INTRODUCTION TO REMOTE SENSING (GEOG 373/573)

New Mexico State University, Department of Geography

FALL 2016

Lecture: Tue & Thu, 8:55-10:10; Breland Hall 185
Lab M1A: Tue, 14:15-16:45; Breland Hall 192 (Nathan)
Lab M1B: Mon, 14:30-17:00; Breland Hall 192 (Manuel)

Professor: **Dr. Michaela Buenemann**
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Advising Hours: Tue, 10:15-11:30 & 15:30-17:00; Wed, 10:00-12:00 & 13:00-16:00; Thu, 10:15-11:30 & 14:00-15:00. To ensure my time is all yours when we meet, please sign up for advising hours on the sign-up sheet next to my office door or schedule an appointment with me.

TAs: **Nathan Lopez-Brody**
Office: Breland Hall #176; 🖃 nbrody@nmsu.edu; ☏ (575) 646-5454

Advising Hours: Mon & Wed, 11:00-12:00, Thu, 15:00-16:00; by appointment.

Manuel Lopez
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Advising Hours: Tue & Thu, 12:00-13:30; by appointment.

COURSE DESCRIPTION

This course introduces you to fundamental concepts, methods, and applications of remote sensing—the art, science, and technology of obtaining information about the environment through the recording, analysis, and interpretation of data acquired through non-contact sensors. The course is divided into three major parts: a discussion of general principles of the remote sensing process and electromagnetic radiation at the beginning of the semester; an examination of various types of aerial and satellite sensor systems and data in the middle of the term; and, at the end of the semester, a discussion of remote sensing of the biosphere, hydrosphere, atmosphere, lithosphere, and urban landscapes. The course includes both a lecture and lab component: the former emphasizes theory; the latter concentrates on practice. The course builds on lower-division courses in physical geography, human geography, map use, cartography, and aerial photography. The course serves as a foundation for upper-division courses such as Advanced Remote Sensing (GEOG 473/582).

STUDENT LEARNING OUTCOMES

Upon completion of this course, you should be able to:
1. explain basic remote sensing concepts and methods;
2. analyze and interpret the spectral signatures of different landscape elements; and
3. produce information about people and the environment from remotely sensed data using basic image processing techniques.

COURSE STRUCTURE

This is a **fast-paced course with a steep learning curve:** the course introduces a variety of interrelated introductory remote sensing concepts and methods. The major topics are treated separately in each of the chapters in your textbook as well as during the lectures and labs. However, the power of remote sensing can only be fully appreciated and exploited by synthesis and integration of the many topics discussed throughout the semester. It is thus crucial that you always keep up with the lectures and labs. **WE** will do our very best to **FACILITATE LEARNING** (i.e., to help you achieve the learning outcomes stated above)—we will always prepare and present class materials to the best of our abilities; give you tasks that will help you better understand key concepts and techniques; and encourage active and cooperative learning. **YOU** are **RESPONSIBLE** for **LEARNING ITSELF**.

COURSE MATERIALS

Website. Materials for this course (e.g., lectures, labs, grades) can be found at https://learn.nmsu.edu/. To access course materials, simply log in to your Canvas account and click the link for this course. The website is a key element of this course and you are required to review its contents regularly. If you encounter problems related to the website, please contact us immediately.

E-mail. Official NMSU communication to you will come through your NMSU e-mail account. Access your NMSU e-mail frequently, or forward it to your current use address, as your success in college may ride on your ability to respond quickly. To guarantee a response to your emails, always a) begin your emails with a proper greeting that includes the name of the person/s you are emailing; b) conclude with a closing that includes your name; and c) use proper spelling, grammar, and punctuation. Unless we are away from the office with limited access to email, we will respond to your emails within one business day. Similarly, we expect you to respond to our emails in a timely manner.

Textbook. You need to acquire a textbook for this course and have three options concerning the book itself: you purchase 1) the required text (**Jensen, J. R. 2006. *Remote Sensing of the Environment: An Earth Resource Perspective*. 2/E ed. Upper Saddle River, NJ: Prentice-Hall.),** 2) an earlier edition of the text, or 3) any intro remote sensing book of your own choice. If you choose a book other than the required book, you are responsible for correlating the content of your chosen book with the required reading assignments. Note that you may be able to check out the book from a library and that you may be able to purchase the book for discounted prices at used bookstores, thrift stores, or online at amazon.com, barnesandnoble.com, or textbookland.com.

