Term Information

Effective Term	Autumn 2026
Previous Value	*Summer 2012*

Course Change Information

What change is being proposed? (If more than one, what changes are being proposed?)

We are requesting:

1. A course name change to "Data Analysis and Parameter Estimation for Geosciences", and

2. A reduction from 5 semester credit hrs to 4 hrs

3. A change to prerequisites to include only Calculus II (MATH 1152 or equival

What is the rationale for the proposed change(s)?

This modification to Adjustment Computations aims to enhance accessibility for undergraduate students across Earth Sciences, Geography, Civil Engineering, and other Natural Science programs. To support this goal, advanced topics including least squares collocation, sequential adjustment, and condition equations will be removed to focus on core statistical methods and practical applications. The revised course name better aligns with EARTHSC 2245, creating a clearer academic pathway for students taking these courses in sequence while providing a more descriptive course name that accurately reflects the course content and objectives. There will also be a reduction in weekly meeting hours to accommodate 4 semester credits. For example:

Lectures: Mondays, Wednesdays, from 11:30 am – 12:50 pm

Lab: Tuesdays from 11:30 am – 12:50 pm

What are the programmatic implications of the proposed change(s)?

(e.g. program requirements to be added or removed, changes to be made in available resources, effect on other programs that use the course)?

There should be no significant programmatic implications of the proposed changes, beyond lowering the bar for entry to the class.

Is approval of the requrest contingent upon the approval of other course or curricular program request? No

Is this a request to withdraw the course? No

General Information

Course Bulletin Listing/Subject Area	Geodetic Sciences MPS
Fiscal Unit/Academic Org	School of Earth Sciences - D0656
College/Academic Group	Arts and Sciences
Level/Career	Graduate, Undergraduate
Course Number/Catalog	5652
Course Title	Data Analysis and Parameter Estimation for Geosciences
Previous Value	*Adjustment Computations*
Transcript Abbreviation	Data Analysis Geo
Previous Value	*Adjstment Comptns*
Course Description	Students will develop skills to read computer files, pre-process observational data, and implement least squares inverse problems and related statistical tools for real-world problem solving. The course emphasizes both theoretical understanding and practical application through hands-on laboratory exercises using industry-standard software.
Previous Value	*Classification of errors; measures of dispersion; variance and covariance; propagation of errors; weights, observations, and normal equations; algorithms and examples, weighted and fixed constraints; statistical tests; error ellipses.*
Semester Credit Hours/Units	Fixed: 4

Previous Value	*Fixed: 5*

Offering Information

Length Of Course	14 Week, 12 Week, 8 Week, 7 Week, 6 Week
Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	No
Grading Basis	Letter Grade
Repeatable	No
Course Components	Laboratory, Lecture
Grade Roster Component	Lecture
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never
Campus of Offering	Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites	Prereq: Math 1172, or equiv.
Previous Value	*Prereq: Math 1172, 2153, 2173 or 254 or equiv; and 2568, 4568, or 572 or equiv.*
Exclusions	
Previous Value	Not open to students with credit for GeodSciM 650 or 651
Electronically Enforced	No

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code	15.1102
Subsidy Level	Doctoral Course
Intended Rank	Junior, Senior, Masters, Doctoral
Previous Value	*Senior, Masters, Doctoral*

Requirement/Elective Designation

The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- · Identify and distinguish the different elements involved in a least squares inverse problems (observations, parameters, deterministic model, stochastic model, etc.)
- · Apply different approaches for weighting observations based on measurement uncertainty
- · Implement constraints in least squares problems through weighted condition equations or infinite weight condition equations
- · Construct design matrices for linear and non-linear least squares inverse problems
- · Design and execute least squares simulations without observational data
- · Perform and interpret statistical analyses of least squares adjustment results
- · Create computer programs to read field observations and estimate parameters for deterministic models

Previous Value

Content Topic List

- Taking measurements using real instruments
- Classification of Errors
- Measuring dispersion
- Variance and covariance
- Propagation of errors
- Weights, observations, and normal equations, algorithms and examples, weighted and fixed constraints
- Statistical tests
- Error ellipses

Previous Value

- *Classification of errors*
- *Measures of dispersion*
- *Variance and covariance*
- *Propagation of errors*
- *Weights, observations, and normal equations, algorithms and examples, weighted and fixed constraints*
- *Statistical tests*
- *Error ellipses*

Sought Concurrence

No

Attachments

- Fall 2026 Syllabus.docx: Syllabus for revised course

  (Syllabus. Owner: Griffith,William ASHLEY)
- Fall 2025 Syllabus.docx: Old syllabus

  (Syllabus. Owner: Griffith,William ASHLEY)
- Syllabus_comparison.docx: Syllabus comparison

  (Syllabus. Owner: Griffith,William ASHLEY)

Comments

- I uploaded the most recent version of the course syllabus (in 5 credit form) plus a document comparing the 5 credit and proposed 4 credit syllabi *(by Griffith,William ASHLEY on 09/29/2025 01:52 PM)*
- Could you please also upload the syllabus for the 5 credit version? The committee will need it to ascertain what has changed. *(by Vankeerbergen,Bernadette Chantal on 09/28/2025 04:04 PM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Griffith,William ASHLEY	09/26/2025 01:25 PM	Submitted for Approval
Approved	Griffith,William ASHLEY	09/26/2025 01:25 PM	Unit Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	09/28/2025 04:05 PM	College Approval
Submitted	Griffith,William ASHLEY	09/29/2025 11:34 AM	Submitted for Approval
Approved	Griffith,William ASHLEY	09/29/2025 01:52 PM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	09/29/2025 01:53 PM	College Approval
Pending Approval	Jenkins,Mary Ellen Bigler Neff,Jennifer Vankeerbergen,Bernadette Chantal Steele,Rachel Lea	09/29/2025 01:53 PM	ASCCAO Approval

GEOSCIM 5652 Data Analysis and Parameter Estimation for Geosciences

Meeting times

Lectures: Mondays, Wednesdays, from 11:30 am – 12:50 pm
Lab: Tuesdays from 11:30 am – 12:50 pm
Instructor's office hours (in ML 321): Mo – Fri 9:30 am to 4:00 pm, or let me know by email when you're coming. I can also schedule a Zoom meeting for one or multiple students.

