please don't hesitate to do so. Examples and case studies will be drawn from a multiplicity of sources and disciplines, which won't likely be listed on the syllabus.

No Fault Extension Policy

Given the realities of being a grad student in 2025, deadlines in this class should be considered lifelines, and if you need more time, give yourself an extension and let bt know via e-mail.

Grading

--class participation and attendance 35%

----> please read the lecture notes and come to class with questions. contributions to the discussion and group problem solving during class or posting answers to questions/problems if you can't attend a particular class

----> participate in posting questions ahead of class and unanswered questions or answers to the unanswered questions discussion forum after class

--homework (qualitative OR quantitative OR a mix of both ~ 5-6 assignments) 30%

[weekly – available on fridays, due the following friday]

--final project/presentation 35%

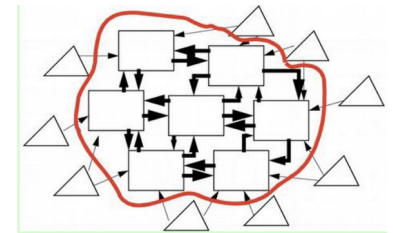
[~30 min presentation plus 15 min questions at end of quarter on a topic related to complex systems]

INTRODUCTION

1. What is Complexity? Approaches to and History of Complex Systems
2. The Tools and Concepts of Complexity – Part One
3. The Tools and Concepts of Complexity – Part Two
4. Formulating and Solving Problems Using Complexity

DYNAMICS APPROACH AND PATTERNS

5. Nonlinearity, Dissipation, Phase Space, Attractors, Maps and Feedbacks
6. Stability of Attractors and Bifurcations
7. Patterns, Feedbacks, Self-Organization, Dynamical Slaving, Engineered Stability and Cellular Automata



OPTIMIZATION

8. Nonlinear Optimization, Simulated Annealing and Neural Networks

CHAOS

9. Routes to Deterministic Chaos, Chaotic Systems
10. Nonlinear Time Series and Spatial Forecasting
11. Measurement and Analysis of Complex Systems

MULTI-SCALE COMPLEX SYSTEMS

12. Translations to Dynamics
13. Hierarchical Complex Systems

AGENT-BASED MODELING OF COMPLEX SYSTEMS

14. Agent-Based Modeling

SOCIAL SYSTEMS

15. Dynamics of Power and Resistance Movements
16. Societal Institutions and Behavior, Unnatural Disasters, AI
17. Capitalism, Anti-Blackness
18. Colonialism and Liberation Struggles

CLIMATE CRISIS AND SUMMARY

19. Climate Crisis as a Manifestation of the Societal-Environmental Coupled System
20. Course Summary and What's Next?

FINAL PRESENTATIONS: Finals Week