Software. We will use ENVI software for image processing in this introductory remote sensing course. The software is available on all computers in the lab room. In addition, to give you maximum flexibility in completing the labs, we will provide you with instructions for installing ENVI on your personal computers.

GRADING

Your final course grade is determined by the amount of points you accrue out of a total possible 1000 points.

Exams (× 3):	330 points	33%	**1,000 Points (100%)**
Labs (× 12):	360 points	36%	
RATs (× 25):	250 points	25%	
MCPs (× 14):	60 points	6%	

Graduate Students: Upon completion of this course, the number of points listed above for undergraduate students will be adjusted to account for only 80 % of your final grade. You will earn the remaining 20 % of your final grade through completion of a term project.

Your final course letter grade will be based on the following scale:

A (4.0)	95-100%	**B (3.0)**	84-86%	**C (2.0)**	74-76%	**D (1.0)**	64-66%
A (4.0)	90-94%	**B- (2.7)**	80-83%	**C- (2.0)**	70-73%	**D- (1.0)**	60-63%
B+ (3.3)	87-89%	**C+ (2.3)**	77-79%	**D+ (1.0)**	67-69%	**F (0)**	< 60%

Individual assignments and tests will not be curved (↑ or ↓). We *may* make adjustments of the final letter grade after an assessment of the class curve at the end of the term. We consider class participation, attendance, and improvement over the term as justification for discounting a grade that is uncharacteristically lower than others.

An **I (Incomplete)** grade will be assigned only if you are unable to complete the course due to circumstances beyond your control (e.g., documented illness or documented death or crisis in your immediate family) that develop after the last day to withdraw from the course. Job-related circumstances are generally not appropriate grounds for assigning an I grade. An I grade will not be used to avoid assigning of D, F, U , or RR grades for marginal or failing work.

Exams. There will be three exams. Exams 1, 2, and 3 will account for 10% (100 points), 10% (100 points), and 13% (130 points) of your final course grade, respectively, and thus for a combined total of **33%** (330 points) of your final course grade. Each exam will be cumulative, assessing your learning since the beginning of the semester. **Make-up exams:** If you have a legitimate excuse for a University-sanctioned activity or work-related event that will cause you to miss an exam, contact us prior to the official exam time so that we can schedule a make-up exam, and provide us with written documentation prior to or on the day of your make-up exam. If you have to miss an exam due to illness, contact us as soon as possible so that we can schedule a make-up exam, and provide us with written documentation on the day of the exam. If you fail to follow these guidelines or if you miss an exam for other reasons, you will receive 0 points for the exam.

Labs. There will be twelve lab exercises, each accounting for 3% (30 points) of your final course grade or for a combined total of **36%** (360 points). The labs are thus crucial to your overall success in this course. There are deadlines for submission of maps and related products in the real world. To reinforce this and to teach you to work under these restrictions, late submissions will be given a score of 0 points. Exercises are to be turned in not later than the beginning of your lab the week after they were assigned. This means you should allow extra time for glitches in computer hardware and software. Should you be unable to submit your work on time, submit it nonetheless and as soon as possible after the deadline: you will learn from completing the lab and you will receive valuable feedback for your work. If you are unable to submit your work on time due to extenuating circumstances, contact us as soon as possible: we will work with you to help you succeed.

Readiness Assessment Tests (RATs). There will be twenty-five RATs this semester, each accounting for 1% (10 points) of your final course grade and thus for a total of **25%** (250 points) of your final course grade. As indicated in the Tentative Course Outline below, each RAT typically covers materials already discussed in class (materials to be reworked) as well as materials to be discussed in class on the day of the RAT (materials to be prepared for class, i.e., readings noted in the Tentative Course Outline below). In contrast to all other grade components, which are individual efforts, RATs will be completed in teams (see below). RATs will be graded by the following class meeting. If your group has any issues with a graded RAT (e.g., ambiguous task, incorrect answer), your group may prepare a written appeal and submit it to us. If we feel that your appeal has merit, the group will be given credit accordingly.

