ADVANCED REMOTE SENSING
(GIS5038C Spring 2022)

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Class Hours: Mondays: 9:45 a.m. – 12:15 p.m.; Bellamy 035

Office Hours: Fridays: 12:00 – 2:00 p.m.; largely through Zoom but in-person meetings possible upon request

Teaching Assistant: NA

Computing Lab Manager (any problem related to computer systems): Shawn Lewers (slewers@fsu.edu)

Course Objective and Description

This course focuses on computer-based methods for information extraction from remotely sensed data to support geographic inquiries in environmental and social domains. It comprises three major components: an overview on the remote sensing process and the major remote sensing systems; an in-depth discussion on the major components in digital image processing ranging from preprocessing, image enhancements, thematic information extraction through pattern recognition and artificial intelligence, digital change detection, to thematic accuracy assessment; and an introduction to lidar remote sensing and hyperspectral remote sensing.

The course comprises instructor-led lectures, lab assignments, literature review and discussion, and an independent research project. The lectures focus on some core areas of remote sensing and digital image processing. An important component of this course is the computer-based lab assignment that mainly practices the principles and methods discussed in the lectures. A literature survey on a technical or applied topic is required for each participant. Each student needs to complete an independent research project and present the result to the entire class.

Prerequisite

GIS4035/5034 (Introduction to Remote Sensing) or equivalent. In addition to this formal prerequisite, students are expected to have a reasonable background in college algebra and univariate and multivariate statistics.

Computing Environment, Software and GIS Lab Policies

The Windows-based ERDAS Imagine software package will be used for lab assignments. However, *you should be aware that this is not a software training course*. If you are looking for such a course (learning a specific software package), you should visit the homepages for specific software packages. These vendors may provide short training courses or more software-specific training materials.

You are expected to observe the related policies outlined below when using the GIS lab facilities.

Typically, you will be given a temporary account in order to log on a computer in COSS GIS Lab. This account may expire by the end of the semester. When you are at the computer lab, you must observe the COSSPP GIS lab and FSU's related policies. The GIS lab rules include:

- No food or drink in the lab.
- Lab computers are for GIS work only. Your other class work is to be done in other labs.
- Lab printers (if available) are for GIS work only.

- DO NOT install software without permission from your instructor or the lab manager. If you need software, ask!
- DO NOT save your work on the local machines. Use your Z:\ drive. If you use the local machine or temp directory, others will be able to see your work and it may not be there later.
- DO NOT waste color prints, as they are expensive. Use the black and white printer whenever possible.
- Be courteous of others in the lab and stay quiet.
- Clean up after yourself. Lab attendants will throw out things that are left behind.
- DO NOT remove equipment that belongs in the lab from the lab. You will be criminally prosecuted if you are caught.
- DO NOT download MP3 or movie files. Most of these websites are compromised by viruses.
- Always log-off the computers when you are done, but DO Not shut them down.
- No instant messaging is allowed.
- Follow the FSU Honor Code and Code of Conduct rules and behave in an adult-like manner.

It is your responsibility to check and observe these rules. Any violation of these rules can result in the loss of privileges to use this facility. If that happens, it is your responsibility to find an alternative so that you could work on your lab assignments. If you are unsure about a rule or rules, ask a lab employee or Shawn Lewers (slewers@fsu.edu).

Course CANVAS Site

CANVAS will be used to host the course lecture and lab materials. You may find the lecture slides there, *but there is no guarantee that these lecture materials will be available on time*. You will still need to take notes during a lecture session. You are required to check that site from time to time because some important announcements may be posted there. The CANVAS address is: https://canvas.fsu.edu. You will need to use your FSU account username and password to access this site.

I will also post your grades for class assignments on the canvas site. Note that these are your UNWEIGHTED raw scores. You can calculate your final grade (in percentage) based on a weighting system discussed in the next section of this syllabus. Please do not hesitate to contact the course instructor should you have any questions for this.

For copyright reason please do not distribute anything posted on the CANVAS site to a third person.