Instructor

Dr. Demián Gómez

Course Description

This course provides students with foundational knowledge and practical skills in statistical methods for analyzing scientific measurements with inherent uncertainty, enabling students to solve inverse problems commonly encountered in geoscience applications. Students will develop programming skills to read computer files, pre-process observational data, and implement least squares inverse problems and related statistical tools for real-world problem solving. The course emphasizes both theoretical understanding and practical application through hands-on laboratory exercises using industry-standard software.

Mode of Delivery

This course will be delivered in person.

Course Goals and Outcomes

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

- Identify and distinguish the different elements involved in a least squares inverse problems (observations, parameters, deterministic model, stochastic model, etc.)
- Apply different approaches for weighting observations based on measurement uncertainty
- Implement constraints in least squares problems through weighted condition equations or infinite weight condition equations
- Construct design matrices for linear and non-linear least squares inverse problems
- Design and execute least squares simulations without observational data
- Perform and interpret statistical analyses of least squares adjustment results
- Create computer programs to read field observations and estimate parameters for deterministic models

Materials and Software

This course uses the "Notes on Adjustment Computations" by Kyle Snow (based on the original course taught by Burkhard Schaffrin). I also recommend the book "Adjustment Computations Spatial Analysis" by Ghilani and Wolf (Wiley). This last book is optional.

The course requires a laptop during the labs and practice hours, so I strongly recommend installing Matlab (any OS version and laptop computer will do fine). I will use Carmen to manage homeworks and grading.

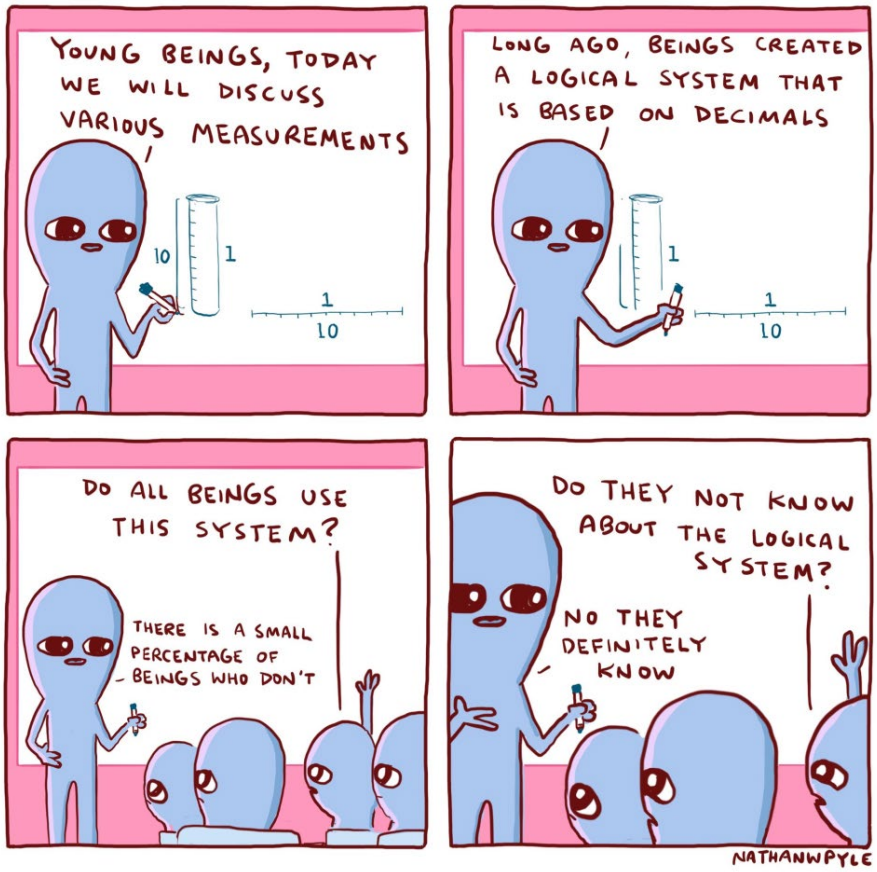
Evaluation

Attendance/Class Participation (15%)
Homework (30%)
Course Project (30%)
Midterm Exam (25%)

Course Policy

The student is responsible for all course related emails, so be sure to check your inbox on a daily basis. When emailing me, please always begin the subject of the email with the course number (GEOSCIM 5652, or just 5652) and then the subject of the email. This helps me organize my emails related to classes. Thanks! A proper email subject should be like this: GEOSCIM 5652 Questions about Lab 3.

System of units used in this course: this course and the instructor fully embrace the International System of Units (SI, commonly known as the metric system). For an in depth discussion of why the SI system is superior to the imperial system, see https://www.nytimes.com/2020/08/18/science/foot-surveying-metrology-dennis.html?referringSource=articleShare and https://xkcd.com/1643/. For your class assignments do not use: feet, US feet, inches, yards, miles, or any other unit that was originally realized using the thumb or foot length of a king. Any results given in imperial units will be automatically returned to the student for amendment.



Mid-term exam: exact date will be discussed with students. The exam will be written and include theoretical and practical questions.

Plagiarism: Plagiarism means representing the work of others as your own. This includes copying other students' work or using Internet resources without citing them. Any form of plagiarism will be penalized.

Screens: We will, of course, use electronic devices during class time. I expect, however, for students to work on their assignments, not on other classes or projects. I also expect all phones to be silenced and put away for the duration of the class.

Health and Safety: Due to the ongoing COVID19 pandemic, you are expected to use a mask and maintain social distance in class at all times. Also, refrain from eating. These measures will be lifted when OSU deems appropriate.

Homework Policy

Homework is considered a bi-weekly assignment. This means that you have at least two weeks to work on it. Homework should be submitted before ***noon*** of the Thursday of the week it is due. I will

penalize late submissions by subtracting five points for every 24 hours past the due date. This means that I will automatically subtract five points from your grade if you submit your homework after 12:00 pm on Thursday, ten points if you submit after 12:00 pm on Friday, and so on. If you are having health issues that prevent you from submitting your assignment on time, please contact me as soon as possible to discuss an extension.