Teams & Peer Evaluations. Collaboration is an important component of most jobs and tends to be very rewarding. We thus encourage collaboration throughout the semester. To facilitate the process, you will be divided into teams, each comprised of about five students. Each team will be made up of a diversity of individuals, but different teams will be comparable to each other (e.g., each team will be composed of roughly the same number of geography and non-geography majors). Members of every individual team will complete RATs as just that—a team. However, while each team member will initially receive the same grades as all other team members, adjustments of each team member's grades (upward or downward) will be made based on peer evaluations that assess an individual's contribution to the success of the team (e.g., preparedness, reliability, participation in discussions, ability to compromise). It is thus in your own best interest to always be prepared and contribute as much as possible to teamwork and discussions.

Muddy & Clear Points (MCPs). MCPs are written notes summarizing aspects of the readings that were unclear and aspects of the readings that made perfect sense to you. There will be fourteen MCPs this semester; thirteen of these will account for 0.4% (4 points) each and one (#3) for 0.8% (8 points). Collectively, the MCPs will thus determine **6%** (60 points) of your final course grade. MCPs are credit opportunities for you to reflect on your understanding of the class materials. They should serve as an incentive for you to prepare the readings for class. At the same time, they allow us to tailor each class meeting specifically to your needs, with emphasis on muddy points and no or only short discussion of the clear points. MCPs are due by the beginning of class and are individual efforts.

Learning Outcomes (LOs). Many LOs (i.e., descriptions of things you should be able to do) could be formulated for each topic, but some are particularly crucial to help you acquire the three big LOs of this course (p. 1). To help you stay focused on the important issues, we will provide you with a set of crucial LOs for each topic. Consider these LOs as your **study guide.**

Term Project (Grad Students Only!). Grad students will be required to submit a term project as part of their course work (20% of final grade). Guidelines for the term project will be outlined in a separate document. If you are a graduate student, please contact me ASAP for details.

Further details regarding all of the above will be provided to you in class, lab, and/or on the course website.

POLICIES, CODES, ETC.

Students with Disabilities. Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act Amendments Act (ADAAA) covers issues relating to disability and accommodations. If you have questions or need an accommodation in the classroom (all medical information is treated confidentially), contact: Trudy Luken, Director; Student Accessibility Services (SAS) - Corbett Center, Rm. 208; Phone: (575) 646-6840 E-mail: sas@nmsu.edu; Website: http://sas.nmsu.edu/

Non-Discrimination. NMSU policy prohibits discrimination on the basis of age, ancestry, color, disability, gender identity, genetic information, national origin, race, religion, retaliation, serious medical condition, sex, sexual orientation, spousal affiliation, and protected veterans status. Furthermore, Title IX prohibits sex discrimination to include sexual misconduct: sexual violence (sexual assault, rape), sexual harassment and retaliation. For more information on discrimination issues, Title IX, Campus SaVE Act, NMSU Policy Chapter 3.25, NMSU's complaint process, or to file a complaint contact: Lauri Millot, Title IX Coordinator; Agustin Diaz, Title IX Deputy Coordinator; Office of Institutional Equity (OIE) - O'Loughlin House, 1130 University Avenue; Phone: (575) 646-3635 E-mail: equity@nmsu.edu; Website: http://www.nmsu.edu/~eeo/

Other NMSU Resources. NMSU Police Department: (575) 646-3311, www.nmsupolice.com; NMSU Police Victim Services: (575) 646-3424; NMSU Counseling Center: (575) 646-2731; NMSU Dean of Students: (575) 646-1722; For Any On-Campus Emergencies: 911

Code of Academic Integrity. Enrollment in this course and acceptance of this syllabus is your **contract** constituting acceptance of all University policies regarding academic integrity, including but not limited to cheating and plagiarism. You are expected to comply fully with the NMSU Honor Code as presented in the Student Handbook (http://studenthandbook.nmsu.edu/). Students who are judged to be guilty of academic dishonesty (http://studenthandbook.nmsu.edu/student-code-of-conduct/academic-misconduct/) on any graded class component will receive no points for that component, and we reserve the right to consider more severe penalties such as failure of the course and referral to the Dean and Student Judicial Affairs.

