GEO424: Advanced Remote Sensing Syllabus

Spring 2016 (4 credits)
MWF 9:10 – 10 am, lab W 10:20 – 12 pm
Geography Building Rm 126
Lab, Geography Rm 201

Instructor	Contact	Office Location & Hours
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1 General Information

1.1 Description

GEO 424 examines the theory and methodology of applied optical and microwave remote sensing technologies. We explore the principles of electromagnetic radiation, as well as the interactions of solar radiation with the earth's atmosphere. The spectral reflectance, transmittance and absorption characteristics of the three main earth cover types – vegetation, soil and water will be emphasized. We will compare the spatial, spectral, radiometric and temporal characteristics of the key low-, medium- and high-resolution multispectral sensor systems and their data products. This course will develop your basic skills in computer processing of digital satellite images using the ERDAS Imagine software. Hands-on experience with atmospheric and topographic radiometric corrections, feature space interpretations and per-pixel supervised and unsupervised, as well as object-based image classification techniques will be provided. Both thermal and active microwave (SAR) remote sensing principles and image interpretation will be introduced. An introduction to LIDAR and airborne hyperspectral systems and data will be provided, as well.

1.1.1 Prerequisites: 324 or instructor permission. **Participants in this course are expected to have a good working knowledge of the principles and elements of visual image interpretation *AND* to be competent in extracting thematic information from images.**

1.1.2 Evaluation: Students will be evaluated by several short homework assignments related to readings, laboratory exercises, and three exams.

1.1.3 On D2L: SS16-GEO-424-001

1.1.4 A Tribute: This course is based on the one Dr. Dave Lusch designed and improved upon over the past ~30 years, so many, many thanks go to Dr. Lusch for developing such a great course and for sharing so many of the materials!

2 Course Materials

2.1 Required Reading

Book: Lillesand, Kiefer, & Chipman (2015) *Remote sensing and image interpretation* (7th Edition*). Wiley & Sons, Inc. pp 720.
(available at the bookstore, 1 copy on 24 hr reserve at the Main Library (available at the 1st floor circulation desk 24 hr/day Sunday @ 10 am – Friday 10 pm, Sat 10 am – 6 pm), or online)

* Note that here I say the 7th edition, which just came out. Either the 6th or 7th edition is fine and I've provided both sets of page numbers, though I recommend the newer version (which you can already find used copies of!)

Other Reading:

Readings will be posted online at least a week before reading assignments are due.

2.2 Recommended Reading

Jensen (2006) *Remote sensing of the environment: An earth resource perspective* (2nd Edition) Prentice Hall, pp 608.

Jones & Vaughan (2010) *Remote sensing of vegetation*. Oxford University Press, pp 384.

3 Course Policies

3.1 Email

If you have questions or issues, please contact me! Students should not expect immediate responses to email messages, however, if you don't receive a response within 48 hours please email again or talk to me before or after class. Please include "GEO424" in the subject line of your email for a faster response.

3.2 Sending Attachments

Homework assignments in this class will be turned in via D2L or handed in on paper after a lab. For D2L assignments, download the file, alter the name of it to represent you, then answer the included questions. Ideally the filename would look something like GEO424_lastname_firstname_assignment#_YYYYMMDD.docx. Completed assignments should be uploaded as MS Word documents (.docx), PDFs (.pdf), or, if all else fails, raw text documents (.txt). If files are received "corrupted" or with other issues, the onus is on you to correct this problem, and if it isn't dealt with promptly it will be considered late. If something goes wrong on D2L, just email the file to me. My preference is for D2L, but don't skip it all together and risk having a late (and therefore 0) assignment.

3.3 Electronics in Class

Laptops and cellphones are permitted in class, in fact, we'll use laptops occasionally (though you are not required to have one), however, if they become a distraction to other students the instructor may ask you to put them away. If you are working on a laptop during class the instructor reserves the right to ask you to look up concepts/definitions and share them with the class as relevant.