Presentation requirements: homeworks must be presented in digital form, unless I say otherwise. When the solution to a problem has multiple steps, include ***ALL*** the steps, not just the final answer. Accepted digital formats include PDFs (LaTex, MS Word converted, etc), Open Office, MS Word, etc. Matlab scripts are also accepted when / if necessary**. Pictures of hand written notes (raster formats or embedded in PDFs) will not be accepted**. When citing another person's work, please use APA or AGU citing format. We will discuss Zotero as a way to simplify this task. If you have questions about the presentation format, please let me know in advance: **do not turn in the homework and THEN ask the question.**

Grading

Participation is worth 5% of your total grade, attendance is worth 10% and each homework is worth 6%. Hopefully no one will get sick during the course, but in the case of sickness, please let me know as soon as possible so that we can seek any required accommodations (visit https://slds.osu.edu/ for more information). Grading will be based on this table:

A	93–100	**C+**	77–79.9
A-	90–92.9	**C**	73–76.9
B+	87–89.9	**C-**	70–72.9
B	83–86.9	**D**	60–69.9
B-	80–82.9	**F**	<60

Topic covered during the course

- Taking measurements using real instruments: error types
- Foundations: observations, parameters, and random errors
- The model of direct observations
- The Gauss-Markov model
- The Gauss-Markov model with constraints
- The Gauss-Markov model with stochastic constraints
- The Gauss-Helmert model
- Statistical analysis

Topics covered during the labs

- Taking measurements to fit a model

- Using Matlab/Python to solve least squares problems
- Practical problems: fitting a line, fitting a circle, fitting an ellipse, network adjustments
- Geophysical and geodesy inverse problems: earthquake location, GPS positioning (closed forms), slip on pre-determined fault surface
- Building design matrices
- Weighting schemes
- Iterative least squares solutions

Weekly schedule

Week	Activity	Notes
1	Taking measurements using real instruments	HW1 (one extra week) Discussion about the class dynamics, homework assignments, and more
2	Observations, parameters, and random errors	
3	The model of direct observations	Project discussion
4	The Gauss-Markov model Iterative reweighting least squares	**HW1 due** HW2
5	Application examples	
6	The Gauss-Markov model with constrains Application examples	**HW2 due** HW3: project proposal
7	The Gauss-Markov model with stochastic constrains	
8	Midterm exam (exact date TBD) Discussion of project progress 1	**HW3 due** HW4 Fall Break
9	Earth Science applications: Guest lecturer - TBD	Mid-course survey
10	The Gauss-Helmert model	**HW4 due**
11	Statistical analysis	HW5 (optional)
12	Project discussion	
13	Project presentations	**HW5 due (optional)** **Project due**
14	Project presentations	Project comments
15	Thanksgiving week	Project comments and grades
16	Last day of classes	

General Statements

Academic Misconduct *Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the University's Code of Student Conduct, and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the University's Code of Student Conduct and this syllabus may constitute Academic Misconduct.*

The Ohio State University's Code of Student Conduct (Section 3335-23-04) defines academic misconduct as: Any activity that tends to compromise the academic integrity of the University or subvert the educational process. Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the University's Code of Student Conduct is never considered an excuse for academic misconduct, so please review the Code of Student Conduct and, specifically, the sections dealing with academic misconduct.

If an instructor suspects that a student has committed academic misconduct in this course, the instructor is obligated by University Rules to report those suspicions to the Committee on Academic Misconduct. If COAM determines that a student violated the University's Code of Student Conduct (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in the course and suspension or dismissal from the University.

If students have questions about the above policy or what constitutes academic misconduct in this course, they should contact the instructor.

Artificial Intelligence and Academic Integrity *There has been a significant increase in the popularity and availability of a variety of generative artificial intelligence (AI) tools, including ChatGPT, Sudowrite, and others. These tools will help shape the future of work, research and technology, but when used in the wrong way, they can stand in conflict with academic integrity at Ohio State.*

All students have important obligations under the Code of Student Conduct to complete all academic and scholarly activities with fairness and honesty. Our professional students also have the responsibility to uphold the professional and ethical standards found in their respective academic honor codes. Specifically, students are not to use unauthorized assistance in the laboratory, on field work, in scholarship, or on a course assignment unless such assistance has been authorized specifically by the course instructor. In addition, students are not to submit their work without acknowledging any word-for-word use and/or paraphrasing of writing, ideas or other work that is not your own. These requirements apply to all students undergraduate, graduate, and professional.

To maintain a culture of integrity and respect, these generative AI tools should not be used in the completion of course assignments unless an instructor for a given course specifically authorizes their use. Some instructors may approve of using generative AI tools in the academic setting for specific goals. However, these tools should be used only with the explicit and clear permission of each individual instructor, and then only in the ways allowed by the instructor.

Religious Accommodations *Ohio State has had a longstanding practice of making reasonable academic accommodations for students' religious beliefs and practices in accordance with applicable law. In 2023, Ohio State updated its practice to align with new state legislation. Under this new provision, students must be in early communication with their instructors regarding any known accommodation requests for religious beliefs and practices, providing notice of specific dates for which they request alternative accommodations within 14 days after the first instructional day of the course. Instructors in turn shall not*

question the sincerity of a student's religious or spiritual belief system in reviewing such requests and shall keep requests for accommodations confidential.

With sufficient notice, instructors will provide students with reasonable alternative accommodations with regard to examinations and other academic requirements with respect to students' sincerely held religious beliefs and practices by allowing up to three absences each semester for the student to attend or participate in religious activities. Examples of religious accommodations can include, but are not limited to, rescheduling an exam, altering the time of a student's presentation, allowing make-up assignments to substitute for missed class work, or flexibility in due dates or research responsibilities. If concerns arise about a requested accommodation, instructors are to consult their tenure initiating unit head for assistance.

