

## COURSE SYLLABUS SUR 4501/SUR 6502: FOUNDATIONS OF UAS MAPPING

**M/W 5<sup>th</sup> Period + M 8-10<sup>th</sup> Period  
(3 Credits)**

### Prerequisites

SUR 3103 or Permission of Instructor (non-Geomatics students are encouraged to take this course)

### Instructors

**Dr. Grenville Barnes** [gbarnes@ufl.edu](mailto:gbarnes@ufl.edu) (352) 392 4998      **Reed Lab 406B**

Grenville Barnes has been on the Geomatics faculty since 1993 and prior to that taught at Ohio State University for 5 years. He worked as a licensed land surveyor in South Africa before coming to the University of Wisconsin to do a PhD. His research is focused on property rights and systems for legalizing them in developing countries, including using UAS for defining property boundaries. He also teaches Cadastral Principles and several graduate classes including Land Tenure and Administration and Field Skills for Forest Conservation (co-taught).

### Distance Student Field Project Instructors

**Adam Benjamin** [abenjamin1@ufl.edu](mailto:abenjamin1@ufl.edu)

Adam is a Geomatics Specialist and Program Assistant in our Ft. Lauderdale Geomatics (FTL) Program. He has a BS in Mathematics from Elon University and a Masters in Geomatics from UF. In his spare time, he is pursuing a PhD in Geomatics at UF.

**Katie Britt** [k.britt@ufl.edu](mailto:k.britt@ufl.edu)

Katie is a Geomatics Specialist and Program Assistant in our Plant City Geomatics (PC) Program. He has a BS in Mechanical Engineering and a second BS in Geomatics from UF and is a licensed surveyor and mapper in Florida.

### Teaching Assistant

**Sean Denney** [sdenney@ufl.edu](mailto:sdenney@ufl.edu) (352) 392-0345      **Reed Lab 404A**

Sean is a recently returned PhD student in our Geomatics Program. After finishing a BS in Geomatics at UF he completed an MS in Ocean Engineering at the University of New Hampshire. Prior to returning to UF Sean worked for Fugro Chance Inc. as a Hydrographic Surveyor. He is also a world famous cave diver.

### Course Description and Learning Objectives

*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 geo-spatial data. This is the first of the three courses required for the Certificate in Geospatial Measurement and Modeling with sUAS. 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.

By the end of this course, the student will:

- Understand the foundations of sUAS
- Be able to identify the essential hardware components of sUAS
- Know how to plan, acquire, and adjust GPS/GNSS and total station measurements, and their role in ground control for sUAS mapping
- Understand the fundamentals of onboard GPS/GNSS and inertial measurements, and their role in airborne navigation and control for sUAS
- Understand the fundamental concepts of photogrammetry and lidar
- Be familiar with the standard sUAS mapping workflow
- Be able to analyze and report on the quality of spatial measurements and maps

### 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; the deadlines are not flexible, but usually vary for non-Gainesville students.

### Meeting Times and Places

The class meets weekly on Monday morning (11:45am-12:35pm) in **302 Reed Lab** for a lecture focused on the topic for that week. For those topics that require a field project this lecture will provide background information on the specific technology being used as well as the requirements of the weekly project. Distance students can attend these lectures virtually via Adobe Connect at the scheduled time through the Polycom system or view the recorded version at a later time.

The field data acquisition part of projects occurs on Monday afternoon (3:00-6:00p.m.) for Gainesville students 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. Distance students do their projects through our programs at Ft. Lauderdale or Plant City Research and Education Centers (RECs), and need to coordinate with them to schedule project field work. Any student who cannot do their labes in Gainesville, Plant City or Ft. Lauderdale, can only do this course if they have access to the hardware and software involved.

In the Gainesville Wednesday lab session (11:45am-12:35pm), data reduction, analysis, etc., is done independently by each student under the supervision of the Instructor and/or the Teaching Assistant in **402 Reed Lab**. REC students must coordinate the time and

location of these sessions with their respective REC instructors. This lab session is not recorded as we do not have this capability in 402 Reed.

### Recommended Readings

Ghilani and Wolf (2015). *Elementary Surveying: An Introduction to Geomatics* (14<sup>th</sup> Edition), Pearson-Prentice Hall, New Jersey

Anderson, C. (2012). "Here Come the Drones." *Wired Magazine*, London, UK, pp. 102–111 [http://www.wired.com/2012/06/ff\\_drones/all/](http://www.wired.com/2012/06/ff_drones/all/)

Anderson, C. (2007-2014). DIY Drones Blog. <http://diydrones.com/profiles/blog/list?user=zlitezlite>

Wolman, D. (2012). Drone's Day Scenario. *The Pennsylvania Gazette*, Nov/Dec. pp. 28-33. [http://www.upenn.edu/gazette/1112/PennGaz1112\\_feature1.pdf](http://www.upenn.edu/gazette/1112/PennGaz1112_feature1.pdf)

### Communication

The course is managed through the UF's e-Learning system (Canvas) and all communication with instructors should be done through the facilities in that system.

