

Foundations of UAS Mapping - SUR4501C/6502C

1 Course Overview

Course description:

Foundations of UAS Mapping introduces students to the fundamental components of small unmanned aerial systems (sUAS) and how they function together to produce high resolution, spatially accurate planimetric maps and 3D models of the terrain. These components include GPS/GNSS, inertial systems, lidar, and on-board sensors like cameras. We focus primarily on the application of these technologies, but also cover basic theoretical aspects. We deal with establishing ground control for sUAS imagery so that the products can be referenced to specific geodetic reference frameworks and integrated with other geospatial data. This is the first of the three courses required for the Certificate in Mapping with Unmanned Aerial Systems. Students who do not have a geomatics background, such as an introductory surveying class or field experience, are required to get the permission of the instructor before they enroll.

- 3 Credits
- Spring 2024
- Hybrid delivery consisting of mandatory in-person field labs and synchronous, online lectures/discussions
- <http://elearning.ufl.edu/> and local labs in Gainesville, FLREC, or GCREC

Course Prerequisites: SUR 3103C Geomatics or instructor consent (non-Geomatics students are encouraged to take this course).

Co-Instructors and Lab Support:

Justin Thomas, PSM (Instructor, Lab Support) Main Campus, Reed Lab 301
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Dr. Youssef Kaddoura, (Instructor, Lab Support) FLREC, Davie West Building 210
Phone: (954) 577-6378 email: kaddoura@ufl.edu

- Please use email for fastest response
- Office hours: available by email or phone; office visits available by appointment

Recommended textbooks:

- Ghilani and Wolf (2015). Elementary Surveying: An Introduction to Geomatics (14th Edition), Pearson-Prentice Hall, New Jersey
- van Sickle, J. (2015). GPS for Land Surveyors (4th Ed.): CRC Press.

Recommended resources:

- ASPRS. (2015). "ASPRS Positional Accuracy Standards for Digital Geospatial Data." Photogrammetric Engineering & Remote Sensing, November 2014, 81(3), A1–A26.
https://www.asprs.org/a/society/committees/standards/Positional_Accuracy_Standards.pdf
- AUVSI (Association for Unmanned Vehicles International): <https://www.auvsi.org/>
- Campbell, L. and D. Katz (2018). How to Use Ground Control in Drone Surveying.
<https://web.archive.org/web/20210507015519/https://www.pobonline.com/articles/101529-how-to-use-ground-control-in-drone-surveying>
- Additional reading provided throughout the semester.

2 Learning Outcomes

By the end of this course, each student will be able to:

- understand the fundamentals of sUAS
- identify the essential hardware components of sUAS
- plan, acquire, and adjust GPS/GNSS and total station measurements, and know their role in ground control for sUAS mapping
- understand the fundamentals of onboard GPS/GNSS and inertial measurements, and know their role in airborne navigation and control for sUAS
- understand the fundamental concepts of photogrammetry and lidar
- articulate the standard sUAS mapping workflow
- analyze and report on the quality of spatial measurements and maps

3 Course Logistics

First day of class: 1/08/24. Last day of class: 4/24/24. This course will be conducted in a hybrid format that includes some face-to-face sessions.

Method of Instruction:

- This course is based on the concept of experiential learning or “learning by doing.” Where possible, the material is learned primarily through a series of hands-on field projects. The field data collection component of the project is done in small teams (2-4 students).
- Analysis of the data and submission of results, however, must be done independently and individually (not as a team).
- The project deliverables are due at specified dates (**deadlines**) throughout the semester according to a set schedule. **These deadlines are not flexible.**

Scheduled Meetings:

All sections *Mon: 8:30am – 9:20am (per. 2) via Zoom or pre-recorded*

- This meeting is used to provide background information on the specific technology and methodology as well as the requirements of the weekly project.
- Links to meeting recordings will be posted in Canvas.

All sections *Thu: 8:20pm – 9:10pm (per E2) via Zoom*

- This meeting is used to do independent data reduction and analysis.
- All meetings are meant to be interactive discussions. Preparation prior to meetings is paramount for course success.
- When applicable, links to meeting recordings will be posted in Canvas.

Scheduled Labs:

GNV-A sections *Mon: 11:45am – 2:45pm (per. 5-7)*

Flavet field site

GNV-B sections *Mon: 3:00pm – 6:00pm (per. 8-10)*

Flavet field site

PCC sections *Sat: 8:00am – 2:30pm**

GCREC/Plant City Campus

FTL sections *Sat: 8:30am – 2:30pm**

FLREC/Davie West Bldg.

