

COURSE SYLLABUS
SUR 3501/SUR 6934: FOUNDATIONS OF UAS MAPPING

M/W 5th Period + M 8-10th 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 (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).

Dr. Ben Wilkinson benew@ufl.edu (352) 392-3465 **Reed Lab 406A**

Ben Wilkinson is an Assistant Professor in Geomatics at the University of Florida. He has been involved in UAS mapping research since 2006. Before joining the faculty at UF in 2013, Dr. Wilkinson worked in private industry as a research scientist focused on airborne lidar and photogrammetry, and also worked as an airborne lidar operator for the National Center for Airborne Lidar Mapping. He currently teaches the introductory and advanced photogrammetry courses at UF, and is a coauthor of *Elements of Photogrammetry with Applications in GIS*, 2014.

Distance Student Field Project Instructors

Adam Benjamin 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.

Justin Harris justin98@ufl.edu

Justin 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 (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 cover both the practical and theoretical aspects of these technologies. We also 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 a 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 history and evolution 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 standard sUAS mapping workflow
- Be able to write effective project reports

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 project reports, however, is the responsibility of each student individually. The project deliverables are due at specified dates (**deadlines**) throughout the semester according to a set schedule; the deadlines are not flexible, but may 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 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.

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.

Recommended Readings

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

Trimble (2007). *GPS – The First Global Navigation Satellite System*, Trimble Navigation Ltd, Sunnyvale, CA

Anderson, C. (2012). “Here Come the Drones.” *Wired Magazine*, London, UK, pp. 102–111 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

Communication

The course is managed through the UF e-Learning system 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:

- a) Project reports and assignments..... 40%
- b) Attendance and participation 10%
- c) Weekly on-line quizzes 30%
- d) Final project presentation 10%
- e) Final quiz 10%

Project Reports (40%)

Project reports are required for the following 9 Projects:

- Project 1 - Establish Ground Control using total stations
- Project 2 - Compare GPS Single Point Positioning and DGPS
- Project 3 – GPS/GNSS Static Baselines using CORS and OPUS
- Project 4 – GPS/GNSS Static Network
- Project 5 – INS Assignment
- Project 6 – Produce geo-spatial products using a small set of UAS data
- Project 7 – Measurements on 3-D Model
- Project 8 – Google Earth spatial quality analysis

- Project 9 – Lidar model and analysis

A project assignment will be provided each week through the course website. Each student should submit a project report back through the Sakai system before mid-night the following Sunday. 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 (10%)

Students are expected to attend all lecture, lab, and field sessions. Ten percent 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.

Weekly On-line Quizzes (30%)

A short weekly quiz covering the main principles, concepts and content of the weekly topic is done on-line outside of class. These are open-book so no proctoring will be necessary.

Final Presentation and Summary Reports (10%)

Each student is given 10 minutes 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.

*Graduate students 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 (10%)

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 and will comprise thirty multiple-choice and true-false questions.

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 through 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. Project deliverables are generally due by midnight on the Sunday following the fieldwork.

Day	Week Activity	Mode	Location
Week 1 Jan 6 - 9			
Wed	Topic: Introduction, history and evolution of UAS*	Lecture	302 Reed
Week 2 Jan 12 - 16			
Mon	Topic: Ground Control for UAS	Lecture	302 Reed
Mon	Lab: Ground control using total stations (Project 1)	Fieldwork	UF campus*
Wed	Topic: Process total station data	Lab Work	402 Reed
Fri	Online Quiz 1	Quiz	
Week 3 Jan 19 - 23			
Mon	<i>MLK Jr. Day – NO CLASS (Jan 19)</i>		
Wed	Topic: Process total station data Deliverable: Project 1 Report	Lab Work	402 Reed*
Week 4 Jan 26 - 30			
Mon	Topic: GPS/GNSS Navigation	Lecture	302 Reed
Mon	Lab: GPS Single Point Positioning and DGPS (acquire uncorrected and WAAS-corrected GPS data) (Project 2)	Fieldwork	UF campus*
Wed	Topic: Analyze and compare accuracy and precision of GPS observations	Lab Work	402 Reed*

