

Internet of Things (IoT) for Precision Agriculture Technology

Syllabus – Fall 2020

Course number: F_S/AG_S_M 4160 (3 credits)

Instructor: Jianfeng Zhou, PhD, Assistant Professor

Agricultural Systems Management

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Office: **211 Agricultural Engineering Building**, Columbia, MO

Delivery Mode: The course will be delivered in **Face-to-face (or blended) Mode**.

- **All sessions will be taught Fact-to-face** (May switch to online mode based on needs. We will announce during lecture sessions.)
 - Meet at AEB Room 107 (Rout to access the classroom can be found at the end of the syllabus)
 - Lectures will be recorded with Zoom and Panopto Videos for students' need.
 - **An affirmation that social distancing and face-covering protocols are required.**
 - **Students should come to class with their own face covering. Limited face masks will be available for students who don't have one.**
 - **The Dean of Students will be contacted if students are not wearing masks** (and do not have an accommodation for not wearing one).
 - Zoom link will be provided for students who can not attend in person.
 - In case of Labs need to be delivered online, we may switch to online mode. Will be announced during lecture sessions.

Office Hours: All queries from students will be answered by email promptly within 24 hours. If you need meetings, phone conferences or Zoom meetings are preferred, but will schedule F2F meetings if needed.

Course description: This course introduces the basic concepts and applications of Internet of Things (IoT) technology in agriculture, and its impacts on farming and agricultural industry. Show-case of typical IoT systems used in farms, on farm equipment and in cloud. Hands on experience on essential IoT components, including hardware (wireless sensors, controllers, computers and network devices) and software.

Course Learning Objectives: Upon completion of this course, the students should be able to:

1. Understand how IoT technologies can be used in agriculture systems and affect an agriculture business;
2. Understand the concept of IoT systems and its major architecture and components;
3. Know typical IoT agricultural systems, understand the architecture and functionalities;
4. Understand how to collect and analyze data with IoT for precision agriculture systems and strategically store and share data for public access;
5. Know basic statistical tools that can be used to analyze the data collected in modern agriculture business.

Course web page: MU Canvas: <https://courses.missouri.edu/>.

Textbook: None. Not required.

Technical Requirements

In the case of online mode, you will need the following in order to participate in this course:

- Computer or tablet;
- Reliable internet connection;
- Microphone;
- Some way to make and post a simple video (e.g., using a webcam, or a smartphone);

Grading:

The final grade of this cause is based on all the assignments, course reports, lab reports and attendance. The percent of each component is listed as follows:

Lecture Materials (exams, quizzes, homework)	45%
Course project/technical review	10%
Laboratory assignments	40%
Attendance	5%

Homework and Lab Assignments:

The electronic versions of the homework and laboratory assignments can be downloaded under the homework and lab tabs on Canvas. Homework assignments are due on Saturday night or as required. Laboratory assignments are due at the beginning of the laboratory session. If you cannot meet this deadline due to health issues, etc., I must be notified as soon as possible or the grade for this assignment will become an F and zero points awarded.

Course project/technical review:

At the end of the semester, a report is required from each student or group. A 10-min presentation is expected for each project. There are two forms of course projects: (1) Design a 'real' IoT system. The designed systems need include the major components of an IoT system. You can develop a team of up to 3 members, depending on the project you proposed. (2) A technical review. Summary of the current IoT systems that are used or potentially used in agriculture. Analyze their economic feasibility.

Attendance:

You are expected to attend both the lecture and lab sessions to be able to complete the homework and lab assignments. Notify the instructor if you are not able to attend a session before class begins.

Letter grades with plus and minuses will be assigned as:

≥98-100 A+ ≥93-98 A ≥90-93 A- ≥90-93 B+ ≥87-90 B ≥83-87 B-

≥77-80 C+ ≥73-77 C ≥70-73 C- ≥67-70 D+ ≥63-67 D ≥60-63 D-
Lower than 60 F

Late and resubmission

Assignments are expected to be submitted no later than due time. A reduction of 5% of earned points will be taken each day after due time. Assignments may be resubmitted once (1 time) with a revision within a week from the time return of homework. The final point of each assignment will equal to 20%*(points of original submission) + 80%*(points of resubmission). Any excuse should be announced in advance.

