

# GEO424: Advanced Remote Sensing Syllabus

Spring 2020 (4 credits)  
Class for all MWF 9:10 – 10 am  
Lab 002: Fri 10:20 am – 12:10 pm  
Geography Building Rm 126  
Lab, Geography Rm 201

| Instructors  | Contact                         | Office Location & Hours  |
|--|---------------------------------|--|
| Dr. Kyla Dahlin,<br>Department of Geography,<br>Environment, & Spatial Sciences  | kdahlin@msu.edu<br>517.353.9739 | Geography Building Rm 121-A<br><i>Office hours:</i> Weds 10 am - noon<br>or by appointment |
| TA: Aaron Kamoske<br>Department of Geography,<br>Environment, & Spatial Sciences | kamoskea@msu.edu                | Geography Building Rm 11<br><i>Office hours:</i> Fri 12:30 – 2:30 pm<br>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 the R programming language. Hands-on experience with feature space interpretations and per-pixel supervised and unsupervised classification techniques will be provided. 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:** SS20-GEO-424-002

## 2 Course Materials

### 2.1 Strongly Recommended Reading

**Book:** Lillesand, Kiefer, & Chipman (2015) *Remote sensing and image interpretation* (7<sup>th</sup> Edition). Wiley & Sons, Inc. pp 720. - available at the bookstore or online to rent or buy (used runs about \$80)

1 copy on 24 hr reserve at the Main Library (available at the 1<sup>st</sup> floor circulation desk 24 hr/day Sunday @ 10 am – Friday 10 pm, Sat 10 am – 8 pm)

## **Other Reading:**

Readings will be posted online at least a week before reading assignments are due. There is also a section on our D2L site called 'Additional Info' full of other readings that might be of interest. You are not responsible for this material, it is just there as an extra resource.

### **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* (2<sup>nd</sup> Edition) CRC Press, Boca Raton, Florida. pp 468.

Jensen (2006) *Remote sensing of the environment: An Earth resource perspective* (2<sup>nd</sup> 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. 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, 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, 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](http://www.allmsu.com) web site or other similar 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 Dr. Dahlin 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](http://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 Dr. Dahlin 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 any challenges or issues related to your ability to succeed in this class, please let Dr. Dahlin know as soon as possible.

### **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.

### **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, Dr. Dahlin is on twitter (@bristleweed), LinkedIn, ResearchGate, and a few other social media type things. You're welcome to follow her, of course (she tweets 90% work/science related stuff), but with very few exceptions she will not follow/friend/link back to you. Please do not take this personally. Dr. Dahlin's Ecological Remote Sensing and Modeling Lab is online at [www.ersamlab.com](http://www.ersamlab.com) and on twitter (@ERSAM\_Lab) and Instagram (@ERSAM.Lab).

### 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 Other Resources & a Note

Being a university student comes with many opportunities and challenges. Just a reminder of some of the many great resources MSU has available to help you maximize the opportunities and address the challenges.

**Spartan Life OnLine** - <http://splife.studentlife.msu.edu/> - Lots of great info here.

**Office of the University Ombudsperson** - <http://ombud.msu.edu/> - If you have an issue (like with an advisor or professor) and do not feel comfortable trying to resolve it with the person/department, the Ombuds Office can offer you advice.

**MSU Title IX Program** - <http://www.titleix.msu.edu/> - If you have questions about gender discrimination or harassment, this is a good place to look for resources.

**MSU Office of Institutional Equity** - <https://oie.msu.edu/> - If you have questions about other forms of discrimination or harassment, this is a good place to look.

**MSU Inclusion and Intercultural Initiatives** - <http://www.inclusion.msu.edu/> - Differences are our strength! This is a good place to look for inclusion-related opportunities and support.

**MSU Counseling & Psychiatric Services** - <https://caps.msu.edu/> - Free! Just walk in or connect virtually via the website.

**NOTE on Confidentiality:** Students should be aware that MSU employees, including instructors, may not be able to maintain confidentiality when it conflicts with their responsibility to report certain issues based on external legal obligations or that relate to the health and safety of MSU community members and others. Dr. Dahlin must report the following information to other MSU offices if you share it:

- Suspected child abuse/neglect, even if this maltreatment happened when you were a child,

- Allegations of sexual assault or sexual harassment when they involve MSU students, faculty, or staff, and
- Credible threats of harm to oneself or to others.

