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## **SUR3520 Measurement Science/SUR5525 Least Squares Adjustment**

### **1. OVERVIEW**

Measurement science involves methodologies for analyzing and handling errors with a focus on least squares adjustments. This course will provide an introduction to common sources and types of errors that occur in geodetic measurements, as well as proper analysis procedures to handle these errors and assess their effect on final computation results, such as point coordinates or areas. Students will learn related concepts covering error theory, statistical distributions, hypothesis testing, law of error propagation, principle of least squares, adjustment procedures (e.g., horizontal surveys, level networks, GPS baselines), and error ellipses.

- Spring semester, 3 credits
- 100% online
- <http://elearning.ufl.edu/>

### **Course Prerequisites:**

MAC 2233, STA 2023, and SUR 3641 Survey Computations, or instructor consent

### **Instructor:**

Dr. Henry Hochmair, Ft. Lauderdale Research & Education Center, Davie West Bldg.  
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### **Teaching assistant:**

Dr. Youssef Kaddoura, Ft. Lauderdale Research & Education Center, Davie West Bldg.  
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### **Communication:**

- Office hours: Mondays 5-7 p in Zoom (on days before a home assignment is due)
- Please use the Canvas message/Inbox feature for fastest response

### **Lectures:**

Tuesdays: 10:40a-11:30a (period 4), Thursdays: 10:40a-12:35p (period 4+5)

Note: Lectures are prerecorded. Links to lecture recordings will be posted on Canvas in weekly modules. One Q&A live sessions will be held in Zoom during lecture times.

### **Recommended textbook (not required):**

- Ghilani, C. D. (2018). Adjustment Computations - Spatial Data Analysis (6th Ed.). New York, NY: John Wiley & Sons

### **Required teaching materials:**

- All necessary information to succeed in the course can be found in online materials (such as lecture videos, lecture notes, Excel sheets for in-class exercises) posted on the Canvas Website. Optional reading materials are marked as such whereas all other materials are required.

### **Software requirements:**

- Microsoft Excel is the primary software used for most topics in this course. Basic skills in Microsoft Excel are essential. Students who do not have access to Microsoft Excel are encouraged to use Microsoft Excel in UF Apps (<https://info.apps.ufl.edu/>).
- Geodetic software (ADJUST and StarNet) is used for selected adjustment topics. Software download instructions for this software will be provided on the course website under the Week 7 and Week 11 module, respectively. StarNet and ADJUST software run on Windows and can be installed locally. Students who do not

have access to a Windows computer can contact the instructor for remote access to a server which runs StarNet and ADJUST.

## 2. LEARNING OUTCOMES

The course objective is to provide students with the following competencies at the completion of the course:

1. Apply statistical methods to describe the distribution and quality of geodetic measurements
2. Use error propagation to model the error of indirect measurements
3. Apply the least-squares method in geodetic software and spread sheet functions to adjust various types of measurements
4. Use error ellipses to describe geodetic network quality
5. Provide a critical interpretation of computational results and concepts

The course Website (see under Modules/Course Overview) contains an alignment table which illustrates how course activities (e.g. assignments, discussion posts, quizzes) are linked to course competencies.

## 3. COURSE LOGISTICS

- Throughout the semester, students will be given 10 homework assignments (graduate students: 11), 2 quizzes, 3 discussion tasks, and one field lab assignment.
- Attendance points will be given for one Q&A session.
- For each type of assessment (home assignment, quiz, discussion), a due date and time is given which is usually midnight one week after the handout
- Assignments and field labs are graded based on timeliness, correctness of computations and interpretation of numerical results, with written feedback provided by the instructor; quizzes are auto-graded based on correctness of multiple choice questions with correct answers shown after completion, and discussion items are graded based on creativity, completeness, technical correctness and the number of comments provided to peers.
- There is a 1-week turnaround for assignment, field lab, and discussion grading. Quizzes are auto-graded instantaneously in Canvas.
- This course does not offer extra credit tasks
- This course is a distance education course taught partly as prerecorded lectures and partly as live lectures using the virtual classroom software Zoom. Lecture materials can be downloaded from weekly modules on the Canvas website.