*** estimated ending time, may vary weekly depending on lab specifics**

- The field data acquisition part of projects occurs during scheduled labs unless equipment constraints or weather dictate otherwise. All field work is done on campus and students should read the project instructions prior to going to the field.
- Any student who cannot complete their labs in Gainesville, Plant City, or Fort Lauderdale, can only complete this course if they have access to the hardware and software involved.

Office hours:

All sections *Fri: 11:30am –12:30pm via Zoom*

- If needed, appointments can be made in advance for availability outside of the normal hours. For alternate office hour times, the instructors can be best reached via email. Please note that responding to Canvas messages through UF email may remove attachments and that message delivery may be slightly delayed. Students are also welcomed to call by phone or arrange a video conference meeting in Zoom.

Communication:

- The course is managed through the UF's e-Learning system (Canvas - <https://elearning.ufl.edu/>). All communication and submission of project reports and results should be done through the facilities in that system.
- Questions and suggestions to the whole class can also be posted under the Discussions tab.
- Any short-term changes concerning meetings, labs, or other course components will be announced through Canvas.
- Students are also welcome to arrange a video conference meeting to go over any questions.
- Though projects are due by 11:59pm on Fridays, all project related questions for instructors should be sent by 5:00pm to ensure a response.

Technology Requirements:

- A computer or mobile device with high-speed internet connection to view lectures.
- A headset and/or microphone and speakers
- For Zoom: A supported web browser on a supported operating system (Windows, Mac OS, Linux); and minimum bandwidth. More details can be found [here](#).
- For software and hardware requirements, a mandatory quiz will be conducted during the beginning of the term to determine the computational needs of students for software used throughout the semester.

Using Zoom:

- Live lectures and office hour meetings (including individual student requests) will be conducted with the Zoom conferencing software. Sessions can be joined by clicking a link posted by the instructor on Canvas.
- Synchronous online sessions will be recorded. By sharing your video, screen, or audio during any synchronous online class sessions, you are consenting to being recorded for the benefit of students who cannot attend live as well as for class review during the current semester. If you have special circumstances or concerns about privacy, it is your responsibility to discuss it with your instructor.
- Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.
- A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.
- Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or

uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third-party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

3.1 Description of Assessments & Activities

Project Reports:

Project reports are required for the following projects:

- P01: UAS mission planning
- P02: Observe, process, and evaluate GPS/GNSS static baselines using CORS/OPUS and Static Networks
- P03: Establish ground control points using total stations and Digital Levels
- P04: Establish ground control points and survey flight lines using RTK GNSS
- P05: Process UAS RGB imagery
- P06: Evaluate inertial navigation system (INS) measurements
- P07: Processing LIDAR Data – Ground Truthing and Feature Extraction
- P08: Process and analyze multispectral UAS imagery – NDVI Analysis

Attendance and Participation:

- Students are expected to attend all field labs and Thursday evening discussion sessions. Ten percent (graduate students 5%) of the grade is dedicated to attendance of field labs and discussions. More than two unexcused absences related to the Thursday evening discussions will result in a deduction of the student final grade.
- Group members will be periodically polled on the participation of their peers in lab activities.
- Meaningful posting of questions and project troubleshooting on discussion boards is incorporated into the participation grade. Students are expected to participate to provide meaningful posts in at least 4 out of the 8 project discussion boards.
- For unexcused absences from field lab activities, the corresponding project report grade will receive a 50% reduction.

Final Presentation & Peer Review:

- Final Presentations:
 - The presentation needs to include an executive summary of the objective, methodology, data processing, analysis, results, and conclusion(s) reached.
 - Students will be given detailed instructions on how to pre-record their presentations and share the recording on Canvas with the class.
 - Undergraduates:
 - Each student is given 3 minutes to present a summary of one of the topics or projects completed during the semester.
 - Graduates
 - Each student is given 8-10 minutes to present a summary of one's Term Paper (see below).
- Peer Review:
 - Students will be grouped. Each student is required to peer review the presentations of all other group members according to a specific rubric.

Term Paper (Graduate Students only):

- Graduate students are required to write a journal length paper on a topic related to the class. This should include analysis beyond what was done in the assigned project (such as comparisons of different methods from different projects) and should show a thorough understanding of the technology and

techniques involved. This manuscript should follow the typical format used in peer-reviewed journals (e.g., MDPI journal Drones - <https://www.mdpi.com/journal/drones/instructions>). More detailed instructions will be provided in Canvas.