A student's request for time off shall be provided if the student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement and the student has notified their instructor, in writing during the first 14 days after the course begins, of the date of each absence. Although students are required to provide notice within the first 14 days after a course begins, instructors are strongly encouraged to work with the student to provide a reasonable accommodation if a request is made outside the notice period. A student may not be penalized for an absence approved under this policy.

If students have questions or disputes related to academic accommodations, they should contact their course instructor, and then their department or college office. For questions or to report discrimination or harassment based on religion, individuals should contact the Civil Rights Compliance Office.

Disability Statement (with Accommodations for Illness) *The university strives to maintain a healthy and accessible environment to support student learning in and out of the classroom. If students anticipate or experience academic barriers based on a disability (including mental health and medical conditions, whether chronic or temporary), they should let their instructor know immediately so that they can privately discuss options. Students do not need to disclose specific information about a disability to faculty. To establish reasonable accommodations, students may be asked to register with Student Life Disability Services (see below for campus-specific contact information). After registration, students should make arrangements with their instructors as soon as possible to discuss your accommodations so that accommodations may be implemented in a timely fashion.*

If students are ill and need to miss class, including if they are staying home and away from others while experiencing symptoms of viral infection or fever, they should let their instructor know immediately. In cases where illness interacts with an underlying medical condition, please consult with Student Life Disability Services to request reasonable accommodations.

Intellectual Diversity *Ohio State is committed to fostering a culture of open inquiry and intellectual diversity within the classroom. This course will cover a range of information and may include discussions or debates about controversial issues, beliefs, or policies. Any such discussions and debates are intended to support understanding of the approved curriculum and relevant course objectives rather than promote any specific point of view. Students will be assessed on principles applicable to the field of study*

and the content covered in the course. Preparing students for citizenship includes helping them develop critical thinking skills that will allow them to reach their own conclusions regarding complex or controversial matters.

Grievances and Solving Problems *According to University Policies, if you have a problem with this class, you should seek to resolve the grievance concerning a grade or academic practice by speaking first with the instructor or professor. Then, if necessary, take your case to the department chairperson, college dean or associate dean, and to the provost, in that order. Specific procedures are outlined in Faculty Rule 3335-8-23. Grievances against graduate, research, and teaching assistants should be submitted first to the supervising instructor, then to the chairperson of the assistant's department.*

Creating an Environment Free from Harassment, Discrimination, and Sexual Misconduct *The Ohio State University is committed to building and maintaining a welcoming community. All Buckeyes have the right to be free from harassment, discrimination, and sexual misconduct. Ohio State does not discriminate on the basis of age, ancestry, color, disability, ethnicity, gender, gender identity or expression, genetic information, HIV/AIDS status, military status, national origin, pregnancy (childbirth, false pregnancy, termination of pregnancy, or recovery therefrom), race, religion, sex, sexual orientation, or protected veteran status, or any other bases under the law, in its activities, academic programs, admission, and employment. Members of the university community also have the right to be free from all forms of sexual misconduct: sexual harassment, sexual assault, relationship violence, stalking, and sexual exploitation.*

To report harassment, discrimination, sexual misconduct, or retaliation and/or seek confidential and non-confidential resources and supportive measures, contact the Civil Rights Compliance Office (CRCO):

Online reporting form: http://civilrights.osu.edu/

Call 614-247-5838 or TTY 614-688-8605

civilrights@osu.edu

The university is committed to stopping sexual misconduct, preventing its recurrence, eliminating any hostile environment, and remedying its discriminatory effects. All university employees have reporting responsibilities to the Civil Rights Compliance Office to ensure the university can take appropriate action:

All university employees, except those exempted by legal privilege of confidentiality or expressly identified as a confidential reporter, have an obligation to report incidents of sexual assault immediately.

The following employees have an obligation to report all other forms of sexual misconduct as soon as practicable but at most within five workdays of becoming aware of such information:

1. Any human resource professional (HRP);
2. Anyone who supervises faculty, staff, students, or volunteers;
3. Chair/director; and
4. Faculty member.

GEOSCIM 5652 Adjustment Computations

Meeting times

Lectures: T R 9:10 AM – 11:00 AM
Lab: W 9:10 AM – 11:00 AM
Instructor's office hours (in ML 321): Mo – Fri 9:30 am to 4:00 pm, or let me know by email when you're coming. I can also schedule a Zoom meeting for one or multiple students.

Instructor

Dr. Demián Gómez

Course Description

The goal of this course is to learn about the statistical tools, methods, and techniques used to solve inverse problems using least squares. The course has a theoretical and a practical portion to help students model observed data. For example, surface interpolation techniques using least squares collocation, deterministic GNSS trajectory parameters, de-noising of observations using least squares, etc.

Mode of Delivery

This course will be delivered in person.

Course Goals and Outcomes

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

- Distinguish the different elements involved in a least squares adjustment (observations, parameters, deterministic model, stochastic model, etc)
- Understand different approaches for weighing observations
- Introduce constraints into your least squares problem through weighted condition equations or "infinite weight" condition equations
- Build the design matrix for a linear or non-linear least squares adjustment
- Perform a sequential least squares adjustment
- "Simulate" a least squares problem without observations
- Understand and perform a statistical analysis on your least squares problem

Materials and Software

For this course we will use the "Notes on Adjustment Computations" by Kyle Snow (based on the original course taught by Burkhard Schaffrin). I also recommend the book "Adjustment Computations Spatial Analysis" by Ghilani and Wolf (Wiley). This last book is optional and you don't need to buy it if you don't want to.