These reports may trigger contact from a campus official who will want to talk with you about the incident that you have shared. In almost all cases, it will be your decision whether you wish to speak with that individual. If you would like to talk about these events in a more confidential setting you are encouraged to make an appointment with the MSU Counseling Center.

## 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. **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. 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.

## 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     | Final Grade Scale |     |
|----------------------------------|------------|-------------------|-----|
| Syllabus quiz                    | 10         | 552 - 600         | 4.0 |
| Labs (12 x 10 pts)               | 120        | 522 - 551         | 3.5 |
| Reading Assignments (6 x 25 pts) | 130*       | 492 - 521         | 3.0 |
| Exam 1                           | 100        | 462 - 491         | 2.5 |
| Exam 2**                         | 100        | 438 - 461         | 2.0 |
| Participation                    | 20         | 402 - 437         | 1.5 |
| Final Exam                       | 120        | 360 - 401         | 1.0 |
| <b>TOTAL</b>                     | <b>600</b> | < 360             | 0   |

## 7 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. LKC7 = Lillesand et al 7<sup>th</sup> Edition.

Lab assignments should be handed in at the end of the lab period. If you can't finish in that amount of time then 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     | 6-Jan  | Syllabus review & quiz  | LKC Ch. 1           |                  |
| 1  | 2     | 8-Jan  | Review, RS applications, & Color  |                     |                  |
| 1  | 3     | 10-Jan | Electromagnetic Radiation Fundamentals  |                     |                  |
| 1  |       | 10-Jan | LAB01: Color formation and false color images. Also see Lab 00 ERDAS self-help. |                     |                  |
| 2  | 4     | 13-Jan | Electromagnetic Radiation Fundamentals  | Color Science (D2L) | Assignment 1 Due |
| 2  | 5     | 15-Jan | Atmospheric Interaction with EMR  |                     |                  |
| 2  | 6     | 17-Jan | Biophysical interpretation of vegetation reflectance                            | LKC7 Ch. 4.1-4.7    |                  |
| 2  |       | 17-Jan | LAB02: Fundamentals of electromagnetic radiation (EMR)                          |                     | LAB01            |
| 3  |       | 20-Jan | <b>MLK Jr Day – NO CLASS</b>  |                     |                  |
| 3  | 7     | 22-Jan | Intro to R  |                     |                  |
| 3  | 8     | 24-Jan | Biophysical interpretation of vegetation reflectance                            |                     |                  |
| 3  |       | 24-Jan | LAB03: Measuring spectral reflectance   |                     | LAB02            |
| 4  | 9     | 27-Jan | Biophysical interpretation of soil and water reflectance                        |                     |                  |
| 4  | 10    | 29-Jan | Image Enhancement & Band Ratios   | LKC Ch. 7.1-7.6     | Assignment 2 Due |
| 4  | 11    | 31-Jan | PCA and Tasseled Cap  |                     |                  |
| 4  |       | 31-Jan | LAB04: Analyzing Spectral Data in R   |                     | LAB03            |
| 5  |       | 3-Feb  | <b>EXAM 1</b>   |                     |                  |
| 5  | 12    | 5-Feb  | Computer classification of digital images                                       | LKC Ch. 7.7-7.18    |                  |
| 5  | 13    | 7-Feb  | Per Pixel supervised classification of digital images                           |                     |                  |
| 5  |       | 7-Feb  | LAB05: Principal components analysis and tasseled cap – first ERDAS lab         |                     | LAB04            |
| 6  | 14    | 10-Feb | Per Pixel supervised classification of digital images                           |                     |                  |
| 6  | 15    | 12-Feb | Per pixel unsupervised classification, object-based image classification        | Paper on D2L        | Assignment 3 Due |