Final Quiz:

- A final 50-minute quiz will be given May 2 from 3:00 PM to 5:00 PM. The quiz will be delivered through Canvas using Honorlock, which requires a high-speed internet connection and a webcam. This quiz covers the concepts and principles associated with the topics covered during the semester. This date and time are firm. Any exceptions must be arranged with the instructors at least 2 weeks in advance.

3.2 Grades & Grading Scale

Grading is based on project deliverables, online quizzes, a final project presentation, and participation. Due to undergraduate and graduate students populating this class, final grades are not published in Canvas. See grade worksheet to determine final grade. Grading is distributed as follows for undergraduates (UG) and graduates (G):

<i>Item</i>	<i>Percentage</i>
Timeliness and completeness of project reports and assignments	70% (UG), 60% (G)
Attendance and participation (field labs, discussions, etc.)	10% (UG), 5% (G)
Peer review	3%
Final project presentation	7%
Term paper	NA (UG), 20% (G)
Final quiz (cumulative)	10% (UG), 5% (G)
Total	100%

Grading scale:

<i>Grade</i>	<i>Percentage</i>	<i>Grade</i>	<i>Percentage</i>
A	95.0-100.0	C+	77.0-79.9
A-	90.0-94.9	C	73.0-76.9
B+	87.0-89.9	C-	70.0-72.9
B	83.0-86.9	D	60.0-69.9
B-	80.0-82.9	E	0-59.9

For information on current UF policies for assigning grade points, see <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>.

4 Learning Content

Course Schedule:

Please note that bad weather and/or other unpredictable factors may cause this schedule to change during the semester.

SUR4501/6502 - Schedule - Spring 2024 - updated: 2024 - 01 - 04

Online meetings and office hours can be accessed through links in Canvas

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
1/8 UF 1st Day of Classes ALL-WEB: Overview, UAS Mapping	1/9	1/10	1/11 ALL-WEB: Overview P1: UAS Mapping	1/12 ALL-OH	1/13	1/14
1/15 Holiday - MLK	1/16	1/17	1/18 ALL-Q/A: P1	1/19 ALL-OH P1 Report Due	1/20 FTL: P2 (Field) PCC: P2 (Field)	1/21
1/22 ALL-WEB: P2 OPUS / Static Networks GNV-A: P2 (Field) GNV-B: P2 (Field)	1/23	1/24	1/25 ALL-Q/A: P2	1/26 ALL-OH	1/27	1/28
1/29 ALL-WEB: Continuation of Project 2 GNV-A: P2 (OH 2-4PM) GNV-B: P2 (OH 2-4PM)	1/30	1/31	2/1 ALL-Q/A: P2	2/2 ALL-OH P2 Report Due	2/3 FTL: P3 (Field) PCC: P3 (Field)	2/4
2/5 ALL-WEB: P3 - Ground Control via TS and DL GNV-A: P3 (Field) GNV-B: P3 (Field)	2/6	2/7	2/8 ALL-Q/A: P3	2/9 ALL-OH	2/10	2/11
2/12 ALL-WEB: P3 - Continuation of Project 3 GNV-A: P3 (OH 2-4PM) GNV-B: P3 (OH 2-4 PM)	2/13	2/14	2/15 ALL-Q/A: P3	2/16 ALL-OH P3 Report Due	2/17 FTL: P4 (Field) PCC: P4 (Field)	2/18
2/19 ALL-WEB: P4 RTK GNV-A: P4 (Field) GNV-B: P4 (Field)	2/20	2/21	2/22 ALL-Q/A: P4	2/23 ALL-OH P4 Report Due	2/24 GRAD: Project Proposal due 2/25 (No Grace Period)	2/25
2/26 ALL-WEB: P5 - RGB Analysis GNV-A: (P07 Lidar Flights 2-4PM) GNV-B: (P07 Lidar Flights 2-4PM)	2/27	2/28	2/29 ALL-Q/A: P5	3/1 ALL-OH	3/2	3/3
3/4 ALL-WEB: P5 - Continuation of Project 5 GNV-A: P5 (OH 2-4PM) GNV-B: P5 (OH 2-4PM)	3/5	3/6	3/7 ALL-Q/A: P5	3/8 ALL-OH P5 Report Due	3/9 Spring Break	3/10
3/11	3/12	3/13	3/14	3/15	3/16	3/17
Spring Break						
3/18 ALL-WEB: P6 INS Evaluation GNV-A: P6 (OH 2-4PM) GNV-B: P6 (OH 2-4PM)	3/19	3/20	3/21 ALL-Q/A: P6	3/22 ALL-OH P6 Report Due	3/23 FTL: P07 (Field) PCC: P07 (Field) GRAD: Refined Project Proposal due 3/24 (No Grace Period)	3/24
3/25 ALL-WEB: P07 Lidar GNV-A: P07 (Field) GNV-B: P07 (Field)	3/26	3/27	3/28 ALL-Q/A: P07	3/29 ALL-OH	3/30	3/31
4/1 ALL-WEB: P7 - Continuation of Project 07 GNV-A: P07 (OH 2-4PM) GNV-B: P07 (OH 2-4PM)	4/2	4/3	4/4 ALL-Q/A: P07	4/5 ALL-OH P07 Report Due	4/6	4/7
4/8 ALL-WEB: P08 Multispectral - NDVI GNV-A: P08 (OH 2-4PM) GNV-B: P08 (OH 2-4PM)	4/9	4/10	4/11 ALL-Q/A: P08	4/12 ALL-OH P08 Report Due	4/13	4/14