### Technology Requirements:

- A computer or mobile device with high-speed internet connection
- A headset and/or microphone and speakers to participate in live sessions
- For Zoom: A supported web browser on a supported operating system (Windows, Mac OS, Linux); and minimum bandwidth. More details can be found [here](#).

### Using Zoom:

Q&A sessions and office hour meetings (per individual student requests) will be conducted with the Zoom web conferencing software. Sessions can be joined by clicking a link posted on Canvas.

**Grades:**

In order to give students more control over their education, the class is invited to select the weight of each assessment category as a percentage of the semester grade from the ranges provided in the table below:

<i>Item</i>	<i>Percentage</i>
Homework assignments (UG: 10; G: 11)	22-28%
Quizzes (3)	4-10%
Topical discussions (4)	4-10%
Home assignment discussions (6)*	3-5%
Attendance of Q&A sessions (1)	1-3%
Exams (2)	46-50%
Field Lab (1)	6-8%
Total (mid-points)	<b>100%</b>

For this purpose, a survey (not graded) will be set up in Canvas, where each student can enter the preferred percentage weight for each item. From all submitted survey responses, the average percentage value will be computed for each category, normalized to sum up to 100% across all items, and used for grading.

\* To earn full points for this item, one post and one response must be submitted for at least six different home assignment discussions

**Grading scale:**

<i>Grade</i>	<i>Percentage</i>	<i>Grade</i>	<i>Percentage</i>
A	90.0-100.0	C+	73.0-74.9
A-	87.0-89.9	C	67.0-72.9
B+	85.0-86.9	C-	65.0-66.9
B	77.0-84.9	D	50.0-64.9
B-	75.0-76.9	E	0-49.9

Graduate students are required to complete an additional assignment that consists of advanced tasks relating to topics taught throughout the semester. Completing the tasks requires adjustment computations that are not part of other assignments. The additional assignment counts towards the homework assignment grade. A minimum point score is not required on this additional assignment to receive a final course grade.

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

**4. COURSE CONTENT**

<b>Week</b>	<b>Topic</b>	<b>Assignment</b>	<b>Book chapter</b>
Week 1, Jan 9	Course introduction Types of measurements and errors	D1	ch. 1
Week 2, Jan 16	Analysis of observations Random errors	H1	ch. 2 ch. 3
Week 3, Jan 23	Distributions used in sampling theory Confidence intervals	H2	ch. 4
Week 4, Jan 30	Hypothesis testing	H3, Q1	ch. 5
Week 5, Feb 6	Law of error propagation	Q2	ch. 6

Week 6, Feb 13	Error Propagation in distance, angle, and elevation measurements	H4, D2	ch. 7-9
Week 7, Feb 20	Principles of Least Squares Adjustment	H5, D3	ch. 11
Week 8, Feb 27	<b>Feb 27: Midterm exam</b> between 5-9 pm (2 hours)		
Week 9, Mar 5	Solving nonlinear equation systems	H6	ch. 11
Mar 11 – Mar 15	<i>Spring break (no classes)</i>		
Week 10, Mar 19	Adjustment of level networks	H7	ch. 12
Week 11, Mar 26	Adjustment of trilateration networks	H8	ch. 14
Week 12, Apr 2	Adjustment of triangulation networks Error ellipse	H9	ch. 15 ch. 19
Week 13, Apr 9	Adjustment of GNSS baselines	H10, D4	ch. 17
Week 14, Apr 16	Exam review Q&A (4/18) – <i>attend. req'd</i>	Q3, HG	
Week 15, Apr 23	No lecture. Finish field lab		
Week 16	<b>Apr 30: Final exam</b> between 5-9 pm (2 hours)		

D: Discussion, Q: Quiz, H: Home assignment

**Exam dates:**

- Midterm exam: Tue Feb 27; exam time window: 5-9 pm; exam duration: 2 hours
- Final exam: Tue Apr 30; exam time window: 5-9 pm; exam duration: 2 hours

**Other dates with attendance required:**

- Thursday 4/18, 10:40a: Final exam review Q&A session

Note: If a student cannot attend a class with live attendance required for a justified reason (e.g., job related), the student needs to let the instructor know this in advance, and an alternative task is given instead so that attendance points can still be earned.

