BE423/523 Biosystems Analysis and Design

Shantz 440, MWF, 11 – 11:50 Spring 2021

Description of Course

Application of systems analysis to biologically-related problems; computer modeling and use of simulations, optimization methods, decision support systems.

Course Prerequisites or Co-requisites

Adv. Stdg: Engineering

Instructor and Contact Information

Peter Waller, Shantz 536, 520-440-5803, pwaller@email.arizona.edu

Monday 1-2 "Open Zoom Policy"

Course is conducted in D2L. All videos, pdfs, homeworks, and exams are in D2L.

Course Format and Teaching Methods

Online lectures and notes will be available prior to class. Students will be expected to watch lectures or read notes, answer quiz questions, and write computer programs prior to class. The quiz is due the night before each class period, and students are expected to make a good faith effort on this first attempt. Class periods will be oriented toward discussing the questions and completing the required computer programs in the quiz, and then students can resubmit the quiz with correct answers and programs on the day of the next class. You can take the quiz three times, and count the highest score. Students self-grade their quiz, and then review the submitted work with the instructor during Zoom meetings.

Course Objectives and Expected Learning Outcomes

Course objectives

The objective of this course is to enable students to numerically analyze biological systems. Examples include microbes, animals, and plants. Students use and program python codes to calculate growth rate and interactions. Numerical methods and models in Python include Euler method, Taylor series, analytic solutions, linear programming, database management.

Learning objectives

- Students use numerical methods in python to analyze systems of biological organisms, including microorganisms, animals, and plants.
- Students use linear programming methods to solve problems such as pharmacokinetics, stoichiometry and metabolic engineering
- Students set up and run population and disease models such as logistic function, SIS and SIR models, and quantitative risk assessment.
- Students understand, set up, and run competition models such as interspecies competition, predatory-prey, phase models, and Jacobian analysis.
- Students set up models of plant systems and learn basic principles of precision agriculture management.

Absence and Class Participation Policy

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, http://policy.arizona.edu/human-resources/religious-accommodation-policy.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: https://deanofstudents.arizona.edu/absences

Good faith efforts on quizzes are 6% of the class grade. It is important that you attend classes, especially when we schedule group meetings.

Makeup Policy for Students Who Register Late

Students who sign up late can make up assignments for 75% credit. A low fraction of the course points come in the first few weeks so it is not important.

Course Communications

All course communications will be conducted with UA e-mail address, and D2L

Required Texts or Readings

Online powerpoints, pdfs, computer codes, and videos are available in D2L. Much of the material in the course is from MathInsights website, which provides a great mix of math and biology. We add the python programming and a little sauce.

The course uses the textbook Irrigation and Drainage Engineering, but Peter Waller and Muluneh Yitayew. It is available free online at the University Library website. Type Irrigation Waller into the library search engine.

Required or Special Materials

No special materials are required. Let me know if you don't think that your laptop is reliable for exams.

Required Extracurricular Activities

There are no required extracurricular activities.

Assignments and Examinations: Schedule/Due Dates

A D2L quiz is due prior to almost all class periods. 6% of the course grade will be based on making a good faith effort on these quizzes prior to the following class period. I will make a quick check on student quizzes each morning prior to class. Then you can resubmit the quiz after we discuss the problems in class.

There will 5 five zoom exams. Students will present their homework programs and describe them. The instructor will ask random questions from the quizzes and questions related to the homework problems. A rubric will be posted soon.

Final Examination

Students can drop in for the zoom final exam on Monday May 10 (3-8 pm) or Tuesday May 11 (8 am – 12 noon)

Grading Scale and Policies

Criteria	423	523	Grading Scale	
Zoom midterms	42%	42%	90.0 – 100.0	A
Homework (quizzes)	25%	20%	80.0 – 89.9	B
Group project	25%	20%	65.0 – 79.9	C
Graduate project		10%		
Good faith effort on quizzes	8%	8%	50.0 – 65	D
			< 50.0	E

University policy regarding grades and grading systems is available at http://catalog.arizona.edu/policy/grades-and-grading-system

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

Dispute of Grade Policy Students are welcome to dispute a grade on a quiz, project, or exam at any time during the semester.

Classroom Behavior Policy

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Students are asked to refrain from disruptive conversations with people sitting around them during lecture. Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave lecture or discussion and may be reported to the Dean of Students.

There are no restrictions on phones or computers in this class. However, during exams, no cell phone use is allowed.

Threatening Behavior Policy

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

Accessibility and Accommodations

Our goal in this classroom is that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center (520-621-3268) to establish reasonable accommodations. For additional information on the Disability Resource Center and reasonable accommodations, please visit http://drc.arizona.edu.