### Course Evaluation

Grading is based on project deliverables, on-line quizzes, a final project presentation, and participation and is distributed as follows (ugrad/grad):

- a) Project reports and assignments..... 60/55%
- b) Attendance and participation ..... 10/5%
- c) Peer Review ..... 5/5%
- d) Final project presentation ..... 10/10%
- e) Term Paper ..... NA/20%
- f) Final quiz ..... 15/5%

### Project Reports

Project reports are required for the following 9 Projects:

- Project 1 - Establish Ground Control using total stations
- Project 2 - Evaluate GPS Single Point Positioning and DGPS
- Project 3 – Observe, process and evaluate GPS/GNSS Static Baselines using CORS and OPUS
- Project 4 – Reconnaissance and Planning of GPS/GNSS Network
- Project 5 – Observe and evaluate GPS/GNSS Static Network
- Project 6 – Evaluate Inertial Navigation System (INS) measurements
- Project 7 – Evaluate Google Earth spatial quality
- Project 8 – Process UAS data to produce orthophoto and 3-D point cloud
- *Project 9* – Observe and process Lidar data
- Project 10 – Compare Lidar and 3-D model produced from UAS aerial photographs
- Project 11 – Flight planning
- Project 12 - ?

A project assignment will be provided each week through the course website. Each student should submit a project report back through the Canvas system before the specified deadline. No reports will be accepted after the deadline.

*Report Format:* Students are given a report template for each project assignment. Each student *individually* must submit their report using the template provided.

### **Attendance and Participation**

Students are expected to attend all lecture, lab, and field sessions. Ten percent (graduate students 5%) of the grade is dedicated to attendance of Mon and Wed classes (distance students are assessed on the frequency with which they access the course website). More than two unexcused absences will result in a deduction of the student final grade.

### **Final Presentation and Summary Reports**

Each student is given 3 minutes (8-10 minutes for graduate students) to present a summary of one of the topics or projects completed during the semester. The presentation should include a brief summary of the objective, methodology, data processing, analysis, results and conclusion(s) reached. \* Each student is required to peer review the presentations of 5 other students 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.

### **Final Quiz**

A final 50 minute quiz will be given on the last Wednesday class of the semester in RLA 402. This quiz covers the concepts and principles associated with the topics covered during the semester.

### **Grade Scale**

A	95 -100
A-	90 - 94.99
B+	87 - 89.99
B	83 - 86.99
B-	80 - 82.99
C+	77 - 79.99
C	73 - 76.99
C-	70 - 72.99
D+	67 - 69.99
D	63 - 66.99
D-	60 - 62.99
E	0 - 59.99

### **Grades and Grade Points**

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

### Attendance and Make-Up Work

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>

### Distance Students Complaints

Each online distance learning program has a process for, and will make every attempt to resolve, student complaints within its academic and administrative departments at the program level. See <http://distance.ufl.edu/student-complaints> for more details.

### Weekly Lecture, Project, and Quiz Schedule

Please note that bad weather and/or other unpredictable factors may cause this schedule to change during the semester. Lectures in 302 Reed will be available live through Adobe Connect and Polycom and will also be recorded for distance students who cannot ‘attend’ those classes. Lab locations are shown below for Gainesville only (\*), but will take place on FTL and PC campuses as well at a time to be scheduled by the instructors at those locations.

Day	Week Activity	Mode	Location
<b>Week 1 Jan 5 - 8</b>			
Wed	<b>Topic:</b> Introduction to UAS and course	Lecture	302 Reed
<b>Week 2 Jan 11 - 15</b>			
Mon	<b>Topic: Ground Control for UAS</b>	Lecture	302 Reed
Mon	<b>Lab:</b> Ground control using total stations (Project 1)	Fieldwork	UF campus*
Wed	<b>Topic:</b> Process total station data	Lab Work	402 Reed
<b>Week 3 Jan 18 - 22</b>			
Mon	<i>MLK Jr. Day – NO CLASS (Jan 19)</i>		
Wed	<b>Topic:</b> Process total station data <b>Deliverable:</b> Project 1 Report	Lab Work	402 Reed*
Fri	Online Quiz 1		
<b>Week 4 Jan 25 - 29</b>			
Mon	<b>Topic:</b> GPS/GNSS Navigation	Lecture	302 Reed
Mon	<b>Lab:</b> GPS Single Point Positioning and DGPS (acquire uncorrected and WAAS-corrected GPS data) (Project 2)	Fieldwork	UF campus*
Wed	<b>Topic:</b> Analyze and compare accuracy and precision of GPS observations <b>Deliverable:</b> Project 2 Report	Lab Work	402 Reed*
Fri	Online Quiz 2		
<b>Week 5 Feb 1 - 5</b>			
Mon	<b>Topic:</b> Inertial navigation systems – INS	Lecture	302 Reed
Mon	<b>Lab:</b> INS Project (Project 3)	Field/Lab	UF campus*

