# Syllabus for HORT 8160 – "Measurement and Control in Plant and Soil Science"

## Course Information

**Semester**: Fall 2025

**Credits and format**: 3 credit hours. In person only at the UGA Athens campus.

**Meeting times and locations**:

| | Days | Time (EST.) | Location |
|---|---|---|---|
| **Lectures** | Tues. and Thurs. | 9:35 – 10:50 AM | Room #1503, Miller Plant Science Bldg |
| **Labs** | Thurs. | 2:20 – 4:40 PM | Room #2201, Miller Plant Science Bldg |

## Instructor Information

**Instructor**: Dr. Zhihang Song, Assistant Professor of Controlled Environment Agriculture Phenomics

**Contact**: Email communication is preferred. In-person and walk-in visits without an appointment are permitted for quick questions only.

DO NOT use email to submit any course assignments unless you are instructed to do so.

**Office hours**: By appointment only. Department of Horticulture, Room #1311, Miller Plant Science Building. UGA Athens campus.

## Course Description & Details

**Course Description**: This course covers the principles and practices of measuring and controlling environmental parameters, emphasizing dataloggers and sensors. Measurement theory, common error sources, and appropriate use of equipment will be discussed. Course materials will be based on class lectures, handouts and slide presentations, readings, videos, and hands-on laboratories emphasizing Plant and Soil Sciences. The theory behind measurements will be applied during the lab component. Students will be responsible for compiling a fully functional sensing system and collecting independent datasets in the lab sessions and for their course project. Students are required to propose their individual course projects with a proposal and conclude the project at the end of the semester with a conference-style presentation and a journal-style project report.

## Course materials

**Required course materials**: No textbook is required. Handouts will be provided electronically via the eLearning Commons (eLC).

**Disclaimer**: The syllabus provides a general outline for the course; deviations may be announced to the class by the instructor as necessary.

**Topical outline**:

1. Principles behind measurements:
   - Accuracy, precision, variability, and repeatability.
   - Spatial and temporal variability in environmental conditions.
   - Common error sources in environmental measurements.
   - Sensor calibration and noise reduction.
2. Sensors for environmental measurements. Operating principles and error sources of:
   - light sensors
   - temperature sensors (soil, water, and air)
   - humidity sensors
   - rain gauges
   - soil moisture probes
   - electrical conductivity
   - ion-selective electrodes (pH, specific nutrients)
3. Automated data collection:
   - Introduction to commonly used dataloggers
   - Datalogger programming
   - Comparison of different dataloggers
   - Interfacing sensors and dataloggers
   - Troubleshooting common problems
   - Deployment and operations of dataloggers in different environments
   - Using dataloggers for environmental control in plant and soil science research

**Course-level student learning outcomes**:

This course will introduce students to measurement theory (what, when, and how to measure). Common measurement methods will be discussed in detail with an emphasis on accuracy, precision, variability, and repeatability. The theoretical principles behind common sensors used for environmental measurements (light, temperature, humidity, rain, soil water, etc.) will be discussed. Automated methods to control such environmental variables will be discussed. Efficient data collection methods, including using dataloggers, will be discussed. At the end of the course, students will:

- be able to clearly explain measurement principles and common sources of error
- be able to narrate how a variety of different sensors work
- be able to select the correct sensors for a particular measurement
- be able to use peripheral equipment to manipulate environmental conditions for research purposes.

The overall objective is to ensure that graduate students have the ability to measure relevant environmental conditions correctly.

## Miscellaneous instructional activities in the lab sessions

**Lab activities:** Hands-on activities in the lab are your opportunity to gain practical experience with a wide variety of equipment and sensors. General activities include connecting electronic components with wires, microcontrollers, and a laptop computer. The instructor will prepare all electronic components needed for the lab activities, except for the laptop. Students must bring

their own laptop computers and have the required software installed prior to the lab session as part of the pre-lab activities.

**Dress code**: Students need to dress appropriately for doing physical work. Closed-toe shoes must be worn while participating in any lab activities (i.e., rubber boots, hiking shoes, sneakers) with or without the need to work in a greenhouse.