If you have reasonable accommodations, please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate. Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Scheduled Topics/Activities

		Class Activity (homework due the night before) (resubmit for more effort credit)
Jan 13	Wed	Class introduction – Installation of Anaconda , Group formation
Jan 15	Fri	Python refresher
Jan 20	Wed	Binary fission
Jan 22	Fri	Binary fission part 2
Jan 25	Mon	Penicillin clearance
Jan 27	Wed	Discrete dynamical systems
Jan 29	Fri	Doubling time and Ke (turn in group and individual outlines prior to zoom meeting)
Jan 29-30	**Fri-Sat**	**Zoom meeting. Drop in during Friday (3-8 pm) or Saturday (8 am – 12 noon)**
Feb 1	Mon	Concepts in Numerical Analysis – Euler method and Taylor series
Feb 3	Wed	Concepts in Numerical Analysis – Error analysis
Feb 5	Fri	Environmental carrying capacity
Feb 8	Mon	Green algae biology
Feb 10	Wed	Green algae growth model
Feb 12	Fri	Green algae growth model
Feb 15	Mon	Logistic model
Feb 17	Wed	First group presentations (individuals present their proposal)
Feb 19	Fri	First group presentations (individuals present their proposal)
Feb 19-20	**Fri-Sat**	**Zoom meeting. Drop in during Friday (3-8 pm) or Saturday (8 am – 12 noon)**
Feb 22	Mon	Harvest of natural populations
Feb 24	Wed	Logistic model for human and animal populations
Feb 26	Fri	SIS models (Disease without immunity)
March 1	Mon	SIR models (Disease with immunity)
March 3	Wed	Quantitative Risk Assessment (wastewater)
March 5	Fri	Competition models: Interspecies competition for resources
March 8	Mon	Competition models: Predator prey relationships and phase diagrams
March 12	Fri	Competition models: Advanced numerical techniques – Runga Kutta
Mar 12-13	**Fri-Sat**	**Zoom meeting. Drop in during Friday (3-8 pm) or Saturday (8 am – 12 noon)**
March 15	Mon	Competition models: Python ODE integration method
March 17	Wed	Competition models: the Jacobian and stability
March 19	Fri	Drug delivery and enzyme reactions: Python ODE integration method
March 22	Mon	Linear equations in biosystems: matrix algebra
March 24	Wed	Linear equations in biosystems: pharmacokinetics and room ventilation
March 26	Fri	Linear equations in biosystems: stoichiometry and metabolic engineering
March 29	Mon	Second group presentations (present to class on zoom)
March 31	Wed	Second group presentations (present to class on zoom)
April 5	Mon	Finite differences
April 7	Wed	Finite differences
April 9	Fri	Heat transfer in a chocolate bar
Apr 9-10	**Fri-Sat**	**Zoom meeting. Drop in during Friday (3-8 pm) or Saturday (8 am – 12 noon)**
April 12	Mon	Simulation of crop growth in greenhouses
April 14	Wed	Plant simulation models and value of different models
April 16	Fri	Terminologies and units for crop simulation
April 19	Mon	Smart irrigation sensor systems and measurements
April 23	Fri	Run preprogrammed WINDS model and optimize yield and environmental conserv
April 26	Mon	Select and implement data collection methods
April 28	Wed	Quantify plant biomass and yield response to water and nutrients
April 30	Fri	Implement precision agriculture research: guar experiment (n. probe and PIX4D)
May 3	Mon	Implement precision agriculture research: guayule experiment (TDR and PIX4D)
May 5	Wed	In class activity to select sensors and models for research or ag project
May 10-11	**Mo-Tu**	**Zoom meeting. Drop in during Mon (3-8 pm) or Tues (8 am – 12 noon)**

Group Projects

Groups of 4 students will complete a group project. The group will design an irrigation system or process. Each student will design a component of the system. The first presentation will describe the project, proposed models, and estimated time investment. Each group member will write a minimum of a three-page report (2% of course grade), and prepare a PowerPoint presentation (2% of course grade) The first page (one-page single-spaced) will describe the site. The second page will include a brief description of the design approach. The third page will include a brief summary of the tasks in the design. Each group member will speak for a minimum of 4 minutes on their part of the project. The presentation will include a PowerPoint that includes the information in the report. The group will also prepare a written and flowchart summary that describes how the individual designs will mesh together (1% of class grade). One member of the group will also present the group report, which will be a minimum of 3 minutes. These presentations will be used to help students and groups refine their projects.

Students will need to have completed their individual designs by the time of the second report. Each student's second report (8% of course grade) and presentation (2% of course grade) will describe their individual design. Individual reports will begin with the already completed three-page proposal. Subsequent pages will describe the finalized design.

The third report (7% of course grade) and presentation (3 % of course grade) will describe the complete irrigation system designed by the group. The group will write a five-page report on their overall design. The third presentation will take 3 minutes per person and describe how the group has integrated the models into a single model of the entire system.

Code of Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

UA Nondiscrimination and Anti-harassment Policy

The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Additional Resources for Students

UA Academic policies and procedures are available at http://catalog.arizona.edu/policies

Student Assistance and Advocacy information is available at http://deanofstudents.arizona.edu/student-assistance/students/student-assistance

Confidentiality of Student Records

http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa

Subject to Change Statement

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.