Decreasing the Risk of COVID-19 in Classrooms and Labs

MU cares about the health and safety of its students, faculty, and staff. To provide safe, high-quality education amid COVID-19, we will follow several specific campus policies in accordance with the advice of the Center for Disease Control and Boone County health authorities. This statement will be updated as information changes.

- **If you are experiencing any COVID-related symptoms**, or are otherwise feeling unwell, do not attend in-person classes and contact your health care provider and/or student health immediately. COVID symptoms include: fever greater than 100.4 or chills; cough, shortness of breath or difficulty breathing; fatigue; unexplained muscle or body aches; headache; new loss of taste or smell; sore throat; congestion or runny nose; nausea or vomiting; diarrhea.
- We will all wear **face coverings while in the classroom**, unless you have a documented exemption due to a disability or medical condition.
- We will maintain a **6-foot distance from each other at all times** (except in specific lab/studio courses with other specific guidelines for social distancing).
- We will enter the classroom and **fill the room starting at the front, filing all the way across a row**. When class ends, we will exit the row nearest to the door first; the instructor or TA will give the signal for the next row to exit, in the same manner.
- In any small section or lab class that requires them, **additional measures will be listed in the syllabus and be mandatory for class participation**.
- Online office hours will be available for all students.

This course may be recorded for the sole purpose of sharing the recording with students who can't attend class. The instructor will take care not to disclose personally identifiable information from the student education records during the recorded lesson.

Compliance with these guidelines is required for all; anyone who fails to comply will be subject to the [accountability process](#), as stated in the University's [Collected Rules and Regulations](#), Chapter 200 Student Code of Conduct.

If an instructor has concerns about how a student is following COVID-19 policies and protocols, please report those concerns to the Office of the Dean of Students. You can fill out a COVID

Safety Measures Reporting Form

here: https://cm.maxient.com/reportingform.php?UnivofMissouriSystem&layout_id=38

By taking the above measures, we are supporting your health and that of the whole Mizzou community. Thank you in advance for joining me and your peers in adhering to these safety measures.

Academic honesty policy:

Academic integrity is fundamental to the activities and principles of a university. All members of the academic community must be confident that each person's work has been responsibly and honorably acquired, developed, and presented. Any effort to gain an advantage not given to all students is dishonest whether or not the effort is successful. The academic community regards breaches of the academic integrity rules as extremely serious matters. Sanctions for such a breach may include academic sanctions from the instructor, including failing the course for any violation, to disciplinary sanctions ranging from probation to expulsion. When in doubt about plagiarism, paraphrasing, quoting, collaboration, or any other form of cheating, consult the course instructor.

Policy Related To Students With Disabilities - Americans with Disabilities Act:

If you anticipate barriers related to the format or requirements of this course, if you have emergency medical information to share with me, or if you need to make arrangements in case the building must be evacuated, please let me know as soon as possible.

If disability related accommodations are necessary (for example, a note taker, extended time on exams, captioning), please register with the Office of Disability Services (<http://disabilityservices.missouri.edu>), S5 Memorial Union, 882-4696, and then notify me of your eligibility for reasonable accommodations. For other MU resources for students with disabilities, click on "Disability Resources" on the MU homepage.

Intellectual Pluralism:

The University community welcomes intellectual diversity and respects student rights. Students who have questions or concerns regarding the atmosphere in this class (including respect for diverse opinions) may contact the Departmental Chair or Divisional Director; the Director of the [Office of Students Rights and Responsibilities](http://osrr.missouri.edu/) (<http://osrr.missouri.edu/>); or the [MU Equity Office](http://equity.missouri.edu/) (<http://equity.missouri.edu/>), or by email at equity@missouri.edu. All students will have the opportunity to submit an anonymous evaluation of the instructor(s) at the end of the course.