Absence Policy. Absences due to University-sanctioned activities, work-related events, holidays or special events observed by organized religions, or illness will be excused, if you provide us with official written documentation explaining your absence. We don't really have any additional absence policies. Just keep the following in mind: learning is your responsibility and, if you miss a lecture or lab, you will have to figure out how to "make it up;" your peers will evaluate you in terms of your contributions to the success of your team and the class and these evaluations will be used to convert team grades to individual grades.

Withdrawal. Withdrawal from this course is solely your responsibility; we will not drop you from this class under any circumstances. If you no longer wish to be enrolled in this course, you must withdraw from it. If you are still on the class roll at the end of the semester, you will receive a grade based on the work submitted.

What you can expect from us. We will be available in class, during office hours and scheduled appointments, and via email to respond to any questions or concerns you may have**.** Don't be shy and contact us as soon as ambiguities, problems, or concerns arise! We will take all of your

concerns seriously and respond to you as soon and as specific as possible. We will address any issues that are of importance to all students in class and on Canvas. We will do our very best to always be prepared for class, grade assignments fairly, and return your work promptly (within one week). We reserve the right to change scheduled lectures, exams, and assignments. Any changes made will not adversely affect your workload or grade.

What we expect from you: Enrollment in this course and acceptance of this syllabus is your **contract** constituting acceptance of all New Mexico State University policies and codes as well as all specific policies outlined in this syllabus. We expect you to be on time for all class-related activities, submit all tasks as instructed, and always show "good" behavior toward both your instructor and peers. Have fun!

TENTATIVE COURSE OUTLINE

Week	Date	Topic	Due: At Home | In Class * Pages in Jensen 2006
PART I: INTRODUCTION TO REMOTE SENSING			
1	08/18	Fun with Remote Sensing	✓ Acquire Textbook
2	08/23	Getting Organized	✓ Study Syllabus
	08/25	**Introduction to Remote Sensing (1)**	✓ RAT #1 (Syllabus & Textbook)
	Lab	***No Lab***	
3	08/30	Introduction to Remote Sensing (1)	✓ Reading #1: Ch. 1, 1-31* ✓ MCP #1 (Topic 1) ✓ RAT #2 (Topic 1)
	09/01	**Electromagnetic Radiation Principles (2)**	✓ Reading #2: Ch. 2, 37-60* ✓ MCP #2 (Topic 2) ✓ RAT #3 (Topics 1-2)
	Lab	***No Lab***	
4	09/06	Electromagnetic Radiation Principles (2)	✓ Rework Topics 1-2 ✓ RAT #4 (Topics 1-2)
	09/08	**Aerial Photography (3)** Peer Evaluation #1	✓ Reading #3: Ch. 3-4, 61-88*, 91-125* ✓ MCP #3 (Topic 3) ✓ RAT #5 (Topics 2-3)
	Lab	***Lab #1:*** *Getting Started with ENVI*	✓ Lab #1
5	09/13	**Elements of Visual Image Interpretation (4)**	✓ Reading #4: Ch. 5, 127-147* ✓ MCP #4 (Topic 4) ✓ RAT #6 (Topics 3-4)
	09/15	Elements of Visual Image Interpretation: Focus on Color (4)	✓ Rework Topics 1-4 ✓ RAT #7 (Topics 1-4)
	Lab	***Lab #2:*** *Basic Image Processing in ENVI*	✓ Lab #2
6	09/20	**Photogrammetry (5)**	✓ Reading #5: Ch. 6, 149-192*