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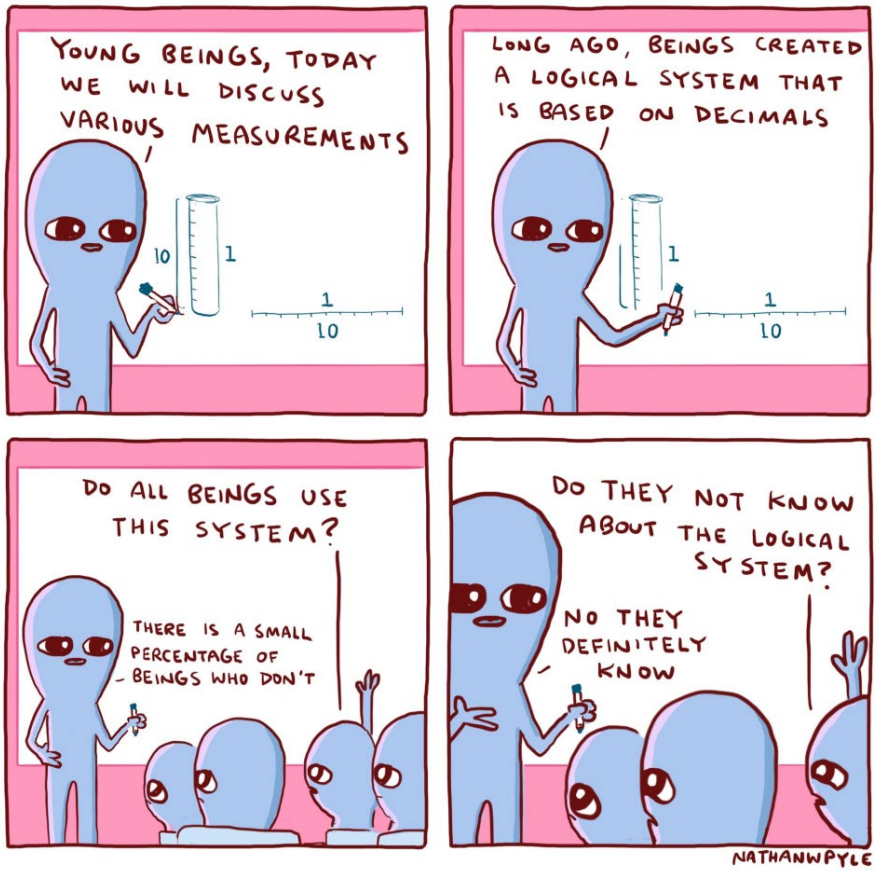

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Grading

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Topic covered during the course

- Taking measurements using real instruments: error types
- Foundations: observations, parameters, and random errors
- The model of direct observations
- The Gauss-Markov model
- The model of condition equations
- The Gauss-Markov model with constraints
- The Gauss-Markov model with stochastic constraints
- Sequential adjustment
- The Gauss-Helmert model
- Statistical analysis
- Least squares collocation

Topics covered during the labs

- Taking measurements to fit a model
- Using Matlab to solve least squares problems
- Practical problems: fitting a line, fitting a circle, fitting an ellipse, network adjustments
- Geophysical and geodesy inverse problems: earthquake location, GPS positioning (closed forms), slip on pre-determined fault surface
- Building design matrices
- Weighting schemes
- Iterative least squares solutions
- Least squares collocation: practical aspects

Weekly schedule

Week	Activity	Notes
1	Taking measurements using real instruments	HW1 (one extra week) Discussion about the class dynamics, homework assignments, and more
2	Observations, parameters, and random errors	
3	The model of direct observations	Project discussion
4	The Gauss-Markov model Iterative reweighting least squares	**HW1 due** HW2
5	The model of condition equations	
6	The Gauss-Markov model with constrains Application examples	**HW2 due** HW3: project proposal
7	The Gauss-Markov model with stochastic constrains Midterm exam (exact date TBD)	
8	Discussion of project progress 1 Guest lecturer: TBD	**HW3 due** HW4 Fall Break, no classes on Thursday
9	Sequential adjustment	Mid-course survey
10	The Gauss-Helmert model	**HW4 due**
11	Statistical analysis	HW5 (optional)
12	Least squares collocation	
13	Project discussion	**HW5 due (optional)** **Project due**
14	Project presentations	Project comments
15	Thanksgiving week (classes on Tuesday 26)	Project comments and grades
16	Last day of classes (Dec 10)	

General Statements

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The

term “academic misconduct” includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

Disability Services: The University strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. SLDS contact information: slds@osu.edu; 614-292-3307; slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.

Mental Health Statement: As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student’s ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life’s Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273-TALK or at suicidepreventionlifeline.org.

Sexual Misconduct/Relationship Violence: Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu

Diversity Statement: The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.

GEOSCIM 5652 ~~Adjustment Computations~~Data Analysis and Parameter Estimation for Geosciences

Meeting times

Lectures: ~~T R 9~~Mondays, Wednesdays, from 11:~~10 AM~~30 am – ~~11~~12:~~00 AM~~50 pm
Lab: ~~W 9~~Tuesdays from 11:~~10 AM~~30 am – ~~11~~12:~~00 AM~~50 pm
Instructor's office hours (in ML 321): Mo – Fri 9:30 am to 4:00 pm, or let me know by email when you're coming. I can also schedule a Zoom meeting for one or multiple students.

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Instructor

Dr. Demián Gómez

Course Description

~~The goal of this~~This course ~~is to learn about the~~provides students with foundational knowledge and practical skills in statistical ~~tools,~~ methods for analyzing scientific measurements with inherent uncertainty, ~~and techniques used~~enabling students to solve inverse problems ~~using~~commonly encountered in geoscience applications. Students will develop programming skills to read computer files, pre-process observational data, and implement least squares inverse problems and related statistical tools for real-world problem solving. The course ~~has a~~emphasizes both theoretical understanding and ~~a~~ practical ~~portion to help students model observed data. For example, surface interpolation techniques~~application through hands-on laboratory exercises using ~~least squares collocation, deterministic GNSS trajectory parameters, de~~industry-~~noising of observations using least squares, etc~~standard software.

Mode of Delivery

This course will be delivered in person.