**Lab rules**: Please keep the lab room clean and in good, manicured condition. Report the occurrence of any problem for repair directly to the instructor.

*General safety rules*

- Do not bring food or drink cups to the lab. Bottled water is acceptable. However, you must tighten the cap and place it in a secure location (such as inside your backpack) before continuing on the lab work. Remember, we will be working with electronic components. *They are fun to work with, but can be dangerous!*
- Wear closed-toe footwear.
- Return all electronic components, tools, and supplies to the designated storage areas.
- Always wash your hands after working and exiting the lab before eating and drinking.
- Know the locations of fire alarms and fire extinguishers.
- In the event of a fire, immediately evacuate the lab, set off the fire alarm, and notify the authorities.
- Wear safety glasses and other proper personal protection equipment (PPE) when working with chemicals.
- Without prior approval from the instructor, no field samples or equipment should be stored or processed in the lab.
- Follow the safety rules and instructions if you need to work in a greenhouse.

*General wiring rules*

- Disconnect all power before wiring anything or changing any wires.
- ALWAYS double-check and make sure wire connections are secure
- Strictly follow the common color code when possible, use red for positive, black for negative, and green for ground. For other wiring, use as many different colors as practical.
- No exposed bare wires (which can and will create short circuits)

*General programming rules*

- We will be using C++ (Arduino), Python (Raspberry Pi), and CR-Basic (Campbell Scientific)
- Include sufficient comments throughout your program!
- Dataloggers do exactly what you program them to do. If things don't work as expected, it's not the datalogger's fault; it's your program (or wiring).

## Assessments & Grading

| Component | Points | % Final grade |
|---|---|---|
| Class participation & In-class Quizzes | 15 | 15% |
| Lab reports | 30 | 30% |
| Course project | - | - |
| *Project proposal* | 10 | 10% |
| *Project presentation – peer evaluation* | 10 | 10% |
| *Project presentation – instructor evaluation* | 15 | 15% |
| *Project report* | 20 | 20% |
| Total | **100** | **100%** |
| Bonus point | 2 | 2% |

**Scale (100/100)**: A (94-100), A- (90-93), B+ (87-89), B (84-86), B- (80-83), C+ (77-79), C (74-76), C- (70-73), D+ (67-69), D (64-66), D- (60-63), F (≤59) (digits place will be rounded).

**Late submission**: Students must request and acquire approval from the instructor via email with valid reason(s) for late submission of any assignment at least 24 hours before the due date. Late submission without authorization from the instructor will result in a maximum of 50% grade deduction accumulated 10% per week after the due date. To know more about "valid reasons", please refer to the "**Attendance and participation policy**" stated in this syllabus.

**Participation:** Students will be required to participate in all classes unless with an authorized excuse.

**Quiz:** A total of 11 quizzes will be given during lectures. Each quiz will contain questions related to the last lectures, labs, and miscellaneous readings. Students are only allowed to refer to their hand-written notes. The use of Internet search or AI tools is strictly prohibited. We will drop your lowest quiz grade.

**Labs:** Participation in all lab sessions is required. A lab handout will be prepared by the instructor and accessible on eLC prior to the lab session. The lab handout will include basic reading materials and step-by-step instructions for the students to work on the assigned tasks during a lab session. Each lab handout will include a section called "Lab Report", which will contain a list of short-answer questions where students will need to answer based on the experience and knowledge learned in the lab session. Students can either type or handwrite on the report, but it must be submitted via eLC for grading purposes. The due date for each lab report is the next day at 5 PM after the lab session unless otherwise noted.

**Course project:** All students will be required to independently propose a course project and complete the project by the end of the semester. The project should be research-style and include multiple tasks that are related to course content, such as designing an experiment, installing sensors and dataloggers, collecting data, and analyzing data.

> **Project proposal**: All students are required to prepare a project proposal describing the project background, anticipated methodology, materials, and schedule of steps. Students must submit the draft and schedule an appointment with the instructor to discuss the project **by September 12$^{th}$**. Appointments for discussions will be held from September 15$^{th}$ to September 26$^{th}$. The instructor will share ideas during the class and provide feedback during the individual discussion. Students must submit the final version by **September 28$^{th}$**. Detailed requirements and a template will be posted on eLC and

announced in class. Students must acquire formal approval from the instructor to get the full grade.