Executive Order #38, Academic Inquiry, Course Discussion and Privacy:

University of Missouri System Executive Order No. 38 lays out principles regarding the sanctity of classroom discussions at the university. The policy is described fully in Section 200.015 of the Collected Rules and Regulations. In this class, students may not make audio or video recordings of course activity, except students permitted to record as an accommodation under Section 240.040 of the Collected Rules. All other students who record and/or distribute audio or video recordings of class activity are subject to discipline in accordance with provisions of Section 200.020 of the Collected Rules and Regulations of the University of Missouri pertaining to student conduct matters.

Those students who are permitted to record are not permitted to redistribute audio or video recordings of statements or comments from the course to individuals who are not students in the course without the express permission of the faculty member and of any students who are recorded. Students found to have violated this policy are subject to discipline in accordance with provisions of Section 200.020 of the Collected Rules and Regulations of the University of Missouri pertaining to student conduct matters.

Tentative lecture schedule:

Week	Topics	Assignment
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Week 1	Course overview Special topic (1): An overview of IOT in agriculture: potential and challenge	Discussions: application of IoT in agriculture
Week 2	Architecture and components of a typical IoT system	
Week 3	Feeling Things: typical sensors and sensor nodes used in Ag, such as weather, soil, air and crops	
Week 4	Tag Things: technology available to tag things, such as RFID, bar code Acting Things: typical actuators in agricultural applications	Summarize the work principle of at least four sensors and discuss how they can be part of IoT.
Week 5	Thinking Things: embedded and single chip controllers	How to select controllers
Week 6	Connectivity and networks: wired and wireless technology	
Week 7	Security Exam 1:	How to setup a server for IoT systems
Week 8	Conceptual design: Smart irrigation	Group discussion: smart irrigation system
Week 9	<u>Guest lecture</u> : Microsoft FarmBeats Sensors and microcontrollers	
Week 10	<u>Guest lecture</u> : Dr. Calyam -- Edge Computing for IoT-based Systems - Performance and Security Considerations IoT server setup	
Week 11	<u>Guest lecture</u> : IOT America Special topic (2): IoT in field management	
Week 12	Special topic (3): IoT in irrigation management	
Week 13	Special topic (4): IoT in livestock management	
Thanksgiving Break		
Week 15	<u>Guest lecture</u> : AGCO Special topic (5): IoT in and smart field equipment	Course report: summarize the potential applications of IOT in your future work.
Week 16	Student Project Presentations	
Finals	No class	

Note: Schedule is subject to change.

Student project: No more three students will work on a topic.

Guest Speakers: Part of special topics will be covered by Visiting speakers from academic and industrial partners (for example Climate Fieldview, Farmoile, CropTrak, Topcon, Microsoft) who will be invited to share their perspective on the current state-of-the-art in the IoT industry.

Laboratory Activities, Fall Semester, 2019

	#	Lab	Subject
Week 1	1	Introduction	(1) IoT system overview. (2) Lab and equipment tour. (3) Lab requirement and rules
Week 2	2	Network devices (1)	Ethernet modem, router, switch, hub and connection; Ethernet cables
Week 3	3	Network devices (2)	Connection, setup and trouble shooting Ethernet cables, installation and maintenance
Week 4	4	Network devices (3)	
Week 5	5	Manageable switches and Point to point setup (bridge)	
Week 6	6	Security camera setup	
Week 7	7	Field trip (1)	Data center
Week 8	8	Smart irrigation systems	
Week 9	9	IoT system – sensors (T & RH sensor), controllers and data loggers (Pi and Arduino)	
Week 10	10	IoT system – Wireless communication (node and gateway: LoRa/BT/ZigBee))	
Week 11	11	Field trip (2)	TBD
Week 12	12	Special Lab: IoT America	
Week 13	13	IoT system – IoT platform	
Week 14	Fall break		
Week 15	14	TBD	
Week 16	15	Course project review	
Finals		No lab	

Note: Schedule is subject to change.