Course Goals and Outcomes

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

- ~~Distinguish~~Identify and distinguish the different elements involved in a least squares ~~adjustment~~inverse problems (observations, parameters, deterministic model, stochastic model, etc.)
- ~~Understand~~Apply different approaches for ~~weighing~~weighting observations based on measurement uncertainty
- ~~Introduce~~Implement constraints ~~into your~~in least squares ~~problem~~problems through weighted condition equations or ~~"~~infinite weight~~"~~ condition equations
- ~~Build the~~Construct design ~~matrix~~matrices for ~~a~~ linear ~~or~~and non-linear least squares ~~adjustment~~inverse problems
- ~~Perform a sequential~~Design and execute least squares ~~adjustment~~simulations without observational data

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- ~~"Simulate" a~~Perform and interpret statistical analyses of least squares ~~problem without observations~~adjustment results
- ~~Understand~~Create computer programs to read field observations and ~~perform a statistical analysis on your least squares problem~~estimate parameters for deterministic models

Materials and Software

~~For this~~This course ~~we will use~~uses the "Notes on Adjustment Computations" by Kyle Snow (based on the original course taught by Burkhard Schaffrin). I also recommend the book "Adjustment Computations Spatial Analysis" by Ghilani and Wolf (Wiley). This last book is optional ~~and you don't need to buy it if you don't want to~~.

~~We will be using laptops~~The course requires a laptop during the labs and practice hours, so I strongly recommend ~~you install~~installing Matlab ~~on your computer~~ (any OS version and laptop computer will do fine). I will use Carmen to manage homeworks and grading ~~so make sure your Internet browser is up to date~~.

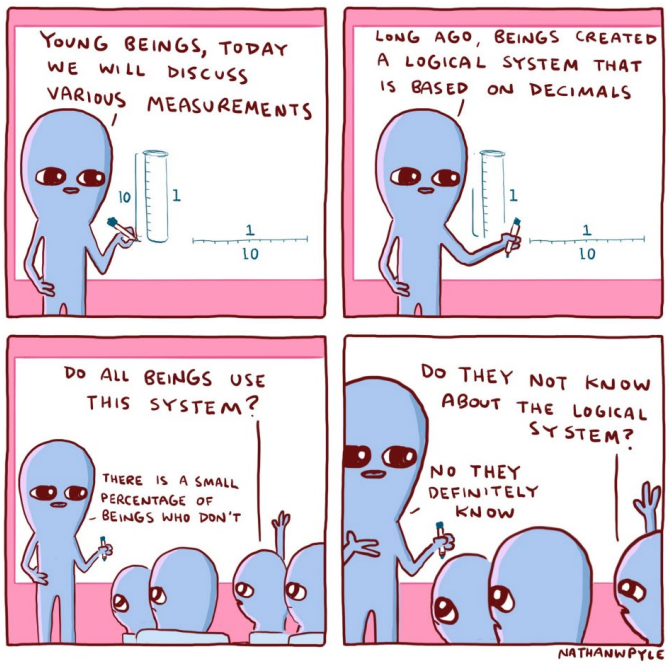
Evaluation

Attendance/Class Participation (15%)
Homework (30%)
Course Project (30%)
Midterm Exam (25%)

Course Policy

~~You are~~The student is responsible for all course related emails, so be sure to check your inbox on a daily basis. When emailing me, please always begin the subject of the email with the course number (GEOSCIM 5652, or just 5652) and then the subject of the email. This helps me organize my emails related to classes. Thanks! A proper email subject should be like this: GEOSCIM 5652 Questions about Lab 3.

System of units used in this course: this course and the instructor fully embrace the International System of Units (SI, commonly known as the metric system). For an in depth discussion of why the SI system is superior to the imperial system, see https://www.nytimes.com/2020/08/18/science/foot-surveying-metrology-dennis.html?referringSource=articleShare and https://xkcd.com/1643/. For your class assignments do not use: feet, US feet, inches, yards, miles, or any other unit that was originally realized using the thumb or foot length of a king. Any results given in imperial units will be automatically returned to the student for amendment.



Mid-term exam: exact date will be discussed with students. The exam will be written and include theoretical and practical questions.

Plagiarism: Plagiarism means representing the work of others as your own. This includes copying other students' work or using Internet resources without citing them. Any form of plagiarism will be penalized.

Screens: We will, of course, use electronic devices during class time. I expect, however, for students to work on their assignments, not on other classes or projects. I also expect all phones to be silenced and put away for the duration of the class.

Health and Safety: Due to the ongoing COVID19 pandemic, you are expected to use a mask and maintain social distance in class at all times. Also, refrain from eating. These measures will be lifted when OSU deems appropriate.

Homework Policy

Homework is considered a bi-weekly assignment. This means that you have at least two weeks to work on it. Homework should be submitted before ***noon*** of the Thursday of the week it is due. I will

penalize late submissions by subtracting five points for every 24 hours past the due date. This means that I will automatically subtract five points from your grade if you submit your homework after 12:00 pm on Thursday, ten points if you submit after 12:00 pm on Friday, and so on. If you are having health issues that prevent you from submitting your assignment on time, please contact me as soon as possible to discuss an extension.

Presentation requirements: homeworks must be presented in digital form, unless I say otherwise. When the solution to a problem has multiple steps, include ***ALL*** the steps, not just the final answer. Accepted digital formats include PDFs (LaTex, MS Word converted, etc), Open Office, MS Word, etc. Matlab scripts are also accepted when / if necessary**. Pictures of hand written notes (raster formats or ~~imbedded~~embedded in PDFs) will not be accepted**. When citing another person's work, please use APA or AGU citing format. We will discuss Zotero as a way to simplify this task. If you have questions about the presentation format, please let me know in advance: **do not turn in the homework and THEN ask the question.**

Grading

Participation is worth 5% of your total grade, attendance is worth 10% and each homework is worth 6%. Hopefully no one will get sick during the course, but in the case of sickness, please let me know as soon as possible so that we can seek any required accommodations (visit https://slds.osu.edu/ for more information). Grading will be based on this table:

A	93–100	**C+**	77–79.9
A-	90–92.9	**C**	73–76.9
B+	87–89.9	**C-**	70–72.9
B	83–86.9	**D**	60–69.9
B-	80–82.9	**F**	<60

Topic covered during the course

- Taking measurements using real instruments: error types
- Foundations: observations, parameters, and random errors
- The model of direct observations
- The Gauss-Markov model
- ~~The model of condition equations~~
- The Gauss-Markov model with constraints
- The Gauss-Markov model with stochastic constraints
- ~~Sequential adjustment~~
- The Gauss-Helmert model
- Statistical analysis
- ~~Least squares collocation~~

