ASEN6070 – Satellite Geodesy - Fall 2019
(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 8:00 – 9:15 am
Class Location	ECCR 1B08
Class Web Page	http://canvas.colorado.edu
Office Hours	9:30-10:30 TTH (after class), or anytime door is open, or by email
Required Text (PDFs supplied)	*Geodesy: Treatise on Geophysics (Vol. 3)* by Tom Herring (editor), Elsevier, 2005 ISBN 978-0444534606
Optional Text	*Theory of Satellite Geodesy*, 2000 by William M. Kaula, Dover Publishing Co. ISBN 0-486-41465-5
Required Text (PDF supplied)	*Geodesy and Gravity* by John Wahr
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
Schedule	October 17 – Take-Home Mid-Term Exam Passed Out (due 10/22) December 12 – Take Home Final Exam Passed Out (due 12/17)
Lecture Material	PDF files will be posted on the class website.
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.

Syllabus – ASEN6070 – Satellite Geodesy
(reading assignments – Herring, Wahr)

I. Introduction to Geodesy (HCh1)

II. Introduction to Observational Techniques (HCh1, WCh2)
1. Ground-based gravity measurements (HCh2, HCh3)
2. Satellite Laser Ranging (SLR)
3. DORIS
4. The Global Navigation Satellite System (GNSS)
5. Very Long Baseline Interferometry (VLBI)
6. Satellite-to-Satellite Tracking / GRACE
7. Accelerometer Measurements
8. Gravity Gradiometer Measurements (GOCE)
9. Satellite Altimetry (HCh5)
10. Interferometric SAR (WCh12)

III. Potential Theory (WCh3, HCh2)
1. MacCullagh's Formula
2. Laplace's Equation
2. Spherical Harmonic Representation
3. Point Mass / Density Layer
4. The Geoid
5. Current Knowledge of the Earth's Gravity Field

IV. Interpretation of Observed Gravity Anomalies (WCh6)

V. Satellite Equations of Motion, Reference Frames, Time Systems
1. Coordinate Systems and Reference frames
2. Time Systems
3. Gravitational and non-gravitational forces
4. Introduction to orbital mechanics

VI. Satellite Orbital Perturbations Due to the Gravity Field (Kaula Book)
1. Kaula's Solution
2. Perturbation Spectrum

VII. Space-Based Geodetic Methods (HCh11)
1. Lunar Laser Ranging (LLR)
2. Satellite Laser Ranging (SLR)
3. Very Long Baseline Interferometry (VLBI)
4. GPS/GNSS
5. Geophysical Applications of Positioning

VIII. Earth Rotation Variations (HCh10, WCh9)

1. Nutation and Precession
2. Polar Motion Variations
3. Rotation Variations

IX. Applications of Satellite Altimetry (HCh5)
1. The Ocean Circulation
2. Geostrophic Currents
3. The Geoid and Dynamic Sea Surface Topography (DSST)
4. Satellite Altimeter Measurements of DSST
5. Sea Level change

X. Tidal Variations (HCh6, WCh8)
1. Solid Earth Tides
2. Ocean Tides
3. Tidal Loading
4. Tide Models Derived from Satellite Altimetry

XI. Non-Tidal Variations of the Gravity Field (HCh8)
1. Post-Glacial Rebound (WCh7, HCh7)
2. Melting/Accumulation of Polar/Glacial Ice
3. Mass Redistribution in the Ocean
4. Mass Redistribution in the Atmosphere
5. Redistribution of Continental Water Mass
6. Geocenter Variations

XII. Geodesy Using Interferometric SAR (HCh12)

XIII. Structure from Motion techniques.

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.

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