Grading Polices

System:

A	93-100	B	83-86	C	73-76	D	63-66
A-	90-92	B-	80-82	C-	70-72	D-	60-62
B+	87-89	C+	77-79	D+	67-69	F	59-0

In qualitative terms, the grade standards are: **A,** Outstanding, few errors or omissions (if any); **B,** Good, only minor errors/omissions; **C**, Satisfactory, at least one major error/omission; **D**, Poor, several major errors/omissions; and **F**, Fail: many major errors/omissions.

Components:

Components	Description	Weights
Lab assignments	Several lab assignments to be completed within a fixed time frame	28%
One open-book exam (writing assignment)	A set of questions to be answered within a fixed time period	28%
Literature review	Review at least two articles, present them in the class, and write a report	16%
Research project	Identify a technical or applied topic, write a short proposal, conduct research, present the findings, and write a final report	28%

Course Attendance

Students are required to attend all classes and be punctual. Missing even one lecture can substantially affect your grade. Announcements regarding the course outline and the schedule of the lectures, labs, and writing assignments (including changes of these) may be made in class. All organizational/administrative announcements made during the class period are assumed to be known by all students.

Attendance will be regularly checked. If you are not able to attend a class meeting, you will need to contact the instructor with an excuse provided. Usually, a substantial excuse should be provided for the second time when you miss a class meeting. A 10% of the total grade reduction will be applied for each unexcused absence. Being late or leaving earlier twice will be counted as ONE unexcused absence.

If you have to miss the writing assignment or are not able to come to the class during the date you are scheduled to review your journal articles or present your research projects, you will have to provide an acceptable excuse before I could reschedule your work.

The list of acceptable excuses includes documented illness, deaths in the immediate family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. Most other excuses for missing an exam may not be acceptable.

Cell phones, pagers, alarms, laptops, calculators, and other electronic devices must be turned off in class at all times.

Writing Assignment

The writing assignment can involve any material covered in lectures, reading or discussion assignments, and labs. There is no provision for extra credit work. A make-up writing assignment may be arranged only when you present an acceptable excuse: documented illness, deaths in the immediate family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. Most other excuses for missing this assignment are NOT acceptable. This policy will be strictly applied.

Lab/Assignment Grading Policies

Grades of your lab exercises and other assignments are based on the quality of your answers. Any answer should be concise and be well organized. The grade for each of the exercises is reported as *points_scored /total_points_of_exercise*. For example, if an assignment is worth 20 points and your answers score16 points then you should see 16/20 on your marked assignment.

Each assignment will have a due day (normally at 11:59 pm of that day). Any assignment that is turned in after the due day is considered late, which would receive penalty. The penalty for a late assignment is based on the number of days late (including weekends). If an assignment is late less than 24 hours, it is considered 1 day late. If an assignment is late less than 48 hours but more than 24 hours, it is considered 2 days late, and so on. Late assignments are penalized **20%** per day. Here is the formula for calculating the points of a late assignment:

Points_get = Points_scored - 0.20*num_days_late*Points_scored

The minimum value of Points_get is 0. Assignments handed in after I have returned the graded assignment to class (usually one week after the due date) will receive no points. Again, you must provide acceptable excuse (see exam section) in order to receive more time for you to complete lab exercises or other assignments without penalty applied. You should discuss with the instructor about your situation no later than the due day. This policy will be strictly applied.

Note that every person must hand in his or her own lab assignments. Working together is permitted and encouraged, BUT each person will be graded separately, must answer "creative response" questions independently, and must create his or her OWN maps/visual products if appropriate. Turning in identical or substantially similar assignments will result in significant grade reduction.