			✓ MCP #5 (Topic 5) ✓ RAT #8 (Topics 4-5)
	09/22	Photogrammetry (5)	✓ Rework Topics 1-5 ✓ RAT #9 (Topics 1-5)
	Lab	***Lab #3:*** *Qualitative Analysis and Interpretation of Air Photos*	✓ Lab #3
7	**09/27**	**Exam 1**	✓ Prepare for Exam #1
PART II: REMOTE SENSING SYSTEMS			
	09/29	**Multispectral Remote Sensing (6)**	✓ Reading #6: Ch. 7, 193-247* ✓ MCP #6 (Topic 6) ✓ RAT #10 (Topic 6)
	Lab	***Lab #4:*** *Quantitative Analysis and Interpretation of Air Photos*	✓ Lab #4
8	10/04	Multispectral Remote Sensing (6) Peer Evaluation #2	✓ Rework Topics 1-6 ✓ RAT #11 (Topics 1-6)
	10/06	**Thermal Infrared Remote Sensing (7)**	✓ Reading #7: Ch. 8, 249-288* ✓ MCP #7 (Topic 7) ✓ RAT #12 (Topics 6-7)
	Lab	***Lab #5:*** *Working with MS Data I*	✓ Lab #5
9	10/11	Thermal Infrared Remote Sensing (7)	✓ Rework Topics 1-7 ✓ RAT #13 (Topics 1-7)
	10/13	**RADAR Remote Sensing (8)**	✓ Reading #8: Ch. 9, 291-332* ✓ MCP #8 (Topic 8) ✓ RAT #14 (Topics 7-8)
	Lab	***Lab #6:*** *Working with MS Data II.1*	✓ Lab #6
10	10/18	**LIDAR Remote Sensing (9)**	✓ Reading #9: Ch. 10, 335-352* ✓ MCP #9 (Topic 9) ✓ RAT #15 (Topics 8-9)
	10/20	**Exam 2**	✓ Prepare for Exam #2
	Lab	***Lab #7:*** *Working with MS Data II.2*	✓ Lab #7
PART III: REMOTE SENSING OF THE ENVIRONMENT			
11	10/25	**RS of the Biosphere (10)**	✓ Reading #10: Ch. 11, 355-402* ✓ MCP #10 (Topic 10) ✓ RAT #16 (Topic 10)
	10/27	RS of the Biosphere (10)	✓ Rework Topics 1-10 ✓ RAT #17 (Topics 1-10)
	Lab	***Lab #8:*** *Working with MS Data II.3*	✓ Lab #8
12	11/01	**RS of the Hydrosphere (11)** Peer Evaluation #3	✓ Reading #11: Ch. 12, 409-439* ✓ MCP #11 (Topic 11) ✓ RAT #18 (Topics 10-11)

	11/03	RS of the Hydrosphere (11)	✓ Rework Topics 1-11 ✓ RAT #19 (Topics 1-11)
	Lab	***Lab #9:*** *RS of the Biosphere*	✓ Lab #9
13	11/08	**RS of the Lithosphere (12)**	✓ Reading #12: Ch. 14, 507-566* ✓ MCP #12 (Topic 12) ✓ RAT #20 (Topics 11-12)
	11/10	RS of the Lithosphere (12)	✓ Rework Topics 1-12 ✓ RAT #21 (Topics 1-12)
	Lab	***Lab #10:*** *RS of the Hydrosphere*	✓ Lab #10
14	11/15	**RS of Urban Environments (13)**	✓ Reading #13: Ch. 13, 443-502* ✓ MCP #13 (Topic 13) ✓ RAT #22 (Topics 12-13)
	11/17	RS of Urban Environments (13)	✓ Rework Topics 1-13 ✓ RAT #23 (Topics 1-13)
	Lab	***Lab #11:*** *RS of the Lithosphere*	✓ Lab #11
15	**---**	**Thanksgiving Break (11/21-11/25): No Lectures, No Labs**	
16	11/29	**In Situ Reflectance Measurements (14)**	✓ Reading #14: Ch. 15, 569-578* ✓ MCP #14 (Topic 14) ✓ RAT #24 (Topics 13-14)
	12/01	In Situ Reflectance Measurements (14)	✓ Rework Topics 1-14 ✓ RAT #25 (Topics 1-14)
	Lab	***Lab #12:*** *RS of Urban Landscapes*	✓ Lab #12
17	**12/08**	**Final Exam: 8:00 - 10:00 AM** Peer Evaluation #4	✓ Prepare for Exam #3

NOTES