Note:

- Some sensors are available from the instructor's lab (first-come, first-served).
- Be creative! You can work on 'silly' things as long as you are learning something new. That said, think about how you may be able to use what you learn in your research. If feasible, work on a system you (or someone else) can use later on.
- If the project is existing research, indicate the current progress and what's left. Request permission from your advisor or the principal investigator if necessary.
- DO NOT share any information about a confidential or highly classified project.
- DO NOT wait until the last moment to schedule a meeting.
- Please bring a copy of your draft proposal to the meeting.

**Project presentation**: Students are required to give a presentation of the course project in a format similar to an academic conference in the final week. The agenda will be announced in class. Attendance is required for all students. Students must submit a peer evaluation form for each of the presenters. Your grade for the project presentation will be the sum of the average peer and instructor evaluations. Absence from the others' presentation or non-submission of the evaluation form will result in a one-point deduction for each of the missed presentations.

Tips on how to give a dynamic presentation are available at https://www.elsevier.com/connect/how-to-give-a-dynamic-scientific-presentation

**Project report**: Students are required to prepare a project report using a format similar to a peer-reviewed journal. The report must be submitted in a single PDF file. A template and detailed requirements, including the due date, will be posted on eLC and announced in class. In general, the report should contain the following sections: Introduction, Materials and Methods, Results, Discussion, Conclusion, and References. The report will be graded based on the following criteria:

- Completion of the proposed project – 35%
- Level of challenge – 10%
- Level of novelty – 15%
- Quality of data analysis and interpretation – 20%
- Quality of data or method visualization – 10%
- Quality of language and format – 10%

**Bonus points**: To receive bonus points, students must complete the course evaluation with constructive feedback to the instructor/TA and submit proof of completion to eLC. Constructive feedback can be both what you like and what you don't like about the course. It can also be suggestions on how we can improve in the future or reflections of your own experiences. Proof of completion can be a screenshot of a confirmation email or the webpage, and it must be submitted to the dedicated place on eLC.

## Course Statements and Policies

**Tips for success in the course**: Read the class syllabus carefully, attend class regularly, be involved in class, take good notes, review your notes as soon as possible after class, use your time wisely, use a calendar, watch online videos, use the time allocated by the instructor to ask questions. More resources can be found:

- Note-Taking Skills, Effective Note-Taking in Class, and The Ultimate Guide To Note-Taking
- What does it take to succeed in college?

**Use of AI in this Course:** To ensure you develop and master the foundational knowledge and skills in this course, the use of generative AI (GAI) is strictly prohibited. This includes all stages of your work process, even the preliminary ones. Certain AI tools, such as Grammarly, are only allowed for grammar checking but cannot be used to write for you. This prohibition extends to AI writing tools like ChatGPT, Copilot, Writesonic, Rytr, Rtutor, etc. If you are uncertain about using a particular tool to support your work, please consult with the instructor before using it. The instructor will be equipped with AI detection technologies to identify the usage of prohibited AI tools.

**Attendance and participation policy**: Attendance is essential to your grade, and you are expected to attend all class sessions. Accommodations will be made if you are sick, have ill family members, are attending a conference, etc. Please note that you are responsible for obtaining any information presented in class and keeping up with assignments & deadlines, regardless of the reason for your absence.

**Make-up procedures for exams and assignments:** Make-up work will be given only for previously excused absences for a university-approved reason. If you need to reschedule an exam, you are responsible for notifying the instructor by eLC and email before the exam as early as possible.

**Diversity/Inclusion/Community statements:** The diversity that students bring to the class is considered a resource, potential strength, and benefit to the learning process. I intend that students from diverse backgrounds and perspectives be well-served by this course. The student learning needs will be addressed both in and outside class. My objective is to prepare activities that are respectful of diversity, considering gender, sexual orientation, disability, age, socioeconomic status, ethnicity, race, culture, perspective, and other background characteristics. We encourage and appreciate suggestions about improving the value of diversity and inclusion in this course. Please let me know ways to improve the effectiveness of the course for you personally or for other students.