Peer-reviewed Journal Article Review and Discussion

Each participant is required to review two major **research articles** that discuss specific techniques, methods, or applications. The articles should come from a major peer-reviewed scholarly journal (check Section Course Materials for details) and must **NOT** have been reviewed by you in a different course. You are **NOT** allowed to use any web materials to replace a journal article. Each participant needs to do a powerpoint presentation of 30 minutes or so and lead discussion. The leader is expected to prepare several questions for that particular set of the articles in one week before the actual discussion. These questions should be posted on the canvas site momentarily with the help of the instructor. Along with a leader (who actually reviews the articles), at least one "discussant" will be assigned to each set of the articles. Every student will need to address the review questions when reading through the articles, and the assigned "discussant" should play a critical role in the discussion. The leader should prepare some slides to initiate the discussion and summarize the major findings resulting from the classroom discussion. The summary report is due one week after the discussion. Each discussion session could last up to 30 minutes depending upon the topic. All students are expected to participate in the discussion.

Research Project

To be discussed in a separate document.

Course Materials

Required Textbook: Jensen, J.R. 2016. *Introductory Digital Image Processing: A Remote Sensing Perspective* (4th). Upper Saddle River, N.J.: Prentice Hall. This book is required and is available at the campus bookstore. ***You should bring this book for all lecture hours.***

Other Textbooks:

- Berlin, G. L.L. and Avery, T.E. 2003. *Fundamentals of Remote Sensing and Airphoto Interpretation* (6th). Upper Saddle River, N.J.: Prentice Hall. 540p.
- Campbell, J.B. and Wynne, R. H. 2011. *Introduction to Remote Sensing* (5th). New York: Guilford Publications. 666p.
- Elachi, C. and van Zyl, J. 2006. *Introduction to the Physics and Techniques of Remote Sensing* (2nd). John Wiley. 552p.
- Gibson, P. and Power, C. 2000. *Introductory Remote Sensing: Digital Image Processing & Applications*. Routledge Chapman & Hall. 288 p.
- Hopkins, M. 2018. *Introduction to Remote Sensing*. Syrawood Publishing House. 231p.
- Jensen, J. 2007. *Remote Sensing of the Environment: An Earth Resource Perspective (2nd)*. Upper Saddle River, N.J.: Prentice Hall. 592p.
- Jones, H. G. and Vaughan, R. A. 2011. *Remote Sensing of Vegetation: Principles, Techniques, and Applications*. Oxford University Press. 384p.
- Landgrebe, D. A. 2003. *Signal Theory Methods in Multispectral Remote Sensing*. New Jersey: Wiley-Interscience. 508p.
- Liang, S. 2004. *Quantitative Remote Sensing of Land Surfaces*. New Jersey: Wiley-Interscience. 534p.
- Liang, S., Li, X., and Wang, J. (eds). 2012. *Advanced Remote Sensing: Terrestrial Information Extraction and Applications*. Amsterdam: Academic Press. 800 p.
- Lillesand, T.M., Kiefer, R. W. and Chipman, J.W. 2015. *Remote Sensing and Image Interpretation* (7th). New York: Wiley. 768p.
- Lo, C. P. 1986. *Applied Remote Sensing*. New York: Longman. 393 p.
- Mather, P.M.2004. *Computer Processing of Remotely-Sensed Images* (3rd). Chichester: Wiley. 324 p.
- Paine, D. P. and Kiser, J.D. 2012. *Aerial Photography and Image Interpretation* (3rd). New Jersey: Wiley. 648p.
- Richards, J.A. and Jia, X. 2013. *Remote Sensing Digital Image Analysis* (5th). Berlin: Springer. 512p.
- Sabins, F.F. and Ellis, J. M. 2020. *Remote Sensing: Principles, Interpretation, and Applications* (4th). Waveland Pr. Inc. 524p.
- Schowengerdt, R. A. 2006. *Remote Sensing: Models and Methods for Image Processing* (3rd). London:

Academic Press. 560p.
- Weng, Q. 2012. *An Introduction to Contemporary Remote Sensing*. McGraw-Hill Professional. 320 p.
- Yang, X. (ed) 2009. *Remote Sensing and Geospatial Technologies for Coastal Ecosystem Assessment and Management.* Springer, 561p.
- Yang, X. (ed) 2011. *Urban Remote Sensing: Monitoring, Synthesis and Modeling in the Urban Environment (1st edn.)*. John Wiley. 408p.

