

ASEN6070 – Satellite Geodesy - Spring 2021
(crosslisted with EPP2 in GEOL/PHYS/ASTR 6620)

Instructor	Dr. R. Steven Nerem (Office: AERO 456, Ph. 492-6721, Email: nerem@colorado.edu)
Class Time	TTH 3:55 – 5:10 pm
Class Location	ECCS 1B12
Class Web Page	http://canvas.colorado.edu
Office Hours	By appointment on Zoom – please email me
Class Grader	Tyler Gaston (Tyler.Gaston@colorado.edu)
Required Text	<i>Geodesy: Treatise on Geophysics (Vol. 3)</i> by Tom Herring (editor), Elsevier, 2005 ISBN 978-0444534606 (PDFs supplied)
Optional Text	<i>Theory of Satellite Geodesy</i> , 2000 by William M. Kaula, Dover Publishing Co. ISBN 0-486-41465-5
Required Text	<i>Geodesy and Gravity</i> by John Wahr (PDF supplied)
Grading	Take Home Mid-Term (25%) Take Home Final Exam (25%) Homework (25%) (10 pts deducted for each day late!) Research Project (25%) 90-100 = A, 80-89 = B, 70-79 = C, 60-69 = D, < 60 = F
Exam Schedule	March 4 – Take-Home Mid-Term Exam Passed Out (due 3/11) April 27 – Take Home Final Exam Passed Out (due 5/4)
Lecture Material	PDF files will be posted on the class website.
Homework	Use of Matlab or similar is required
Course Overview	This course provides an overview of how artificial satellites are used to study the Earth's shape, rotation, and gravitational field, emphasizing Earth and space-based tracking of artificial satellites. Specific topics include satellite orbit perturbations due to the gravity field, satellite tracking systems (including SLR, GPS, DORIS, etc.), parameter estimation, Earth rotation and reference frames, time systems, ocean and solid Earth tides, and gravity field representations.

Lecture Schedule

#	Date	Topic	Lecturer	Reading
1	1/14/2021	Course Introduction	Nerem	
2	1/19/2021	Introduction	Nerem	HCh1
3	1/21/2021	Satellite Geodetic Techniques 1	Nerem	HCh1, WCh2
4	1/26/2021	Satellite Geodetic Techniques 2	Nerem	HCh11
5	1/28/2021	Spherical Harmonics and the Gravitational Potential	Nerem	WCh3, HCh2
6	2/2/2021	Gravity and the Potential	Nerem	
7	2/4/2021	Earth Rotation	Gross	HCh10, WCh9
8	2/9/2021	Time Systems and Earth Rotation	Nerem	
9	2/11/2021	Reference Frames	Bevis	Bevis & Brown 2014
10	2/16/2021	Introduction to Satellite Orbits		
11	2/18/2021	Gravity Perturbations & Kaula's Solution	Nerem	
12	2/23/2021	Time Variable Gravity	Nerem	WCh7, HCh7, HCh8
13	2/25/2021	Satellite Gravity Measurements	Bettadpur	
14	3/2/2021	Tides 1	Nerem	HCh6, WCh8
15	3/4/2021	Tides 2	Ray	
16	3/9/2021	GRACE Data Analysis	Nerem	
17	3/11/2021	Loading of the Earth 1	vanDam	
18	3/16/2021	Loading of the Earth 2	vanDam	
19	3/18/2021	Satellite Altimetry 1	Nerem	HCh5
20	3/23/2021	Satellite Altimetry 2	Nerem	
21	3/25/2021	GNSS1	Nerem	
22	3/30/2021	GNSS2	Nerem	
23	4/1/2021	GNSS3	Freymueller	
24	4/6/2021	InSAR1	Tiampo	HCh12
25	4/8/2021	InSAR2	Tiampo	
26	4/13/2021	Terrestrial Laser Scanning	Miner	
27	4/15/2021	DEMs from Stereo Images	Willis	
28	4/20/2021	Planetary Geodesy	McMahon	
29	4/22/2021	Planetary Geodesy	Scheeres	
30	4/27/2021	Class Research Presentations	All	
31	4/29/2021	Class Research Presentations	All	

(reading assignments – Herring, Wahr)

References

- Anderson, A. J., and A. Cazenave, Eds., *Space Geodesy and Geodynamics*, Academic Press, 1986.
- Hofmann-Wellenhof, B., H. Lichtenegger, and J. Collins, *GPS Theory and Practice*, 4th Edition, Springer, 1997.
- Kaula, W. M., *Theory of Satellite Geodesy*, Dover, 2000.
- Lambeck, K., *The Earth's Variable Rotation*, Cambridge University Press, 1980.
- Lambeck, K., *Geophysical Geodesy: The Slow Deformations of the Earth*, Oxford, 1988.
- Leick, A., *GPS Satellite Surveying*, 2nd Edition, Wiley, 1995.
- Seeber, G., *Satellite Geodesy: Foundations, Methods, and Applications*, De Gruyter, 2nd Edition, 2003.
- Strang, G., and K. Borre, *Linear Algebra, Geodesy, and GPS*, Wellesley-Cambridge Press, 1997.
- Teunissen, P. J. G., and A. Kleusberg, Eds., *GPS for Geodesy*, 2nd Edition, Springer, 1998.
- Torge, W., *Geodesy*, de Gruyter, 1980.

Syllabus Statements

Classroom Behavior

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) and the [Student Code of Conduct](#).

Requirements for COVID-19

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements, and public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:

- maintain 6-foot distancing when possible,
- wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
- clean local work area,
- practice hand hygiene,
- follow public health orders, and
- if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert [CU Boulder Medical Services](#).

Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policies on [COVID-19 Health and Safety](#) and [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the “Accommodation for Disabilities” statement on this syllabus.

All students who are new to campus must complete the [COVID-19 Student Health and Expectations Course](#). Before coming to campus each day, all students are required to complete the [Buff Pass](#).

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home. In this class, if you are sick or quarantined, please send me an email and let me know.

Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu; 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the [Honor Code Office website](#).

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#). Please know that faculty and graduate instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, let me know if you have any religious obligations that will conflict with attending lecture, homework, or exams.

See the [campus policy regarding religious observances](#) for full details.