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Topics covered during the labs

- Taking measurements to fit a model
- Using Matlab/Python to solve least squares problems
- Practical problems: fitting a line, fitting a circle, fitting an ellipse, network adjustments
- Geophysical and geodesy inverse problems: earthquake location, GPS positioning (closed forms), slip on pre-determined fault surface
- Building design matrices
- Weighting schemes
- Iterative least squares solutions
- ~~Least squares collocation: practical aspects~~

Weekly schedule

Week	Activity	Notes
1	Taking measurements using real instruments	HW1 (one extra week) Discussion about the class dynamics, homework assignments, and more
2	Observations, parameters, and random errors	
3	The model of direct observations	Project discussion
4	The Gauss-Markov model Iterative reweighting least squares	**HW1 due** HW2
5	~~The model of condition equations~~Application examples	
6	The Gauss-Markov model with constrains Application examples	**HW2 due** HW3: project proposal
7	The Gauss-Markov model with stochastic constrains ~~Midterm exam (exact date TBD)~~	
8	Midterm exam (exact date TBD) Discussion of project progress 1 ~~Guest lecturer: TBD~~	**HW3 due** HW4 Fall Break~~, no classes on Thursday~~
9	~~Sequential adjustment~~Earth Science applications: Guest lecturer - TBD	Mid-course survey
10	The Gauss-Helmert model	**HW4 due**
11	Statistical analysis	HW5 (optional)
12	~~Least squares collocation~~Project discussion	
13	Project ~~discussion~~presentations	**HW5 due (optional)** **Project due**
14	Project presentations	Project comments
15	Thanksgiving week ~~(classes on Tuesday 26)~~	Project comments and grades
16	Last day of classes ~~(Dec 10)~~	

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General Statements

Academic Misconduct *Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the University's Code of Student Conduct, and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the University's Code of Student Conduct and this syllabus may constitute Academic Misconduct.*

~~***Academic Misconduct***~~*The Ohio State University's Code of Student Conduct (Section 3335-23-04) defines academic misconduct as*~~:~~ ~~It is~~*Any activity that tends to compromise the* ~~responsibility~~*academic integrity of the* ~~Committee on Academic Misconduct to investigate~~*University or* ~~establish procedures for~~*subvert the* ~~investigation of all reported cases of student academic misconduct~~*educational process.* ~~The term "academic misconduct" includes all forms~~*Examples of* ~~student~~ *academic misconduct* ~~wherever committed; illustrated by,~~ *include (but are not limited to) plagiarism,* ~~cases~~*collusion (unauthorized collaboration), copying the work of* ~~plagiarism~~*another student, and* ~~dishonest practices in connection with examinations~~*possession of unauthorized materials during an examination.* ~~Instructors shall report all instances~~*Ignorance of the University's Code of* ~~alleged~~*Student Conduct is never considered an excuse for academic misconduct* ~~to the committee (Faculty Rule 3335-5-487). For additional information,~~ ~~see~~*so please review the Code of Student* ~~Conduct http://studentlife.osu.edu/csc/~~*Conduct and, specifically, the sections dealing with academic misconduct.*

If an instructor suspects that a student has committed academic misconduct in this course, the instructor is obligated by University Rules to report those suspicions to the Committee on Academic Misconduct. If COAM determines that a student violated the University's Code of Student Conduct (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in the course and suspension or dismissal from the University.

If students have questions about the above policy or what constitutes academic misconduct in this course, they should contact the instructor.

Artificial Intelligence and Academic Integrity *There has been a significant increase in the popularity and availability of a variety of generative artificial intelligence (AI) tools, including ChatGPT, Sudowrite, and others. These tools will help shape the future of work, research and technology, but when used in the wrong way, they can stand in conflict with academic integrity at Ohio State.*

All students have important obligations under the Code of Student Conduct to complete all academic and scholarly activities with fairness and honesty. Our professional students also have the responsibility to uphold the professional and ethical standards found in their respective academic honor codes. Specifically, students are not to use unauthorized assistance in the laboratory, on field work, in scholarship, or on a course assignment unless such assistance has been authorized specifically by the course instructor. In addition, students are not to submit their work without acknowledging any word-for-word use and/or paraphrasing of writing, ideas or other work that is not your own. These requirements apply to all students undergraduate, graduate, and professional.

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To maintain a culture of integrity and respect, these generative AI tools should not be used in the completion of course assignments unless an instructor for a given course specifically authorizes their use. Some instructors may approve of using generative AI tools in the academic setting for specific goals. However, these tools should be used only with the explicit and clear permission of each individual instructor, and then only in the ways allowed by the instructor.

Religious Accommodations *Ohio State has had a longstanding practice of making reasonable academic accommodations for students' religious beliefs and practices in accordance with applicable law. In 2023, Ohio State updated its practice to align with new state legislation. Under this new provision, students must be in early communication with their instructors regarding any known accommodation requests for religious beliefs and practices, providing notice of specific dates for which they request alternative accommodations within 14 days after the first instructional day of the course. Instructors in turn shall not question the sincerity of a student's religious or spiritual belief system in reviewing such requests and shall keep requests for accommodations confidential.*

With sufficient notice, instructors will provide students with reasonable alternative accommodations with regard to examinations and other academic requirements with respect to students' sincerely held religious beliefs and practices by allowing up to three absences each semester for the student to attend or participate in religious activities. Examples of religious accommodations can include, but are not limited to, rescheduling an exam, altering the time of a student's presentation, allowing make-up assignments to substitute for missed class work, or flexibility in due dates or research responsibilities. If concerns arise about a requested accommodation, instructors are to consult their tenure initiating unit head for assistance.

A student's request for time off shall be provided if the student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement and the student has notified their instructor, in writing during the first 14 days after the course begins, of the date of each absence. Although students are required to provide notice within the first 14 days after a course begins, instructors are strongly encouraged to work with the student to provide a reasonable accommodation if a request is made outside the notice period. A student may not be penalized for an absence approved under this policy.

If students have questions or disputes related to academic accommodations, they should contact their course instructor, and then their department or college office. For questions or to report discrimination or harassment based on religion, individuals should contact the Civil Rights Compliance Office.