Remote Sensing Journals

- Photogrammetric Engineering and Remote Sensing (ASPRS)
- International Journal of Remote Sensing (Taylor & Francis)
- Remote Sensing of Environment (Elsevier)
- GIScience and Remote Sensing
- ISPRS Journal of Photogrammetry and Remote Sensing
- IEEE Transactions of Geosciences and Remote Sensing
- IEEE Geoscience and Remote Sensing Letters
- Remote Sensing Letters (Taylor & Francis)
- International Journal of Applied Earth Observation and Geoinformation
- Canadian Journal of Remote Sensing (CRSS)
- GeoCarto International
- International Journal of Digital Earth
- Remote Sensing (An open access journal)

Academic Honor Policy

The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to ". . . be honest and truthful and . . . [to] strive for personal and institutional integrity at Florida State University."   (Florida State University Academic Honor Policy, found at http://fda.fsu.edu/academic-resources/academic-integrity-and-grievances/academic-honor-policy)

PLAGIARISM: All submitted assignments must be your own original, independent work. All sources must be properly cited (especially in the graduate student paper). Ask the instructor if you are unsure what to do. Plagiarism will result in significant grade reduction.

Academic Success

Your academic success is a top priority for Florida State University. University resources to help you succeed include tutoring centers, computer labs, counseling and health services, and services for designated groups, such as veterans and students with disabilities. The following information is not exhaustive, so please check with your advisor or the Dean of Students office to learn more.

Americans with Disabilities Act

Florida State University values diversity and inclusion; we are committed to a climate of mutual respect and full participation. Our goal is to create learning environments that are usable, equitable, inclusive, and welcoming. FSU is committed to providing reasonable accommodations for all persons with disabilities in a manner that is consistent with academic standards of the course while empowering the student to meet integral requirements of the course.

To receive academic accommodations, a student: (1) must register with and provide documentation to the Office of Accessibility Services (OAS); (2) must provide a letter from OAS to the instructor indicating the need for accommodation and what type; and (3) should communicate with the instructor, as needed, to discuss recommended accommodations. A request for a meeting may be initiated by the student or the

instructor. This should be done during the first week of class.

Please note that instructors are not allowed to provide classroom accommodations to a student until appropriate verification from the Office of Accessibility Services has been provided.

This syllabus and other class materials are available in alternative format upon request. For more information about services available to FSU students with disabilities, contact the

Office of Accessibility Services
874 Traditions Way
108 Student Services Building
Florida State University
Tallahassee, FL 32306-4167
850- 644-9566 (voice)
850-644-8504 (TDD)
oas@fsu.edu
https://dsst.fsu.edu/oas

Confidential campus resources

Various centers and programs are available to assist students with navigating stressors that might impact academic success. These include the following:

Victim Advocate Program
University Center A, Rm. 4100
(850) 644-7161
Available 24/7/365
Office Hours: M-F 8-5
https://dsst.fsu.edu/vap

Counseling and Psychological
Services
Askew Student Life Center, 2nd
floor
942 Learning Way
(850) 644-8255
https://counseling.fsu.edu/

University Health Services
Health and Wellness Center
(850) 644-6230
https://uhs.fsu.edu/

Free Tutoring from FSU

On-campus tutoring and writing assistance is available for many courses at Florida State University. For more information, visit the Academic Center for Excellence (ACE) Tutoring Services' comprehensive list of on-campus tutoring options - see http://ace.fsu.edu/tutoring or contact tutor@fsu.edu. High-quality tutoring is available by appointment and on a walk-in basis. These services are offered by tutors trained to encourage the highest level of individual academic success while upholding personal academic integrity.

Syllabus Change Policy

Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advance notice. The instructor reserves the right to change the content of the syllabus or course material during the course of the semester. Any changes will be posted in the announcement section on Canvas or be notified through emails. Students

should check announcements and your FSU email account timely.

