Control Methods in SmartAg Systems
ABE 5009   Section 30063
Credits: 3
Class Periods: T, TH: 7th and 8th Period, from 1:55PM to 3:50 PM
Location: Hybrid Zoom and 283 Rogers Hall
Academic Term: Spring 2024

Instructor:
Name: Tom Burks
Email Address: tburks@ufl.edu
Office Hours: By email appointment only, for Zoom or personal meetings,
Office: Rogers Hall room 225

Teaching Assistants:
Please contact through the Canvas website
- TBD,   Name of TA, email address, office location, office hours

Course Description
Design, analysis, simulation and programming modern control methods for applications in production agriculture, biological and food engineering, land and water resources. Students will learn theoretical concepts, application programming, and simulation techniques using classical and modern control approaches, fuzzy logic, neural networks and other intelligent learning algorithms. *Offered each spring*

Course Pre-Requisites
- Differential Equations or equivalent
- Physics with Calculus
- Dynamics or equivalent

Course Recommendation
- Engineering graduate student
- Fluent in general programming language such as C, C++, Python, or Visual Basic, and also MATLAB

Course Objectives
- Gain ability to design, program, and analyze control systems, which can be applied to a broad range of engineering applications relevant to SmartAg systems including, but not limited to, field production, food processing, irrigation systems, and biological systems.
- Master theoretical concepts associated with control system design using classical control and state space approaches, along with neural networks and fuzzy logic based solutions. Theory will be reinforced through homework, programming and term projects.
- Master how to evaluate control oriented design problems, and formulate a solution. Students will develop a formal report and present concepts to class. Students will develop team skills and communicate ideas in written and oral format. Projects will reinforce need for ethical design practices.

Materials and Supply Fees
Not Applicable

Meeting times and Lecture Content
- Normal meeting time is scheduled and planned for Thursdays during 7th and 8th period in Room 283 Rogers Hall for traditional lecture. However, Tuesday is going to be a flexible meeting that may meet in Room 214 for lecture, be a pre-recorded demonstration lecture on using software or hardware that will be posted to a shared folder, or we may meet in Rogers Hall instrumentation lab 214 for hands on laboratory instructions. Thursday will always meet in Room 283, while Tuesday meeting location maybe found on the canvas calendar event for that day.

Textbooks and Software

Recommended/Reference Materials
- Fuzzy and Neural Control by Nguyen, Prasad, Walker and Walker
- 2003, 1st Edition
- ISBN: 1-58488-244-1

- Modern Control Engineering by Ogata
- 2015, 5th Edition
- ISBN: 978-9332550162

- Intelligent Control Design and Matlab Simulation by Jinkun Liu
- 2018, 1st Edition
- ISBN: 978-9811052620

Other Resources
Matlab Controls Tutorial: https://ctms.engin.umich.edu/CTMS/index.php?aux=Home

Course Topic List (Potential)
Topic 1: Intro to SmartAg, IoT, Sensors, Embedded devices, Networks, IoT platforms
Topic 2. Mathematical Modeling of Dynamic Mechanical, Electrical, and Fluid Systems
Topic 3. Dynamic Behavior, Transient and Steady State Response with Matlab Tutorials
Topic 4: Block Diagrams, Laplace transform, Stability, Linearization, non-linear systems
Topic 5: Lag and Lead Compensation, PID Control and Design with Matlab Tutorials
Topic 6. Design and Analysis of Systems with Matlab Tutorials
Topic 7. Frequency Response Analysis with Matlab Tutorials
Topic 8. State Space Analysis, Controllability and Observability with Matlab Tutorials
Topic 9. Fuzzy Math, Sets and Rules, Fuzzy Relations and Defuzzification
Topic 10. Fuzzy Control
Topic 11. Adaptive Fuzzy Control
Topic 12. Neural Networks, BP Nets, RBF Nets
Topic 13. Neural Networks in Control
Topic 14 Adaptive and Sliding Mode RBF Networks for Control
Topic 15. Fuzzy-Neural Systems
Topic 16. Implementing AI enhance Control on Embedded Devices (Raspberry Pi, Jetson Nano)