Wed	<b>Topic:</b> Analyze INS data <i>Deliverable: Project 3 Report</i>	Lab Work	402 Reed
Fri	Online Quiz 3		
<b>Week 6 Feb 8 – 12</b>			
Mon	<b>Topic:</b> GPS/GNSS	Lecture	302 Reed
Mon	<b>Lab:</b> Acquire GPS static baselines and draw obstruction diagrams for ground control points (Project 4)	Fieldwork	UF campus*
Wed	<b>Topic:</b> Process differentially corrected GPS baselines using Continuously Operating Reference Stations (CORS) and the Online Positioning User Service (OPUS) <i>Deliverable: Project 4 Report</i>	Lab Work	402 Reed
<b>Week 7 Feb 15 – 19</b>			
Mon	<b>Topic:</b> GPS/GNSS mission planning and networks	Lecture	302 Reed
Mon	<b>Lab:</b> Acquire GPS static network data (Project 5)	Fieldwork	UF campus*
Wed	<b>Topic:</b> Process and analyze locally-referenced GPS network <b>Deliverable:</b> Project 5 Report	Lab Work	402 Reed
Fri	Online Quiz 4		
<b>Week 8 Feb 22 – 26</b>			
Mon	<b>Topic:</b> How to make a UAS work*	Lecture	302 Reed
Mon	<b>Lab:</b> Project 5 (cont.)	Lab Work	402 Reed
Wed	<b>Topic:</b> Project 5 (cont.)	Lab Work	402 Reed
<b>Week 9 Feb 29 – Mar 4 Spring Break</b>			
<b>Week 10 Mar 7 -11</b>			
Mon	<b>Topic:</b> UAS Work Flow	Lecture	302 Reed
Mon	<b>Lab:</b> Process small set of UAS-based imagery (Project 6)	Lab Work	402 Reed
Wed	<b>Topic:</b> Analyze UAS data <i>Deliverable: Project 6 Report</i>	Lab Work	402 Reed
Fri	Online Quiz 5		
<b>Week 11 Mar 14 – 18</b>			
Mon	<b>Topic:</b> Spatial Data Sharing using Google Earth	Lecture	302 Reed
Mon	<b>Lab:</b> Analyze spatial quality of GE imagery (Project 7)	Lab Work	402 Reed
Wed	<b>Topic:</b> Continue analysis of GE Imagery <i>Deliverable: Project 7 Report</i>	Lab Work	402 Reed
<b>Week 12 Mar 21 – 25</b>			
Mon	<b>Topic:</b> 3-D modeling from stereo-imagery	Lecture	302 Reed
Mon	<b>Lab:</b> Measurements on provided 3-D model (Project 8)	Fieldwork	402 Reed
Wed	<b>Topic:</b> Continue measurements on 3-D model	Lab Work	402 Reed

<i>Deliverable: Project 8 Report</i>			
<b>Week 13 Mar 28 – April 1</b>			
Mon	<b>Topic:</b> Lidar/Laser Scanning	Lecture	302 Reed
Mon	<b>Lab:</b> Scan terrestrial object and process (Project 9)	Fieldwork	UF campus*
Wed	<b>Topic:</b> Analyze scanned data <i>Deliverable: Project 9 Report</i>	Lab Work	402 Reed
Fri	Online Quiz 6	Quiz	
<b>Week 14 April 4 – 8</b>			
Mon	<b>Topic:</b> Commercial software options	Lecture	302 Reed
Mon	<b>Lab:</b> TBA (Project 10)	Lab Work	402 Reed
Wed	<b>Topic:</b> Project 10 <i>Deliverable: Project 10 Report</i>	Lab Work	402 Reed
<b>Week 15 April 11 – 15</b>			
Mon	<b>Topic:</b> Flight Planning Lecture and UAV	Lecture	302 Reed
Mon	<b>Lab:</b> Flight Planning (Project 11)	Lab Work	402 Reed
Wed	<b>Topic:</b> Prepare Presentations <i>Deliverable: Project 11 Report</i>	Lab Work	402 Reed
<b>Week 16 April 18 - 22</b>			
Mon	<b>Topic:</b> Final student presentations	Present	302 Reed
Mon	<b>Lab:</b> Final student presentation (3-6 pm)	Present	302 Reed
Wed	<b>Topic:</b> Final on-line Quiz		

\*Guest lecture

### Online Course Evaluation Process

Student assessment of instruction is an important part of efforts to improve teaching and learning. At the end of the semester, students are expected to provide feedback on the quality of instruction in this course using a standard set of university and college criteria. These evaluations are conducted online at <https://evaluations.ufl.edu>. Evaluations are typically open for students to complete during the last two or three weeks of the semester; students will be notified of the specific open times. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results>.

### UF Academic Honesty

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 to 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>.

### 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.

### Services for Students with Disabilities

The Disability Resource Center coordinates the needed accommodations of 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/](http://www.dso.ufl.edu/drc/)

### Campus Helping Resources

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.

- *University Counseling & Wellness Center, 3190 Radio Road, 352-392-1575, [www.counseling.ufl.edu/cwc/](http://www.counseling.ufl.edu/cwc/)*
  - Counseling Services
  - Groups and Workshops
  - Outreach and Consultation
  - Self-Help Library
  - Wellness Coaching
- *Career Resource Center, First Floor JWRU, 392-1601, [www.crc.ufl.edu/](http://www.crc.ufl.edu/)*

### 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.