| Wk         | Lect. | Date   | Topic   | Reading            | Due              |
|------------|-------|--------|---|--------------------|------------------|
| 6          | 16    | 14-Feb | Rule based/layered classification   |                    |                  |
| 6          |       | 14-Feb | LAB06a: Training site selection, supervised classification using maximum likelihood (1/2) |                    | LAB05            |
| 7          | 17    | 17-Feb | Assessing classification accuracy   |                    |                  |
| 7          | 18    | 19-Feb | Change detection  |                    |                  |
| 7          | 19    | 21-Feb | Radiometric and atmospheric correction of satellite imagery                               |                    |                  |
| 7          |       | 21-Feb | LAB06b: Training site selection, supervised classification using maximum likelihood (2/2) |                    |                  |
| 8          | 20    | 24-Feb | Radiometric and atmospheric correction of satellite imagery                               | LKC7: Ch. 7.2-7.2  |                  |
| 8          |       | 26-Feb | <b>EXAM 2</b>   |                    |                  |
| 8          | 21    | 28-Feb | <b>No Class!</b>  |                    |                  |
| 8          |       | 28-Feb | LAB07: Random Forests Classification in R<br><i>2 pm – Geography Dept Career Day!</i>     |                    | LAB06            |
| 2 to 6-Mar |       |        | <b>SPRING BREAK!</b>  |                    |                  |
| 9          |       | 9-Mar  | LandSat   | LKC7: Ch. 5        |                  |
| 9          | 22    | 11-Mar | SPOT & Sentinel-2   | Paper on D2L       | Assignment 4 Due |
| 9          | 23    | 13-Mar | High Resolution satellites (GeoEye, IKONOS, Quickbird, Worldview)                         |                    |                  |
| 9          |       | 13-Mar | LAB08: Remote sensing experimental design   |                    | LAB07            |
| 10         | 24    | 16-Mar | AVHRR, MODIS, VIIRS & Time series analysis  |                    |                  |
| 10         | 25    | 28-Mar | Airborne & UAVs   |                    |                  |
| 10         |       | 20-Mar | <b>CAREERS</b>  |                    |                  |
| 10         |       | 20-Mar | LAB09: Classification of MODIS timeseries   |                    | LAB08            |
| 11         | 26    | 23-Mar | RADAR   | LKC7: Ch 6         |                  |
| 11         | 27    | 25-Mar | RADAR   |                    | Assignment 5 Due |
| 11         | 28    | 27-Mar | Thermal RS  |                    |                  |
| 11         |       | 27-Mar | LAB10: MODIS with AppEEARS  |                    | LAB09            |
| 12         | 29    | 30-Mar | Thermal RS  | LKC7: Ch 4.8-4.12  |                  |
| 12         |       | 1-Apr  | <b>EXAM 3</b>   |                    |                  |
| 12         | 30    | 3-Apr  | Online tool Demo Day  |                    |                  |
| 12         |       | 3-Apr  | LAB11: Thermal Imagery  |                    | LAB10            |
| 13         | 31    | 6-Apr  | Hyperspectral Imagery   | LKC7: Ch 4.13      |                  |
| 13         | 32    | 8-Apr  | Hyperspectral Imagery   | Paper on D2L       | Assignment 6 due |
| 13         | 33    | 10-Apr | LiDAR   | LKC7: Ch 6.23-6.25 |                  |
| 13         |       | 10-Apr | LAB12a: NDVI & Topo EDDIE module  |                    | LAB11            |
| 14         | 34    | 13-Apr | LiDAR   |                    |                  |
| 14         | 35    | 15-Apr | Tour of Kyla's research   |                    |                  |



| Wk | Lect. | Date   | Topic                                       | Reading | Due   |
|----|-------|--------|---|---------|-------|
| 14 | 36    | 17-Apr | Computational Radiometry                    |         |       |
| 14 |       | 17-Apr | LAB12b: NDVI & Topo EDDIE module            |         | LAB12 |
| 15 | 37    | 20-Apr | Computational Radiometry                    |         |       |
| 15 | 38    | 22-Apr | Google Earth Engine demo day                |         |       |
| 15 |       | 24-Apr | Exam Review & Evaluations                   |         |       |
| 16 |       | 28-Apr | <b>FINAL EXAM: 12:45-2:45 PM in GEO 126</b> |         |       |