3.4 Academic Honesty

Article 2.3.3 of the Academic Freedom Report states that "The student shares with the faculty the responsibility for maintaining the integrity of scholarship, grades, and professional standards." In addition, Dr. Dahlin adheres to the policies on academic honesty as specified in General Student Regulations 1.0, Protection of Scholarship and Grades; the all-University Policy on Integrity of Scholarship and Grades; and Ordinance 17.00, Examinations. (See Spartan Life: Student Handbook and Resource Guide) Therefore, unless authorized by your instructor, you are expected to complete all course assignments, including homework, lab work, quizzes, tests and exams, without assistance from any source. You are expected to develop original work for this course; therefore, you may not submit course work you completed for another course to satisfy the requirements for this course. Also, you are not authorized to use the www.allmsu.com web site to complete any course work in this course. Students who violate MSU academic integrity rules may receive a penalty grade, including a failing grade on the assignment or in the course. Contact your instructor if you are unsure about the appropriateness of your course work. (See also the Academic Integrity webpage.)

3.5 Accommodations for Students with Disabilities

Michigan State University is committed to providing equal opportunity for participation in all programs, services and activities. Requests for accommodations by persons with disabilities may be made by contacting the Resource Center for Persons with Disabilities at 517-884-RCPD or on the web at rcpd.msu.edu. Once your eligibility for an accommodation has been determined, you will be issued a Verified Individual Services Accommodation ("VISA") form. Please present this form to me at the start of the term and/or two weeks prior to the accommodation date (test, project, etc.). Requests received after this date may not be honored.

If you have an issue not directly covered by the RCPD, please contact me and I'll try to accommodate your needs.

3.6 Diversity

In order to learn, we must be open to the views of people different than ourselves. Each and every voice in the classroom is important and brings with it a wealth of experiences, values and beliefs. In this time we share together over the semester, please honor the uniqueness of your fellow classmates, and appreciate the opportunity we have to learn from each other. Please respect your fellow students' opinions and refrain from personal attacks or demeaning comments of any kind. Finally, remember to keep confidential all issues of a personal or professional nature that are discussed in class.

3.7 Attendance & Participation

Students are expected to attend the majority of class meetings, to show up on time, and to contribute intellectually to the class by asking questions and sharing thoughts and opinions. While I won't take strict attendance, this is a small class, so your absence will be noticed.

Students whose names do not appear on the official class list for this course may not attend this class without permission of the instructor. Students who fail to attend the first four class sessions or class by the fifth day of the semester, whichever occurs first, may be dropped from the course. If you anticipate that you will have to miss class for any reason, please discuss this absence with the instructor at least a week in advance. If you miss an exam you will be expected to provide proof of a legitimate emergency before a makeup is allowed. Students seeking a grief absence should be

directed to the Grief Absence Request Form found on the RO home page (https://reg.msu.edu/) under 'Student Services - Grief Absence Request Form' OR to StuInfo (https://stuinfo.msu.edu/) under 'Academics - Enrollment Information and Services - Grief Absence Request Form.' If a grief absence is approved, accommodations will be made. **Late assignments will not be accepted.**

3.8 Collaboration

Collaboration **IN CLASS** outside of exams is encouraged. We will do a number of activities in class where your active participation and interaction with others will, in fact, be required. However, all work done outside of the classroom should be your own. Written assignments, computer code (modified from what I supply), and exams should represent your own independent work. If you need help on an assignment, contact the instructor, not your fellow classmates.

3.9 Social Media

Yep, I'm on twitter (@bristleweed & @ERSAM_Lab), LinkedIn, ResearchGate, and a few other social media type things. You're welcome to follow me, of course (I tweet 90% work/science related stuff), but with very few exceptions I will not follow/friend/link back to you. Please do not take this personally, I just don't want to know what you had for dinner, how hard your other classes are, or whatever other personal stuff is going on in your life that isn't related to remote sensing or geography.

3.10 Emergencies

In the event of an emergency, our primary goal will be to stay safe. There is a wide variety of situations we could potentially face as a class, so please be prepared to stay calm, and never hesitate to interrupt the instructor if something seems awry.