4/8 ALL-WEB: P08 Multispectral - NDVI GNV-A: P08 (OH 2-4PM) GNV-B: P08 (OH 2-4PM)	4/9	4/10	4/11 ALL-Q/A: P08	4/12 ALL-OH P08 Report Due	4/13	4/14					
4/15 ALL-WEB: Final Project Overview	4/16	4/17	4/18 ALL-Q/A: Final Proj.	4/19 ALL-OH	4/20	4/21					
4/22 ALL-WEB: Final Pres./Quiz Overview & Q/A	4/23	4/24 UF last Day of Classes Final Pres due 4/24 (No Grace Period)	4/25 Reading Day No Classes	4/26 Reading Day No Classes	4/27 GRAD: Final Paper due 4/28 (No Grace Period)	4/28					
4/29 Peer Reviews Due (No Grace Period)	4/30	5/1	5/2 Final Quiz 3:00PM - 5:00PM (No Grace Period)	5/3	5/4	5/5					
Class Meetings			Start Time - End Time (Location)			Class Meetings			Start Time - End Time (Location)		
ALL-WEB			830A-920A (Zoom)			GNV-A			1145A-245P (Reed Lab/Field)		
ALL-Q/A			820P-910P (Zoom)			GNV-B			300P-600P (Reed Lab/Field)		
ALL-OH			1130A-1230P (Zoom)			PCC			830A-230P (PCC/Field)		
						FTL			830A-230P (FTL/Field)		
Note #1: All project reports are due at 1159pm on due date. 2 day grace period. 5% penalty per day penalty after grace period. Stay on schedule!											
Note #2: Friday office hours are from 1130AM-1230PM. For working students, if needed, appointments can be made in advance for availability.											

5 Policies and Requirements

This syllabus represents current plans and objectives for this course. As the semester progresses, changes may need to be made to accommodate timing, logistics, or to enhance learning. Such changes, communicated clearly, are not unusual and should be expected.

5.1 Late Submissions & Make-up Requests

It is the responsibility of the student to access online lectures, readings, and quizzes to maintain satisfactory progress in the course.

- A 5% penalty per day will be applied to late project reports turned in after the grace period. A submission is assessed a 5% penalty starting 1 minute after the grace period ends.
- Questions about projects should be brought to the attention of the instructors 5:00pm Friday. Questions asked outside of business hours may not be answered immediately, which is not an excuse for late submission.
- Project reports will not be accepted for credit if handed in more than ten days after the original due date.
- Quizzes cannot be taken past the deadline. There is no grace period for quizzes.
- Exceptions to the late policy are only allowed per university policy, and it is the responsibility of the student to make instructors aware of such extenuating circumstances within 1 week of the due date.

Computer or other hardware failures, except failure of the UF e-Learning system, will not excuse students for missing assignments. Any late submissions due to technical issues MUST be accompanied by the ticket number received from the Helpdesk when the problem was reported to them. The ticket number will document the time and date of the problem. You MUST e-mail your instructor within 24 hours of the technical difficulty if you wish to request consideration.

For computer, software compatibility, or access problems call the HELP DESK phone number—352-392-HELP = 352- 392-4357 (option 2).

Requirements for class attendance and make-up exams, assignments and other work are consistent with university policies that can be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>.