Statement On Public Health Protocols (Approved by FSU Faculty Senate in Fall 2021)

In our classroom, I will expect everyone to wear a proper, well-fitting mask. As our President has informed the university community, FSU expects everyone on campus to use face-coverings. In regions where virus rates are high, the CDC recommends that even vaccinated individuals wear masks in public indoor spaces, like classrooms, especially where social distancing is not possible. Florida infection and hospitalization rates are greater now than they were at the height of the 2020 surge due to the Delta variant, a more infectious and easily transmissible version of the COVID-19 virus. The best way to protect against serious illness is to be fully vaccinated, but not everyone among us can be. Because the Delta variant can infect even vaccinated individuals and can be spread by them to others, it poses a special threat to members of the community with underlying health conditions and children at home who are too young for vaccination.

For these reasons, FSU expects each member of the community to comply with the public health protocols our President set forth on August 9, 2020, including *(1) wearing masks in public indoor spaces, (2) getting fully vaccinated, (3) being tested for the virus if you have symptoms, and (4) staying home and away from others if you are sick.* Please remember that you should NOT attend class in person if you have tested positive for COVID-19 or are quarantining after exposure. Finally, please bear in mind that the COVID-19 situation is fast moving and that university guidance on the issue may change at any time.

Statement for Classes Subject to HB233 Recording (Approved by FSU Faculty Senate in Fall 2021)

In this class, consistent with state law and university policy, students are permitted to make recordings of class lectures for personal use only. As noted, sharing, posting, or publishing classroom recordings may subject you to honor code violations and legal penalties associated with theft of intellectual property and violations of other state law. Moreover, students and educators have expressed concern that recording classroom activities may negatively impact the learning experience for others, especially in classes that involve questions, discussion, or participation. *To protect a learning environment in which everyone feels free to experiment with ideas, we ask you refrain from recording in ways that could make others feel reluctant to ask questions, explore new ideas, or otherwise participate in class.* Students must monitor their recording so that they do not include participation by other students without permission. Students with disabilities will continue to have appropriate accommodations for recordings as established by the Office of Accessibility Services.

Spring 2022 Tentative Schedule*

Weeks	Date	Lectures	Class/Lab Assignment	Readings	Others
1	1/10	Introducing the course	N/A	Ch. 1	COSS GIS Staff/ERDAS Imagine License
2	1/17	**Martin Luther King Jr. Day (No Class)**			
3	1/24	Remote sensing principles	Lab design and software packages	Ch. 1	Literature review guidelines
4	1/31	Remote sensor data acquisition (including drones for remote sensing & Remote sensing data search and download)	Class assignments: Introducing Google Earth Engine/Search for remote sensor data	Ch. 2 & additional readings	Project guidelines Article selection & pdf copy
5	2/07	Digital image processing systems (including cloud computing systems)/Image display & visualization	Lab 1: Data formats, contrast stretching, and density slicing	Ch. 3, 4 & 5/others	Review questions (first group)
6	2/14	Image preprocessing: geometric & radiometric corrections	Lab 2: Radiometric correction	Ch. 5&6	Review I
7	2/21	Image enhancement I	Lab 3: Geometric correction	Ch. 8	Review II Proposal due
8	2/28	Image enhancement II	Lab 4: Image enhancement		Review III Proposal discussion
9	3/07	Pattern recognition I: Supervised and unsupervised classification	Lab 5: Image classification	Ch. 9	Review IV
10	3/14	**Spring break (Enjoy!)**			
11	3/21	Pattern recognition II: Artificial intelligence and deep learning	Lab 5 (cont.)	Ch. 10 Supplement readings	Review V
12	3/28	**Open-book exam (Writing assignment)**			
13	4/04	Accuracy assessment Change detection	Lab 6: Change detection and spatial modeling	Ch.12/13	Review VI
14	4/11	Hyperspectral remote sensing Lidar remote sensing		Ch. 11/Others	Review VII
15	4/18	**Research presentations/**Teaching evaluation (online)			
16	4/25	**Project reports** (Midnight)			

This is tentative by nature, and you should pay attention on my announcements during class meetings or through the CANVAS system.