**Teaching philosophy:** As an educator and mentor, I believe my role is to prepare students to think critically and develop the ability to apply their acquired knowledge for professional activities in ethical and unique ways. I strive to establish a stimulating learning environment by combining theory with hands-on activities. I am a firm believer and supporter of the learning-by-doing methodology. I do all I can to help my students reach their full potential. I challenge my students to adopt non-traditional approaches to solving problems and provide an inspiring learning atmosphere that motivates them to perform their best. I encourage students to be agents of change by delivering the latest and more advanced tools and equipment and reliable sources of information that will allow them to develop new ideas. I challenge my students to be

self-directed learners and strongly encourage them to transform the data into knowledge to develop critical decision-making skills.

**UGA Honor Code**

"I will be academically honest in all of my academic work and will not tolerate academic dishonesty of others." A Culture of Honesty, the University's policy and procedures for handling cases of suspected dishonesty, can be found at honesty.uga.edu.

Violations generally fall into one of three categories:

- Plagiarism
- Unauthorized assistance (e.g. cheating)
- Falsifying data/results

If academic dishonesty is suspected, instructors have a responsibility to report it to the Office of Academic Honesty within fifteen days of the alleged violation. A discussion between the instructor, student, and a facilitator from the Office of Academic Honesty is then scheduled to determine whether a violation had occurred and, if so, the consequences. If a tentative agreement is reached during the facilitated discussion, the student has five days to sign an agreement document describing the consequences of the violation. As part of the agreement, the student would also permit his/her advisor to be notified of the situation. If an agreement is not reached or the document is not signed within five days, there will be a Continued Discussion with an Academic Honesty Panel to determine the outcome.

The consequences for academic dishonesty are determined by the instructor and they can vary depending on the infraction. The Academic Honesty Policy recommends that “sanctions should be educational for the student that violated the policy, but fair to the students that completed the work honestly.” Educational remedies include repeating the work correctly (e.g. for plagiarism) or taking a class that addresses academic honesty. The GradFIRST seminar covers academic honesty in some detail, although not until the fall semester. For some first-time violations, consequences could also include the retaking of tests, a lowered course grade, or suspension from the graduate program, depending on the nature of the violation. A second violation could lead to dismissal.

**Accommodation for disabilities**: If you plan to request accommodations for a disability, please register with the Disability Resource Center. They can be reached by visiting Clark Howell Hall, calling 706-542-8719 (voice) or 706-542-8778 (TTY), or by visiting http://drc.uga.edu

**Electronics:** Prior to class beginning, please turn off all electronic devices, including laptop computers, phones, etc., to minimize distractions. If a class activity requires electronic devices, the instructor will provide permission to use them at that time.

**Well-being resources**

UGA Well-being Resources promotes student success by cultivating a culture that supports a more active, healthy, and engaged student community. Page 5 of 5 Anyone needing assistance is encouraged to contact Student Care & Outreach (SCO) in the Division of Student Affairs at 706-542-8479 or visit sco.uga.edu. Student Care & Outreach helps students navigate difficult circumstances by connecting them with the most appropriate resources or services. They also

administer the Embark@UGA program which supports students experiencing, or who have experienced, homelessness, foster care, or housing insecurity.

UGA provides both clinical and non-clinical options to support student well-being and mental health at any time, any place. Whether on campus or studying from home or abroad, UGA Wellbeing Resources are here to help.

- Well-being Resources: https://well-being.uga.edu
- Student Care and Outreach: https://sco.uga.edu
- University Health Center: https://healthcenter.uga.edu
- Counseling and Psychiatric Services: https://caps.uga.edu or CAPS 24/7 crisis support at 706- 542-2273
- Health Promotion/ Fontaine Center: https://healthpromotion.uga.edu
- Disability Resource Center and Testing Services: https://drc.uga.edu
- Additional information, including free digital well-being resources, can be accessed through the UGA app or by visiting https://well-being.uga.edu