Disability ~~***Services:***~~***Statement (with Accommodations for Illness)*** *The* ~~University~~*university strives to maintain a healthy and accessible environment to* ~~make all~~*support student learning* ~~experiences as accessible as possible~~*in and out of the classroom. If* ~~you~~*students anticipate or experience academic barriers based on* ~~your~~*a disability (including mental health and medical conditions, whether chronic or temporary* ~~medical conditions~~*), please they should let* ~~me~~*their instructor know immediately so that* ~~we~~*they can privately discuss options. Students do not need to disclose specific information about a disability to faculty.* ~~To~~*To establish reasonable accommodations,* ~~I~~*students may* ~~request that you~~*be*

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asked to register with Student Life Disability Services (see below for campus-specific contact information). ~~After~~After registration, students should make arrangements with ~~me~~their instructors as soon as possible to discuss your accommodations so that ~~they~~accommodations may be implemented in a timely fashion. ~~SLDS contact information: slds@osu.edu; 614-292-3307; slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.~~

If students are ill and need to miss class, including if they are staying home and away from others while experiencing symptoms of viral infection or fever, they should let their instructor know immediately. In cases where illness interacts with an underlying medical condition, please consult with Student Life Disability Services to request reasonable accommodations.

~~***Mental Health Statement:*** As~~***Intellectual Diversity*** *Ohio State is committed to fostering a* ~~student you may experience~~*culture of open inquiry and intellectual diversity within the classroom. This course will cover a range of* ~~issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating~~*information and*~~/or lack of motivation. These mental health concerns~~ *may include discussions or* ~~stressful events may lead to diminished academic performance~~*debates about controversial issues, beliefs, or* ~~reduce a student's ability to participate in daily activities~~*policies.* ~~The Ohio State University offers services to assist you with addressing these~~*Any such discussions and* ~~other concerns you may be experiencing. If you or someone you know~~*debates are* ~~suffering from any~~*intended to support understanding of the* ~~aforementioned conditions, you can learn more about the broad range~~*approved curriculum and relevant course objectives rather than promote any specific point of* ~~confidential mental health services available~~*view. Students will be assessed on* ~~campus via~~*principles applicable to the* ~~Office~~*field of* ~~Student Life's Counseling~~*study and* ~~Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on~~ *the* ~~4th Floor of~~*content covered in the* ~~Younkin Success Center and 10th Floor of Lincoln Tower~~*course.* ~~You can~~*Preparing students for citizenship includes helping them develop critical thinking skills that will allow them to reach* ~~an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273-TALK~~*their own conclusions regarding complex or* ~~at suicidepreventionlifeline.org~~*controversial matters.*

~~***Sexual Misconduct/Relationship Violence:*** Title IX makes it clear that violence~~***Grievances and*** ~~harassment based on sex and gender are Civil Rights offenses subject~~***Solving Problems*** *According to University Policies, if you have a problem with this class, you should seek to resolve the* ~~same kinds of accountability and~~*grievance concerning a grade or academic practice by speaking first with the* ~~same kinds of support applied~~*instructor or professor. Then, if necessary, take your case to* ~~offenses against other protected categories (e.g.~~*the department chairperson,* ~~race). If you~~*college dean or* ~~someone you know has been sexually harassed or assaulted~~*associate dean,* ~~you may find~~*and to the* ~~appropriate resources at http://titleix~~*provost, in that order.*~~osu~~ *Specific procedures are outlined in Faculty Rule 3335-8-23.*~~edu or by contacting~~ *Grievances against graduate, research, and teaching assistants should be submitted first to the supervising instructor, then to the chairperson of the* ~~Ohio State Title IX Coordinator at titleix@osu.edu~~*assistant's department.*

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~~***Diversity Statement:***~~***Creating an Environment Free from Harassment, Discrimination, and Sexual Misconduct*** *The Ohio State University* ~~affirms the importance~~*is committed to building* *and* ~~value of diversity in~~*maintaining a welcoming community. All Buckeyes have* *the* ~~student body. Our programs and curricula reflect our multicultural society and global economy and seek~~*right* *to* ~~provide opportunities for students to learn more about persons who are different~~*be free* *from* ~~them. We are committed to maintaining a community that recognizes~~*harassment, discrimination,* *and* ~~values~~*sexual misconduct. Ohio State does not discriminate on* *the* ~~inherent worth and dignity~~*basis* *of* ~~every person; fosters sensitivity~~*age*, ~~understanding~~*ancestry*, ~~and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status~~*color*, ~~which is defined as age~~*disability*, ~~color~~*ethnicity*, ~~disability~~*gender*, *gender identity or expression*, *genetic information, HIV/AIDS status*, *military status,* *national origin*, *pregnancy (childbirth*, *false pregnancy, termination of pregnancy, or recovery therefrom),* *race, religion, sex, sexual orientation, or* *protected* *veteran status,* ~~is prohibited~~*or any other bases under the law, in its activities, academic programs, admission, and employment. Members of the university community also have the right to be free from all forms of sexual misconduct: sexual harassment, sexual assault, relationship violence, stalking, and sexual exploitation.*

To report harassment, discrimination, sexual misconduct, or retaliation and/or seek confidential and non-confidential resources and supportive measures, contact the Civil Rights Compliance Office (CRCO):

Online reporting form: http://civilrights.osu.edu/

Call 614-247-5838 or TTY 614-688-8605

civilrights@osu.edu

The university is committed to stopping sexual misconduct, preventing its recurrence, eliminating any hostile environment, and remedying its discriminatory effects. All university employees have reporting responsibilities to the Civil Rights Compliance Office to ensure the university can take appropriate action:

All university employees, except those exempted by legal privilege of confidentiality or expressly identified as a confidential reporter, have an obligation to report incidents of sexual assault immediately.

The following employees have an obligation to report all other forms of sexual misconduct as soon as practicable but at most within five workdays of becoming aware of such information:

1. Any human resource professional (HRP);
2. Anyone who supervises faculty, staff, students, or volunteers;
3. Chair/director; and
4. Faculty member.

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