<i>Deliverable: Project 2 Report</i>			
<i>Fri</i>	Online Quiz 2		Quiz
Week 5 Feb 2-6			
<i>Mon</i>	Topic: GPS/GNSS	Lecture	302 Reed
<i>Mon</i>	Lab: Acquire GPS static baselines and draw obstruction diagrams for ground control points (Project 3)	Fieldwork	UF campus*
<i>Wed</i>	Topic: Process differentially corrected GPS baselines using Continuously Operating Reference Stations (CORS) and the Online Positioning User Service (OPUS)	Lab Work	402 Reed
<i>Deliverable: Project 3 Report</i>			
<i>Fri</i>			Quiz
Week 6 Feb 9 – 13			
<i>Mon</i>	Topic: GPS/GNSS mission planning and networks	Lecture	302 Reed
<i>Mon</i>	Lab: Acquire GPS static network data (Project 4)	Fieldwork	UF campus*
<i>Wed</i>	Topic: Process and analyze locally-referenced GPS network	Lab Work	402 Reed
<i>Deliverable: Project 4 Report</i>			
<i>Fri</i>	Online Quiz 3		Quiz
Week 7 Feb 16 – 20			
<i>Mon</i>	Topic: Inertial navigation systems – INS	Lecture	302 Reed
<i>Mon</i>	Lab: INS Project (Project 5)	Field/Lab	UF campus*
<i>Wed</i>	Topic: Analyze INS data	Lab Work	402 Reed
<i>Deliverable: Project 5 Report</i>			
<i>Fri</i>	Online Quiz 4		Quiz
Week 8 Feb 23 – 27			
<i>Mon</i>	Topic: Lidar/Laser Scanning	Lecture	302 Reed
<i>Mon</i>	Lab: Scan terrestrial object and process (Project 6)	Fieldwork	UF campus*
<i>Wed</i>	Topic: Analyze scanned data	Lab Work	402 Reed
<i>Deliverable: Project 6 Report</i>			
<i>Fri</i>	Online Quiz 5		Quiz
Week 9 Mar 2 – 6 Spring Break			
Week 10 Mar 9 -13			
<i>Mon</i>	Topic: UAS Work Flow	Lecture	302 Reed
<i>Mon</i>	Lab: Process small set of UAS-based imagery (Project 7)	Lab Work	402 Reed
<i>Wed</i>	Topic: Analyze UAS data	Lab Work	402 Reed
<i>Deliverable: Project 7 Report</i>			
<i>Fri</i>	Online Quiz 6		Quiz

Week 11 Mar 16 – 20			
Mon	Topic: How to make a UAS work*	Lecture	302 Reed
Mon	Lab: Project 7 Cont.	Lab Work	402 Reed
Wed	Topic: Project 7 Cont.	Lab Work	402 Reed
Week 12 Mar 23 – 27			
Mon	Topic: 3-D modeling from stereo-imagery	Lecture	302 Reed
Mon	Lab: Measurements on provided 3-D model (Project 8)	Fieldwork	402 Reed
Wed	Topic: Continue measurements on 3-D model <i>Deliverable: Project 8 Report</i>	Lab Work	402 Reed
Fri	Online Quiz 7	Quiz	
Week 13 Mar 30 – April 3			
Mon	Topic: Spatial Data Sharing using Google Earth	Lecture	302 Reed
Mon	Lab: Analyze spatial quality of GE imagery (Project 9)	Lab Work	402 Reed
Wed	Topic: Continue analysis of GE Imagery <i>Deliverable: Project 9 Report</i>	Lab Work	402 Reed
Fri	Online Quiz 8	Quiz	
Week 14 April 6 – 10			
Mon	Topic: Commercial software options*	Lecture	302 Reed
Mon	Lab: TBA (Project 10)	Lab Work	402 Reed
Wed	Topic: Project 10 <i>Deliverable: Project 10 Report</i>	Lab Work	402 Reed
Fri	Online Quiz 9	Quiz	
Week 15 April 13 – 17			
Mon	Topic: Flight Planning Lecture and UAV	Lecture	302 Reed
Mon	Lab: Flight Planning Project (11)	Lab Work	402 Reed
Wed	Topic: Prepare Presentations <i>Deliverable: Project 11 Report</i>	Lab Work	402 Reed
Fri	Online Quiz 10		
Week 16 April 20 - 22			
Mon	Topic: Final student presentations	Present	302 Reed
Mon	Lab: Final student presentation (3-6 pm)	Present	302 Reed
Wed	Topic: Final on-line Quiz	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/

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/*
 - 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/*

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.