5.2 Communication Courtesy and Professionalism

Just as in any professional environment, meaningful and constructive dialogue is expected in this class and requires a degree of mutual respect, willingness to listen, and tolerance of opposing points of view. **Respect for individual differences and alternative viewpoints will be maintained in this class at all times.** All members of the class are expected to follow rules of common courtesy, decency, and civility in all email messages, threaded discussions, and chats. Failure to do so will not be tolerated and may result in loss of participation points and/or referral to the Dean of Students' Office

(<http://teach.ufl.edu/docs/NetiquetteGuideforOnlineCourses.pdf>Student).

5.3 Semester Evaluation Process

Student assessment of instruction is an important part of efforts to improve teaching and learning.

At approximately the mid-point of the semester, the School of Forest, Fisheries, & Geomatics Sciences will request anonymous feedback on student satisfaction on various aspects of this course. These surveys will be sent out through Canvas and are not required but encouraged. This is not the UF Faculty Evaluation!

At the end of the semester, 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.a.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.a.ufl.edu/public-results/>.

5.4 Academic Honesty Policy

As a student at the University of Florida, you have committed yourself to uphold the Honor Code, which includes the following pledge: *"We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity."*

You are expected to exhibit behavior consistent with this commitment to the UF academic community, and on all work submitted for credit 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."*

It is assumed that you will complete all work independently in each course unless the instructor provides explicit permission for you to collaborate on course tasks (e.g., assignments, papers, quizzes, exams). Furthermore, as part of your obligation to uphold the Honor Code, you should report any condition that facilitates academic misconduct or appropriate personnel. It is your individual responsibility to know and comply with all university policies and procedures regarding academic integrity and the Student Honor Code. Violations of the Honor Code at the University of Florida will not be tolerated.

Violations will be reported to the Dean of Students Office for consideration of disciplinary action. For more information regarding the Student Honor Code, please see: <http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code>.

5.5 Inclusive Learning Environment

This course embraces the University of Florida's Non-Discrimination Policy, which reads,

The University shall actively promote equal opportunity policies and practices conforming to laws against discrimination. The University is committed to non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information and veteran status as protected under the Vietnam Era Veterans' Readjustment Assistance Act.

If you have questions or concerns about your rights and responsibilities for inclusive learning environment, please see the instructor or refer to the Office of Multicultural & Diversity Affairs website:

<http://multicultural.ufl.edu>.

5.6 Services for Students with Disabilities:

The Disability Resource Center coordinates the accommodation needed by students with disabilities. This includes registering disabilities, recommending academic accommodations within the classroom, accessing special adaptive computer equipment, providing interpretation services, and mediating faculty-student disability related issues. Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the instructor when requesting accommodation. 0001 Reid Hall, 352-392-8565, www.dso.ufl.edu/drc/.

5.7 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.

Other Requirements:

Cellular phones must be turned off during class. They may be used in field sessions for field work communication pertaining to this course work only.

6 Campus Helping Resources

For issues with technical difficulties for e-learning in Canvas, please post your question to the Technical Help Discussion in your course, or contact the UF Help Desk at:

- Learning-support@ufl.edu | (352) 392-HELP - select option 2 | <http://elearning.ufl.edu>
- Library Help Desk support <http://cms.uflib.ufl.edu/ask>
- SFFGS Academic Hub <https://ufl.instructure.com/courses/303721>

6.1 Student Life, Wellness, and Counseling Help

Students experiencing crises or personal problems that interfere with their general well-being are encouraged to utilize the university's counseling resources. The Counseling & Wellness Center provides confidential counseling services at no cost for currently enrolled students. Resources are available on campus for students having personal problems or lacking clear career or academic goals, which interfere with their academic performance.

- Counseling and Wellness resources <http://www.counseling.ufl.edu/cwc/>
- U Matter, We Care <http://www.umatter.ufl.edu/>
- Career Connections Center <http://career.ufl.edu/>
- Other resources are available at <http://www.distance.ufl.edu/getting-help> for online students

6.2 Student Complaint Process

The School of Forest, Fisheries, & Geomatics Sciences cares about your experience and we will make every effort to address course concerns. We request that our online students complete a course satisfaction survey each semester, which is a time for you to voice your thoughts on how your course is being delivered. You can also [submit feedback anytime](#).

If you have a more urgent concern, your first point of contact should be the Academic Coordinator or the Graduate/Undergraduate Coordinator for the program offering the course. You may also submit a complaint directly to UF administration:

- Students in online courses: <http://www.distance.ufl.edu/student-complaint-process>

- Students in face-to-face courses: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>