ERTH 491-01 / GEOP 572-02
Geodetic Methods for Understanding Earth's Surface Deformation
Fall 2015, 3 credits
Lecture: MW 8:00-8:50, room: MSEC 103
Lab: W 14:00-16:55, room: WEIR 209
Syllabus v.1.0

Instructor: Dr. Ronni Grapenthin
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Office Hours: T – 14:00-17:00, R – 15:00-16:00
Course Website: `http://grapenthin.org/teaching/geop572_2015`

Course Description: Theory and application of modern geodetic tools to measure Earth's surface deformation with emphasis on GPS and InSAR. Data processing from raw data to kinematic products. Evaluation of signals and modeling of their sources. Applications range magma system characterization and analysis of slip during an earthquake to interseismic strain analysis and evaluation of changes in the hydrosphere such as glacial melt, seasonal precipitation effects and ground water level monitoring. Class includes 2 field trips to nearby sites early in the semester for GPS campaign deployments and data collection.

Pre-requisites: Linear Algebra (MATH 254), Calculus (MATH 132), min. of ERTH 205 as programming experience, or consent of instructor

Class Website: Assignments and supplementary material will be posted on the class website `http://grapenthin.org/teaching/geop572_2015/`. Grades will be posted to canvas.

Required Text: No textbook required, but required readings will be posted on the class website.

Tentative Schedule: (subject to modification)

Week 1	August 17	Lecture 1	Introduction, logistics, Examples
	August 19	Lecture 2	GPS/GNSS 1: History, Background
	August 19	LAB 1	Getting accounts set up (geodesy lab), M/P intro, explanation of provided term projects
Week 2	August 24	Lecture 3	GPS/GNSS: Basics
	August 26	Lecture 4	GPS/GNSS: Basics
	August 26	LAB 2	How to GPS campaign
Week 3	August 31	Lecture 5	GPS: Basics
	September 02	Lecture 6	GPS: Kinematic
	September 02	LAB 3	gd2p.pl: getting static positions
	September 05	field trip?	Set up sites

Week 4	September 07	*Labor Day, no class*	
	September 09	Lecture 7	GPS: Kinematic
	September 09	LAB 4	gd2p.pl: getting kinematic positions
	September 12	field trip?	TAKE DOWN SITES
Week 5	September 14	Lecture 8	GPS: Esoteric
	September 16	Lecture 9	GPS: Esoteric (SNR, phase delay)
	September 16	LAB 5	another kinematic tool: track
	September 16	*5 PM, Term project idea due*	
Week 6	September 21	Lecture 10	Measurement systems II: InSAR
	September 23	Lecture 11	Measurement systems II: InSAR
	September 23	LAB 6	Kinematic GPS – what are the individual signal sources (tide gauge decomposed)
Week 7	September 28	Lecture 12	Measurement systems II: InSAR
	September 30	Lecture 13	Measurement systems II: InSAR
	September 30	LAB 7	Getting Satellite data, processing w/ ISCE
Week 8	October 05	Lecture 14	Measurement systems III: Gravimetry (guest: Alex Rinehart)
	October 07	Lecture 15	Measurement systems III: Gravimetry (guest: Alex Rinehart)
	October 07	LAB 8	Gravity Lab (guest: Alex Rinehart)
Week 9	October 12	Lecture 16	Reference Frames
	October 14	Lecture 17	Reference Frames
	October 14	LAB 9	Making Position Timeseries
Week 10	October 19	Lecture 18	Stress & Strain
	October 21	Lecture 19	Dislocation Theory
	October 21	LAB 10	Making Position Timeseries
	October 21	*5 PM, Term paper draft due*	
Week 11	October 26	Lecture 20	Earthquake Cycle / Fault description
	October 28	Lecture 21	Volcano Deformation
	October 28	LAB 11	Making Velocity Maps
Week 12	November 02	Lecture 22	Applications I: Tectonics/Earthquakes
	November 04	Lecture 23	Applications I: Tectonics/Earthquakes
	November 04	LAB 12	Finite Fault Modeling
Week 13	November 09	Lecture 24	Applications II: Volcanoes
	November 11	Lecture 25	Applications II: Volcanoes
	November 11	LAB 13	Pressure Source Modeling
Week 14	November 16	Lecture 26	Applications III: GIA
	November 18	Lecture 27	Applications III: Loading
	November 18	LAB 14	Surface Loading (CrusDe, TABOO)
Week 15	November 23	Lecture 28	Applications IV: Reflectometry
	November 24	Lecture 29	Applications IV: Reflectometry / Plumes

	November 24	LAB 15	Estimate Soil Moisture (Rinex2SNR)
Week 16	November 30	*Project Presentations*	
	December 02	*Project Presentations*	
	December 02	*Project Presentations, lab 15 due*	
	December 04	*5 PM, Term paper due*	
Week 17	December 7–11	*no class, finals*	

Course Requirements: There will be approx. 5 homework assignments roughly every three weeks throughout the semester. Many of these assignments will require you to write code and produce computational results using MATLAB or Python (preferred). This software is available in the computer labs across campus or you may purchase a student copy of MATLAB (Python is free).