Supplemental Recorded Topics from Guest Speakers
The class will have access to several additional special lecture topics that are pre-recorded from another class on applied SmartAg. You will not be required to do homework or quizzes on these topics.
1. Topic 1: Measurement Systems, Dynamic Signals and Data Acquisition (Burks, Rec.)
2. Topic 2: Intro. To Basic Circuits and RLC Circuits (Burks, Rec.)
3. Topic 3: Software & Programming of Microcontrollers (Ziwen Yu, Rec.)
4. Topic 4: Data in SmartAg Applications (Ziwen Yu, Rec.)
5. Topic 5: Unmanned Aerial Systems and Applications in Agriculture (Yiannis Ampatzidis, Rec.)
6. Topic 6: Smart Irrigation (Sandra Guzman, Rec.)
7. Topic 7: SmartAg Applications in Controlled Environments (Ying Zhang, Rec.)
8. Topic 8: SmartAg Applications in Fruit/Veg Production (Dana Chao, Rec.)

Attendance Policy, Class Expectations, and Make-Up Policy

a) There will be approximately one homework assignment per week, due by midnight on Saturday. You may discuss homework with your classmates, but you may not copy verbatim from another student. Cheating will affect all parties involved. A scanned copy of homework will be turned in online in canvas with a one-day grace period at full points, zero percentage after that.

b) Programming and simulation reports will be assigned on an approximate two to three week basis, examples will be used that are relevant to lecture material. All relevant project material, code, plots and write up will be submitted on line through canvas in a combined pdf file. While a copy of operational coding files will be emailed to instructor in native format, such as Matlab m-files that are ready to execute. There will be a one-day grace period with full points, and zero percentage after that.

c) The term paper will more fully expose the students to the material covered in the class as applied to SmartAg applications. Students will choose topics that are relevant to their area of interest and will be responsible to conduct a literature review of their topic and compose a paper reporting on said technology and how it is relevant to this class. Proper literary methods will be used to notate sources according to the assignment description. Assignments will be turned in online through canvas with a one-day grace period at full points, and zero percentage after that. Due dates will be posted on CANVAS.

d) The term project will be a more comprehensive programming assignment, that will more fully expose the students to the material covered in the class. The scope of the term project will be defined by instructor along with appropriate data sets and expected outcomes. Students will be responsible to design/conceive a SmartAg solution showing simulation program solutions to validate concept. Assignments will be turned in online through canvas with a one-day grace period at full points, and zero percentage after that. Due dates will be posted on CANVAS. There are two possible projects that will involve using embedded systems. 1) Implement a sensor network with classmates to collect environmental conditions at each students location. Send data to cloud application and collect statistics and make heating recommendations evidenced by data sent to local embedded device which could serve as a climate controller. 2) Depending on hardware availability, implement a Smart AI controller user an Nvidia Jetson Nano. (Due to availability concerns, it is not clear whether this will be possible. But we will try. If not jetson, we may try Raspberry PI 3.

e) Two open book take-home exams will be given, a mid-term and a final will be scheduled. Exams will be timed two-hours in duration, and open book. Exam dates will be posted on CANVAS.

f) Excused absences must be consistent with university policies in the undergraduate catalog and require appropriate documentation. (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx)

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework Sets	300	30%
Programming/Simulation	200	20%
Midterm Exam	150	15%
Final Exam	150	15%
Term Projects	100	10%
Term Paper	100	10%
	1000	100%

Grading Policy

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67

66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:
http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades

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 feedback on the quality of instruction in this course by completing online evaluations at https://evaluations.ufl.edu/evals. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/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://www.dso.ufl.edu/sccr/process/student-conduct-honor-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.

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: http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html

Campus Resources:

<u>Health and Wellness</u>

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 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.