GEO424: Advanced Remote Sensing Syllabus

Spring 2018 (4 credits)
Class for all MWF 9:10 – 10 am
Lab 001: Th 3-4:50 pm | Lab 002: F 10:20 am -12:10 pm
Geography Building Rm 126
Lab, Geography Rm 201

Instructors	Contact	Office Location & Hours
Dr. Kyla Dahlin, Department of Geography, Environment, & Spatial Sciences	kdahlin@msu.edu 517.353.9739	Geography Building Rm 122 *Office hours*: Thurs 1 – 3 pm or by appointment
TA: Aaron Kamoske Department of Geography, Environment, & Spatial Sciences	kamoskea@msu.edu	Geography Building Rm 11 *Office hours*: Weds 12:30 – 2:30 pm or by appointment

1 General Information

1.1 Description

GEO 424 examines the theory and methodology of applied optical 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 and will provide an introduction to R. Hands-on experience with feature space interpretations and per-pixel supervised and unsupervised classification techniques will be provided. Applications of thermal and active microwave (SAR) remote sensing and image interpretation will be discussed. An introduction to LIDAR and airborne hyperspectral systems and data will be provided, as well.

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

1.1.2 Evaluation: Students will be evaluated by several short homework assignments related to readings, laboratory exercises, participation, three in-class exams, and a final exam.

1.1.3 On D2L: SS18-GEO-424-all

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 Strongly Recommended Reading

Book: Lillesand, Kiefer, & Chipman (2015) *Remote sensing and image interpretation* (7th Edition*). Wiley & Sons, Inc. pp 720. - available at the bookstore or online

1 copy of 6th edition 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)

* Note that here I say the 7th edition, which is fairly new. Either the 6th or 7th edition is fine and I have provided both sets of page numbers, though I recommend the newer version as there are some good updates.

Other Reading:

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

2.2 Recommended Reading (other good books about remote sensing)

Green, Congalton, & Tukman (2017) *Imagery and GIS: Best practices for extracting information from imagery*. ESRI Press, Redlands, California. pp 437.

Chuvieco (2016) *Fundamentals of satellite remote sensing: An environmental approach* (2nd Edition) CRC Press, Boca Raton, Florida. pp 468.

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

I will use D2L to email the class on a semi-regular basis. People have been having issues recently with D2L messages going to spam – please make sure to regularly check your spam folder and set your email to accept D2L emails as this could impact all of your classes.

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 at 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, 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 may ask you to look up concepts/definitions and share them with the class.

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, I adhere 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 me, you are expected to complete all course assignments, including homework, lab work, quizzes, tests and exams, without assistance from any source other than those provided. 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 website or other similar websites 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 me if you are unsure about the appropriateness of your course work. (See also the Academic Integrity webpage.)

3.5 Accommodations for Students with Disabilities

MSU 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 and lab 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 in class, this is a small class, so your absence will be noticed. Lab attendance is an important part of this course. We *will* take attendance in lab with a sign in/sign out sheet, and excessive absences (>3) or very short durations of attendance will result in a reduction in your 'participation' points. If you have a conflict with your lab time talk to me as soon as possible.

Students whose names do not appear on the official class list for this course may not attend this class without my permission. 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 me 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 go 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 without prior approval or evidence of an emergency.**

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 or TA, not your fellow classmates.

3.9 Social Media

Yep, I'm on twitter (@bristleweed & @ERSAM_Lab), LinkedIn, ResearchGate, and a few other 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 should be handed in at the end of the lab period. If you can't finish in they are officially due at the start of your following lab period. All non-lab assignments are due 15 minutes BEFORE class on the due date via D2L (so at 8:55 am).

Wk	Lect.	Date	Topic	Reading	Due
1	1	8-Jan	Syllabus review & quiz	LKC Ch. 1	
1	2	10-Jan	Review		
1		11/12-Jan	LAB01: Color formation and false color images		
1	3	12-Jan	Introductions		
2		15-Jan	**MLK Day - no school**		
2	4	17-Jan	Electromagnetic Radiation Fundamentals	Color Science (D2L)	Assignment 1 Due
2		18/19-Jan	LAB02: Fundamentals of electromagnetic radiation (EMR)		LAB01
2	5	19-Jan	Atmospheric Interaction with EMR		
3	6	22-Jan	Biophysical interpretation of vegetation reflectance	LKC6 Ch. 5.1-5.7, LKC7 Ch. 4.1-4.7	
3	7	24-Jan	Biophysical interpretation of vegetation reflectance		
3		25/26-Jan	LAB03: Measuring spectral reflectance		LAB02
3	8	26-Jan	Biophysical interpretation of soil and water reflectance		
4	9	29-Jan	Sensors & Spectroscopy & Bands		
4	10	31-Jan	Image Enhancement & Band Ratios	LKC Ch. 7.1-7.6	Assignment 2 Due
4		1/2-Feb	LAB04: Observing vegetation, soil, and water reflectance in multispectral imagery		LAB03
4	11	2-Feb	PCA and Tasseled Cap		
5		5-Feb	**EXAM 1**		
5	12	7-Feb	Computer classification of digital images	LKC Ch. 7.7-7.18	
5		8/9-Feb	LAB05: Principal components analysis and tasseled cap		LAB04
5	13	9-Feb	Per Pixel supervised classification of digital images		
6	14	12-Feb	Per Pixel supervised classification of digital images		
6	15	14-Feb	Per pixel unsupervised classification, object-based image classification	Paper on D2L	Assignment 3 Due
6		15/16-Feb	LAB06a: Training site selection, supervised classification using maximum likelihood (1/2)		LAB05
6	16	16-Feb	Rule based/layered classification		