4 Course Schedule

The following lecture schedule remains subject to change and last minute modifications. If significant changes do occur, students will be notified and an updated syllabus will be posted on D2L. LKC6 = Lillesand et al 6th Edition; LKC7 = Lillesand et al 7th Edition.

Lab assignments are handed in at the end of the lab period, or, if you're not done, they're officially due in class first thing on Friday after the lab. All non-lab assignments are due 15 minutes BEFORE class on the due date (so at 8:55 am).

Wk	Lect.	Date	Topic	Reading	Due
1	1	11-Jan	Syllabus review and Introductions	LKC6: 1-60; LKC7: 1-59;	
1	2	13-Jan	Radiometric principles and nomenclature		
1		13-Jan	LAB1: Fundamentals of electromagnetic radiation (EMR)		
1	3	15-Jan	Atmospheric Interaction with EMR		LAB 1
2		18-Jan	**MLK Day - no school**		
2	4	20-Jan	Biophysical interpretation of vegetation reflectance		

2		20-Jan	LAB2: Color formation and false color images & Start Self Help #1		
2	5	22-Jan	Biophysical interpretation of vegetation reflectance	LKC6: 325-340, 482-522; LKC7: 218-231, 485-516	LAB 2
3	6	25-Jan	Biophysical interpretation of vegetation reflectance	Color Science (D2L)	Assignment 1 Due
3	7	27-Jan	Biophysical interpretation of soil reflectance		
3		27-Jan	LAB3: Measuring spectral reflectance (ASD)		
3	8	29-Jan	Biophysical interpretation of soil and water reflectance		LAB 3
4		1-Feb	Review Day (no class meeting)	Electronic Sensing & Spectroscopy (video lecture on D2L - 50 min)	Assignment 2 Due
4	9	3-Feb	Guest lecture - Kevin Credit	Image Statistics (D2L - 20 min)	Finish Self Help #1 by today
4		3-Feb	LAB4: Observing vegetation, soil, and water reflectance in multispectral imagery		
4	10	5-Feb	Radiometric and atmospheric correction of satellite imagery		LAB 4
5	11	8-Feb	Radiometric and atmospheric correction of satellite imagery	LKC6: 523-540; LKC7: 517-530	
5	12	10-Feb	Computer enhancement of satellite images	Image Enhancement (D2L - 46 min)	
5		10-Feb	LAB5: Image based atmospheric correction, topographic correction		
5		12-Feb	Exam Review		LAB 5
6		15-Feb	**EXAM 1**		
6	13	17-Feb	Multi-image Manipulation: Tasseled cap transformation	LKC6: 540-547; 530-538	
6		17-Feb	LAB6: Principal components analysis and the TM tasseled cap		
6	14	19-Feb	Computer classification of digital images		LAB 6
7	15	22-Feb	Per Pixel supervised classification of digital images	LKC6: 547-620; 538-608	

7	16	24-Feb	Per Pixel supervised classification of digital images	Paper on D2L	Assignment 3 Due
7		24-Feb	LAB7a: Training site selection, supervised classification using maximum likelihood (1/2)		
7	17	26-Feb	Per pixel unsupervised classification, object-based image classification		
8	18	29-Feb	Per pixel rule-based classification, object based image classification	LKC6: 736-740; LKC7: Appendix B online	
8	19	2-Mar	Assessing classification accuracy		
8		2-Mar	LAB7b: Training site selection, supervised classification using maximum likelihood (2/2)		
8	20	4-Mar	Classification Paper Discussion		LAB 7
		7-Mar - 11-Mar	SPRING BREAK!		
9	21	14-Mar	LandSat	LKC6: 392-431; LKC7: 283-323	
9	22	16-Mar	LandSat paper discussion	Paper on D2L	Assignment 4 Due
9		16-Mar	LAB8: Unsupervised classification with isodata		
9	23	18-Mar	SPOT	LKC6: 432-445; LKC7: 324-336	LAB 8
10	24	21-Mar	High Resolution satellites (GeoEye, IKONOS, Quickbird…)		
10	25	23-Mar	Worldview2 & 3		
10		23-Mar	LAB9a: Object oriented classification using OBJECTIVE module (1/2)		
10	26	25-Mar	Thermal Radiation	LKC6: 352-379; LKC7: 243-268	
11	27	28-Mar	Atmospheric interactions with TIR radiation		
11	28	30-Mar	Thermal properties and diurnal cycles	Paper on D2L	Assignment 5 Due
11		30-Mar	LAB9b: Object oriented classification using OBJECTIVE module (2/2)		
11	29	1-Apr	Thermal RS		LAB 9
12		4-Apr	Exam Review		
12		6-Apr	**EXAM 2**		
12		6-Apr	LAB10: Interpretation of TIR imagery		