**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.

**Late submissions and make-up requests:**

It is the responsibility of the student to access on-line lectures, readings, quizzes, and exams and to maintain satisfactory progress in the course.

- A 10% penalty per day will be applied to late assignments. A late submission on the due date also results in a 10% deduction. Students need to submit a late assignment as an attachment in a Canvas e-mail to the instructor. Do not attach it as a note to the submission platform.
- Assignments will not be accepted if handed in more than a week after the due date (unless specified differently).
- Students may request an extension to submitting a home assignment for a justified reason, but need to do so before the submission deadline.
- Quizzes cannot be taken past the deadline
- Online discussions cannot be completed past the deadline.
- Exceptions to the late policy are only allowed per university policy.

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.

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>.

**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 SFFGS 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.aa.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.aa.ufl.edu/public-results/>.

**Netiquette: Communication Courtesy Semester Evaluation Process:**

All members of the class are expected to follow rules of common courtesy in all email messages, threaded discussions and chats, as laid out in the [UF Netiquette Guide](#) for Online Courses. Failure to do so may result in loss of participation points and/or referral to the Dean of Students' Office.

**Diversity Statement:**

This course encourages open and respectful communication among students, fostering a culture of inclusivity, understanding, and empathy. It values the unique backgrounds and experiences that each student brings to the classroom, including diverse racial and ethnic backgrounds, genders, sexual orientations, ages, abilities, religions, and socioeconomic statuses.

**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>

View this video for more information on how to avoid plagiarism.

**University Policy on Accommodating Students with Disabilities:**

Students requesting accommodation for disabilities must first register with the Dean of Students Office ((<https://disability.ufl.edu/>)). The Dean of Students Office will provide documentation to the student who must then provide this documentation to the instructor when requesting accommodation. You must submit this documentation prior to submitting assignments or taking the quizzes or exams. Accommodations are not retroactive, therefore, students should contact the office as soon as possible in the term for which they are seeking accommodations.

**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.

**Class recordings:**

Policies regarding student in-class recordings and publishing them are detailed here: <http://aa.ufl.edu/policies/in-class-recording/>

**6. CAMPUS RESOURCES**

**Academic 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](mailto:Learning-support@ufl.edu) | (352) 392-HELP - select option 2 | <http://elearning.ufl.edu> | <https://helpdesk.ufl.edu/>
- SFFGS Academic Hub <https://ufl.instructure.com/courses/303721>
- [Career Connections Center](#): Reitz Union Suite 1300, 352-392-1601. Career assistance and counseling services.
- [Library Support](#): Various ways to receive assistance with respect to using the libraries or finding resources.
- [Teaching Center](#): Broward Hall, 352-392-2010 or to make an appointment 352- 392-6420. General study skills and tutoring.
- [Writing Studio](#): 2215 Turlington Hall, 352-846-1138. Help brainstorming, formatting, and writing papers.
- Student Complaints On-Campus: [Visit the Student Honor Code and Student Conduct Code webpage for more information.](#)
- On-Line Students Complaints: [View the Distance Learning Student Complaint Process.](#)

**Health and Wellness:**

- *U Matter, We Care*: If you or someone you know is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu), 352-392-1575, or visit [U Matter, We Care website](#) to refer or report a concern and a team member will reach out to the student in distress.
- *Counseling and Wellness Center*: [Visit the Counseling and Wellness Center website](#) or call 352-392-1575 for information on crisis services as well as non-crisis services.
- *Student Health Care Center*: Call 352-392-1161 for 24/7 information to help you find the care you need, or [visit the Student Health Care Center website.](#)
- *University Police Department*: [Visit UF Police Department website](#) or call 352-392-1111 (or 9-1-1 for emergencies).
- GatorWell Health Promotion Services <https://gatorwell.ufsa.ufl.edu/>