Wk	Lect.	Date	Topic	Reading	Due
7	17	19-Feb	Assessing classification accuracy		
7	18	21-Feb	Change detection		
7		22/23-Feb	LAB06b: Training site selection, supervised classification using maximum likelihood (2/2)		
7	19	23-Feb	Radiometric and atmospheric correction of satellite imagery		
8	20	26-Feb	Radiometric and atmospheric correction of satellite imagery		
8		28-Feb	**EXAM 2**		
8		1/2-Mar	LAB07: Unsupervised classification with isodata		LAB06
8		2-Mar	No class (but still lab)		
		5-Mar to 9-Mar	**SPRING BREAK!**		
9	21	12-Mar	LandSat	LKC6: Ch. 6; LKC7: Ch. 5	
9	22	14-Mar	SPOT	Paper on D2L	Assignment 4 Due
9		15/16-Mar	LAB08: Remote sensing experimental design		LAB07
9	23	16-Mar	High Resolution satellites (GeoEye, IKONOS, Quickbird…)		
10	24	19-Mar	Worldview2 & 3		
10	25	21-Mar	MODIS & Time series analysis		
10		22/23-Mar	LAB09: Classification of MODIS timeseries		LAB08
10		23-Mar	CAREERS		
11	26	26-Mar	Airborne & UAVs		
11	27	28-Mar	UAVs		Assignment 5 Due
11		29/30-Mar	LAB10: MODIS with AppEEARS		LAB09
11	28	30-Mar	RADAR	LKC6: Ch 8; LKC7: Ch 6	
12	29	2-Apr	Thermal RS	LKC6: Ch 5.8-5.12; LKC7: Ch 4.8-4.12	
12		4-Apr	**EXAM 3**		
12		5/6-Apr	LAB11: Exploring EarthExplorer		LAB10
12	30	6-Apr	SNAP Demo Day		
13	31	9-Apr	Hyperspectral Imagery	LKC6: Ch 5.14; LKC7: Ch 4.13	

Wk	Lect.	Date	Topic	Reading	Due
13	32	11-Apr	Hyperspectral Imagery	Paper on D2L	Assignment 6 due
13		12/13-Apr	LAB12: Exploring Airborne Hyperspectral		LAB11
13	33	13-Apr	LiDAR	LKC6: Ch 8.23; LKC7: Ch 6.23-6.25	
14	34	16-Apr	LiDAR		
14	35	18-Apr	Intro to R		
14		19/20-Apr	LAB13: LiDAR and/or Imagery in R		LAB12
14	36	20-Apr	Google Earth Engine demo day		
15	37	23-Apr	Computational Radiometry		
15	38	25-Apr	Computational Radiometry		
15		26/27-Apr	*no lab meeting*		LAB13
15		27-Apr	Exam Review & Evaluations		
16		1-May	**FINAL EXAM: 12:45-2:45 PM in GEO 126**		

5 Evaluation

My philosophy on grading is that it is a necessary but not very fun part of being a student (or being a professor). As such, I have tried to set up our grading system to be fair but also to respect the fact that students have complicated lives with unexpected challenges. The keys to getting a good grade in this class are to show up, do the work, and study. If something goes awry, you will then have a cushion to fall back on with accumulated extra credit and/or the option to drop a low exam score.

5.1 Syllabus Quiz

The syllabus is an important part of any class! It serves as a guiding document for the course, and I will likely refer you to it if any questions arise. On the first day of class we'll have a syllabus quiz to ensure that you all actually look at it carefully. This is the one assignment in this class that you can make up. If you miss the first day of class for some reason, please get in touch with me and I will schedule a time with you to take it. Syllabus quiz makeups must be completed by the end of the second week of class.

5.2 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 at the start of the following week's 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. You'll notice that there are 13 labs (10 points each), but the 'Labs' line in Grading (Section 6, see *) is only worth 120 points. This means you may miss or do poorly a few labs with little impact on your grade, or do them all well to earn extra credit. **Labs will not be accepted late no matter what** (unless you have a grief absence excuse or other serious issue). Due to poor attendance in the lab in years past, this year we will have students sign in and sign out of their respective lab meetings and this attendance will

factor into the participation part of your grade.

5.3 Assignments & Reading Summaries

All of the non-text book readings will have some sort of 'product' associated with them (details posted on D2L or handed out in class). 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 (25 points each) but the 'reading assignments' line in Grading (Section 6, see *) is only worth 130 points. This means you may miss or do poorly a few assignments with little impact on your grade, or do them all well to earn extra credit. **Reading assignments will not be accepted late no matter what** (with the usual exceptions), 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!)

5.4 Exams

Each of the three midterm exams will be cumulative (i.e. concepts from the first third of the class could be on the second exam), though focused on the material in the most recent section of the class (since the previous 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 multiple choice and short-answer questions, but some other question types may be incorporated. The exam with the lowest grade of the three will be dropped (see ** in Section 6). The final exam will be cumulative, though, again, the focus will be on broad concepts which should carry through the course and on specific facts and equations that we repeatedly revisit.

5.5 Participation

Everyone starts the semester with 20 participation points. Students will lose points for excessive unexcused absences from class, chronic tardiness, > 3 absences from lab, or very brief lab attendance based on the sign in/sign out sheet.

6 Grading

Assignment	Points
Syllabus quiz	10
Labs (13 x 10 pts)	120*
Reading Assignments (6 x 25 pts)	130*
Exam 1	100
Exam 2**	100
Participation	20
Final Exam	120
TOTAL	**600**

Final Grade Scale	
552 – 600	4.0
522 – 551	3.5
492 – 521	3.0
462 – 491	2.5
438 – 461	2.0
402 – 437	1.5
360 – 401	1.0
< 360	0