12	30	8-Apr	Radar azimuth resolution, SAR processing	LKC6: 626-678; LKC7: 385-440	LAB 10
13	31	11-Apr	Radar image geometry, backscatter, vegetation		
13	32	13-Apr	MODIS	LKC6: 471-481; LKC7: 339-348, 371-378	
13		13-Apr	LAB11: Classification of MODIS timeseries		
13	33	15-Apr	MODIS paper discussion		LAB 11
14	34	18-Apr	Airborne RS intro	Paper on D2L	Assignment 6 due
14	35	20-Apr	Hyperspectral Imagery (air and space-borne)	LKC6: 380-390; LKC7: 349-358	
14		20-Apr	LAB12: Exploring Airborne Hyperspectral Imagery		
14	36	22-Apr	LiDAR	LKC6: 714-725; LKC7: 471-484	LAB 12
15	37	25-Apr	Hyperspectral + LiDAR		
15		27-Apr	guest lecture - careers in RS		
15		27-Apr	*No Lab Meeting*		
15		29-Apr	Exam Review & Evaluations		
16		3-May	**FINAL EXAM: 7:45 - 9:45 AM in GEO 126**		

5 Evaluation

5.1 Labs

A key component of learning remote sensing is actually doing the work and exploring imagery on your own. The labs in this course are designed to walk you through the basics, but also to allow time for you to explore and think on your own. Please use the lab time to *EXPLORE AND LEARN* not just to click through the assignments as fast as possible. Labs should be turned in at the end of the lab period, but they are officially due first thing in class on the Friday following the lab. Labs turned in after this time will not be accepted. If a lab is expected to take longer, or if we face technical issues, you will be informed of the official due-date in person and via D2L message.

5.2 Assignments & Reading Summaries

All of the assigned readings will have some sort of 'product' associated with them (details posted on D2L or handed out in class/lab). These should not be time consuming activities, but will help you identify key points in the readings or chapters and come to class prepared for discussions. You'll notice that there are six assignments in the schedule (20 points each) and 12 labs (10 points each), but each of those lines in Grading (Section 6, see *) is only worth 100 points. This means you may miss or do poorly a few assignments with no impact on your grade, or do them all well to earn

extra credit. Reading summaries and labs **will not be accepted late no matter what**, however (i.e. if you're 2 points away from a higher grade at the end of the semester you can't add a summary to up your grade then. So think ahead!)

5.3 Exams

Each of the two midterm exams will be cumulative (i.e. concepts from the first third of the class could be on the second exam). Exam questions may come from lectures, class discussions, and readings, though the focus will be on understanding concepts, not memorizing facts and statistics. Exams will primarily use short-answer questions, but some other question types may be incorporated. The final exam will be cumulative, though, again, the focus will be on broad concepts which should carry through the course, less on specific facts and equations.

6 Grading

Assignment	Points
Labs (12 x 10 pts)	100*
Reading Assignments (6 x 20 pts)	100*
Exam 1	100
Exam 2	100
Exam 3	100
TOTAL	**500**

Final Grade Scale	
450 - 500	4.0
420-449	3.5
390-419	3.0
350 - 389	2.5
320 – 349	2.0
290 – 319	1.5
260 – 289	1.0
< 360	0