Student Health and Safety Protocol for Courses in Agricultural Engineering 105, 106, 107, 125, 128, 129 & 135

Enter traffic pattern for students

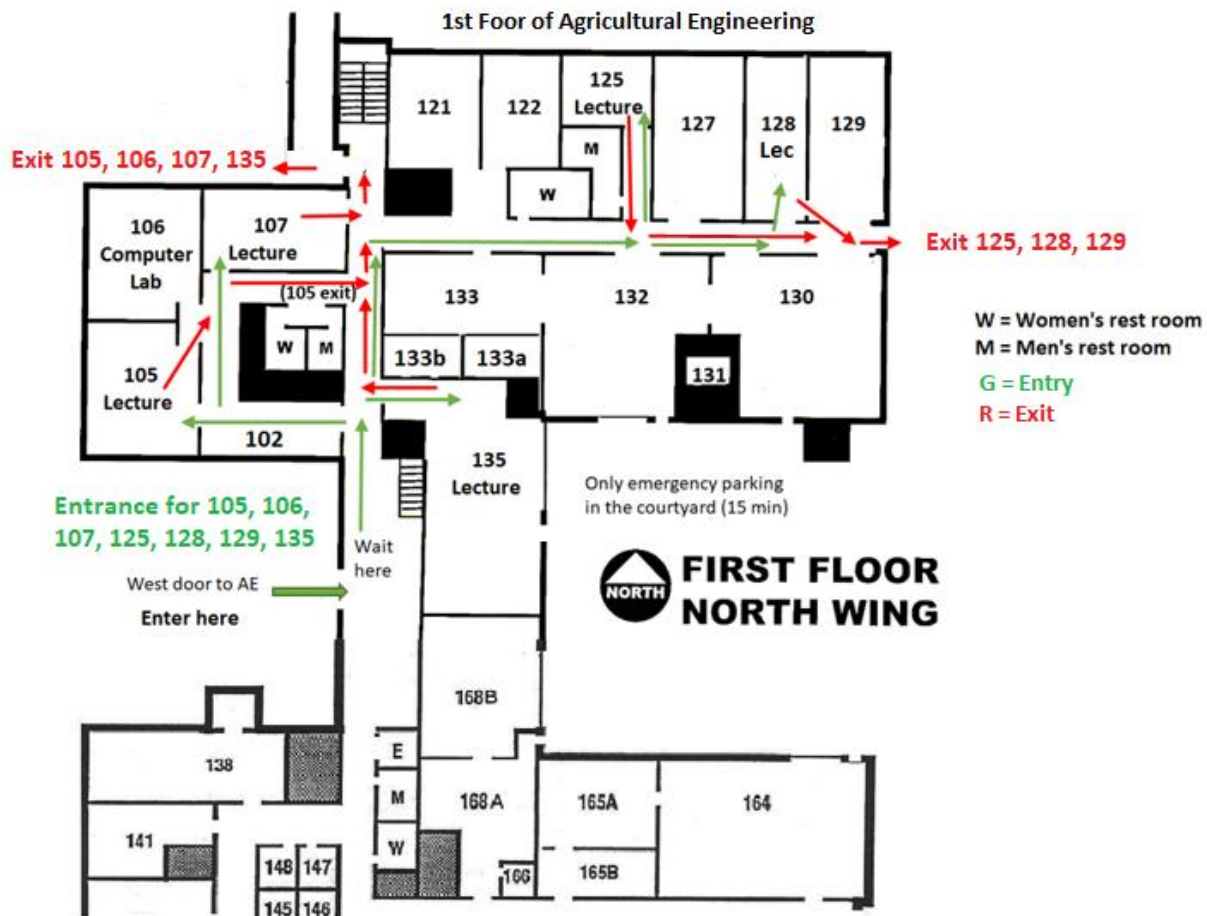
- Enter using the **West door** of the building (labeled Enter here).
- Please wait, socially distanced, in the glassed entry area of the building.
- Review the floor plan below to learn which door to enter each room.
- Fill rooms from back to front.

Exit traffic pattern for students

- Exit rooms from front to back.
- Review the floor plan below to learn which door to exit each room.

Access

- West & South doors of the building open at 7:30 am and lock at 5:00 pm.



Emergency information and procedures will be provided by your instructor.