Modeling Coupled Natural-Human Systems

ABE 4641 Section HUMN
Class Periods: **MWF Period 7 (1:55 PM - 2:45 PM)**
Location: Frazier Rogers 283
Academic Term: Fall 2019

Instructor:
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Office Hours: By appointments, Frazier Rogers 227

Teaching Assistant/Peer Mentor/Supervised Teaching Student: **N/A**

Course Description
Approaches to modeling coupled natural-human systems are explored, drawing from both natural and social sciences. Topics include regime shift from dynamical systems and basic concepts from game theory and social-ecological system literature. These are combined in models that operationalize a conceptual framework. Students develop models—with guidance—for final projects.

Course Pre-Requisites / Co-Requisites
MAC2312 or equivalent (basic understanding of calculus)

Course Objectives
Upon completion of this course, students will be able to:
- Perform stability analysis, construct a bifurcation diagram, and determine critical parameter values for dynamical systems.
- Articulate the nature of regime shifts or tipping points in the context of coupled natural-human systems.
- Make connections between concepts such as resilience and robustness to their mathematical basis.
- Identify and assess the applicability and limitations of different modeling approaches to coupled natural-human systems.
- Develop a model for a coupled natural-human system and analyze it, using tools learned in this course. This is what you are expected to do in your final project.

Materials and Supply Fees
N/A

Professional Component (ABET):
This course contributes 3 credit hours toward the ABET-accredited degree.

Relation to Program Outcomes (ABET):

Outcome	Coverage
1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.	High
2. An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.	
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	
4. An ability to communicate effectively with a range of audiences	Medium
5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	

6. An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge appropriately.	Medium
7. An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty	Medium

Required Textbooks and Software

No textbooks are required. The course may involve numerical simulations in MATLAB, which is available to students at https://info.apps.ufl.edu

Recommended Materials

The materials for this course will be drawn from several sources. Below are some examples (we would likely not cover all of them):

Anderies, J. M., M. A. Janssen, and E. Ostrom (2004), A framework to analyze the robustness of social-ecological systems from an institutional perspective, *Ecology and Society*, 9(1), 18.

Anderies, J. M., A. A. Rodriguez, M. A. Janssen, and O. Cifdaloz (2007), Panaceas, uncertainty, and the robust control framework in sustainability science, *Proceedings of the National Academy of Sciences*, 104(39), 15194–15199.

Gintis, H. (2000). *Game theory evolving: A problem-centered introduction to modeling strategic behavior*. Princeton University Press.

Hardin, G. (1968). The tragedy of the commons. *Science*, 162(3859), 1243-1248.

Madani, K. (2010). Game theory and water resources. *Journal of Hydrology,* 381: 225-238.

Müller-Hansen, F., Schlüter, M., Mäs, M., Donges, J. F., Kolb, J. J., Thonicke, K., & Heitzig, J. (2017). Towards representing human behavior and decision making in Earth system models–an overview of techniques and approaches. *Earth System Dynamics*, *8*(4), 977.

Muneepeerakul, R. & J.M. Anderies (2017), Strategic behaviors and governance challenges in social-ecological systems, *Earth's Future*, 5: 865–876, doi:10.1002/2017EF000562.

Nowak, M. A. (2006). *Evolutionary dynamics: Exploring the equations of life*. Harvard University Press.

Nowak, M. A. (2006). Five rules for the evolution of cooperation. *Science*, 314(5805), 1560-1563.

Ostrom, E., Burger, J., Field, C. B., Norgaard, R. B., & Policansky, D. (1999). Revisiting the commons: local lessons, global challenges. *Science*, 284(5412), 278-282.

Scheffer, M., *et al.* (2009). Early-warning signals for critical transitions. *Nature*, 461(7260), 53-59.

Scheffer, M., *et al.* (2012). Anticipating critical transitions. *Science*, 338(6105), 344-348.

Young, H. P. (2001). *Individual strategy and social structure: An evolutionary theory of institutions*. Princeton University Press.

Yu, D. J., M. R. Qubbaj, R. Muneepeerakul, J. M. Anderies, and R. Aggarwal. The effect of infrastructure design on commons dilemmas in social-ecological system dynamics, *Proceedings of the National Academy of Sciences*, 112(43): 13207—13212.

Course Schedule

Week	TOPIC*
1	Overview, introductions, logistics
2	Basic game theory: classic 2x2 games and their Nash equilibriums
3	Mixed-strategy Nash equilibrium
4	3x3 games; Basic evolutionary game theory—replicator equations
5	Analysis of 1-D replicator equations
6	1-D stability analysis Regime shifts; Examples of models with regime shifts
7	MATLAB introduction

8	2D stability analysis
9	2D stability analysis; **MIDTERM**
10	Putting them together: develop CNH models
11	Analysis of selected CNH models
12	Analysis of selected CNH models; **PROJECT PROGRESS REPORTS**
13	MATLAB sessions on selected systems.
14	MATLAB workshops for final projects
15	Review; **FINAL PROJECT PRESENTATIONS**

* The schedule is tentative. Actual schedule would depend on progress and interest in class.

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance is strongly encouraged. To monitor attendance, a number of unannounced in-class quizzes will be given throughout the semester: the more quizzes a student misses, the more points he/she loses. Students with acceptable reasons for absence will be given reasonable time to complete their work. Excused absences must be consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation.

Evaluation of Grades

Assignments: 45% | Midterm Exam: 25% | In-class Quizzes: 5% | Final Project: 25%

Grading Policy

Your final score will be rounded to the nearest integer—for example, 86.5 will be rounded to 87—and your final grade will be determined accordingly to the scale below.

91-100 = A | 86-90 = A- | 81-85 = B+ | 76-80 = B | 71-75 = B- | 66-70 = C+ | 61-65 = C |56-60 = C- | 51-55 = D+ | 46-50 = D | 41-45 = D-| 0-40 = E

More information on UF grading policy may be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor

Code (https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall*,* 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints*:* http://www.distance.ufl.edu/student-complaint-process.