You will prepare a term project including an in-class presentation and an expository term paper of roughly 10-12 pages. The topic of this project should be related to the course content and objectives and should involve some data processing, modeling and interpretation. Your topic must be approved by the instructor before you begin to work on it. You might apply techniques from the course to process, analyze and interpret data that you have gathered in your research, or you might choose one of the provided projects. If you choose thesis related work, it must be a new aspect; recycling of existing work is not permitted. In-class presentations of the results will be made during the last week of classes.

Grading: Homework: 20%, Labs: 40%, Term Project 40%. Grades will be assigned for each lab and homework assignment based upon assignment completeness and accuracy. Final grade is average of individual lab exercise grades. Unless otherwise noted, assignments will be due one week after they are assigned they must be submitted prior to the beginning of subsequent lab period. Assignments are due both electronically and in print, and must be submitted via email. **Assignments will not be accepted late.** There are no exams in this class.

Term Project Ideas: If you cannot come up with a suitable project of your own, I have a few that would benefit from someone working on them. Get in touch with me if any of these sound interesting:

- (Python) program that adds forward modeled earthquake offsets to rinex files (i.e., earthquake simulator)
- Redoubt station DUMM: Can 04-Apr-2009 lahar signal be picked up (kinematic, reflectometry)?
- Alaska station PBAY (Peterson Bay, South Side of Kachemak Bay): Isolate ocean tides from sub-daily time series analysis, improves daily solutions?
- Ground water pumping in New Mexico: InSAR processing of select New Mexico basins (talk to me about getting data)
- Repeat InSAR processing for Socorro Magma Body, Valles Caldera or Sunset Crater (AZ) (talk to me about getting data)

Place in Curriculum: This elective course is for majors and non-majors who fulfill the requirements.

Course Learning Outcomes: By the end of this course, students will have a working understanding of the geodesy and a set of modern geodetic tools. Students will be able to process basic GPS, InSAR, and gravity data and thus create observations of Earth processes. The students will have an understanding of common error sources that affect geodetic data. A rich set of applications and examples gives the students the mathematical tools to model some processes of this dynamic Earth; such as magma volume changes, earthquake slip and hydrological loading. The term project will allow the students to apply the material learned in the class to one problem in depth. Students will be able to critically evaluate work on geodetic problems presented in the research literature and be able to use geodetic methods in their own research.

Program Learning Outcomes: The learning outcomes of the Earth and Environmental Science program are that students will be able to: (1) Understand and apply the facts and concepts central to Earth science (e.g., geological processes and materials, Earth history, application of quantitative physics and chemistry to earth processes). (2) Demonstrate a working knowledge of the skills and methods necessary to collect, analyze and report data relevant to the discipline (e.g., rock identification, field mapping, geophysical methods). (3) Conceptualize, abstract and solve both qualitative and quantitative problems in the discipline. (4) Integrate and synthesize disparate geoscientific information into a coherent understanding.

Counseling and Disability Services – Reasonable Accommodations: New Mexico Tech is committed to protecting the rights of individuals with disabilities. Qualified individuals who require reasonable accommodations are invited to make their needs known to the Office of Counseling and Disability Services (OCDS) as soon as possible. To schedule an appointment, please call 835-6619.

Counseling and Disability Services – Counseling Services: New Mexico Tech offers mental health and substance abuse counseling through the Office of Counseling and Disability Services. The confidential services are provided free of charge by licensed professionals. To schedule an appointment, please call 835-6619.

Academic Honesty: New Mexico Techs Academic Honesty Policy for undergraduate students is found starting on page 60 of the NMT Undergraduate Catalog,

`http://www.nmt.edu/images/stories/registrar/pdfs/2014-2015_UNDERGRADUATE_Catalog_FINAL.pdf`

New Mexico Techs Academic Honesty Policy for graduate students is found starting on page 59 of the NMT Graduate Catalog,

`http://www.nmt.edu/images/stories/registrar/pdfs/2014-2015_GRADUATE_Catalog_FINAL.pdf`

You are responsible for knowing, understanding, and following this policy.

Respect Statement: New Mexico Tech supports freedom of expression within the parameters of a respectful learning environment. As stated in the New Mexico Tech Guide to Conduct and Citizenship: "New Mexico Techs primary purpose is education, which includes teaching, research, discussion, learning, and service. An atmosphere of free and open inquiry is essential to the pursuit of education. Tech seeks to protect academic freedom and build on individual responsibility to create and maintain an academic atmosphere that is a purposeful, just, open, disciplined, and caring community."

Cell phones: Cell phones will be set on vibrate to accommodate potential emergencies.