Syllabus: Digital Image Processing in the Geosciences
GEOG 461
Spring 2025
Department of Geography
Texas A&M University

Time: TR 12:45 pm-02:00 pm
Room: OMB 103 (sect. 500, 502, 503)
Prerequisite: GEOG 361 or equivalent and junior or senior classification
Credit Hours: 4

Instructor: Dr. Anthony M. Filippi, Associate Professor, 3147 TAMU, Department of Geography, Texas A&M University
Office: OMB 707B (Eller O&M Bldg.)
Office Hours: T 3:00-4:00 pm; R 3:00-5:00 pm; and by appointment
Phone: (979) 845-5744
Fax: (979) 862-4487
Email: filippi@tamu.edu

Teaching Assistant/Lab Instructor:
Dan Liu (sect. 500, 502, 503)
Office: OMB 704 (Eller O&M Bldg.)
Office Hours: M 2:00-3:00 pm; W 2:00-3:00 pm; and by appointment
Phone: N/A
Email: dliu@tamu.edu

Laboratory Schedule:

Time (Section 500): W 03:00 pm-04:50 pm; **Lab Room:** CSA 311
Time (Section 502): M 03:00 pm-04:50 pm; **Lab Room:** CSA 311
Time (Section 503): T 09:35 am-11:25 am; **Lab Room:** CSA 311

Location: Department of Geography GIS Laboratories (CSA 307 and CSA 311)

Course Description

Catalog Description: "Key remote-sensing digital image processing methods; advanced topics in feature extraction, radiometric calibration, image enhancement, pattern recognition and geoscience applications.
Prerequisite: GEOG 361 or equivalent and junior or senior classification."

This course emphasizes coverage of remote-sensing digital image processing (DIP) methods/algorithms, with Earth science applications. Students will become proficient in using a state-of-the-art remote-sensing digital image processing software package. The nature and physics of the interaction of electromagnetic radiation (EMR) with various Earth surface materials and the intervening atmosphere will be discussed, as will remote-sensor systems for Earth-observation.

Learning Objectives

The material covered in this course is aligned with learning objectives in the Geographic Information Science & Technology Body of Knowledge, which was produced by the University Consortium for Geographic Information Science (UCGIS) and published by the American Association of Geographers (AAG).

The primary learning objectives of this course are as follows:

--Articulate the fundamental knowledge base of how electromagnetic radiation (EMR) interacts with various Earth surface materials and the intervening atmosphere, and how these EMR interactions facilitate or hinder Earth remote sensing;

--Understand and apply a range of remote-sensing digital image processing (DIP) methods/algorithms;

--Analyze/determine when (under which circumstances) it is appropriate to use/apply a given digital image-processing procedure;

--Create information products derived from remote-sensing image data; and

--Understand how to qualitatively and quantitatively evaluate the quality and accuracy of remote sensing-derived data and/or information products.

Required Text:

Jensen, J. R., 2016, *Introductory Digital Image Processing: A Remote Sensing Perspective*, 4th Ed., Glenview, IL: Pearson Education, Inc., 623 pp., ISBN-10: 0-1340-5816-X, ISBN-13: 978-0-134-05816-0.

Recommended Readings (Optional):

Remote Sensing Classroom: Earth Resources Observation and Science (EROS) Center https://eros.usgs.gov/remote-sensing-classroom

Fundamentals of Remote Sensing: NASA ARSET https://appliedsciences.nasa.gov/sites/default/files/2022-11/Fundamentals_of_RS_Edited_SC.pdf

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Grading Policy

This course includes both lecture and laboratory components. The lecture material complements the course readings. Grades are assigned based on student performance on two (2) exams and assigned laboratory exercises. Examinations will be based on the material from the lectures, the textbook and other readings, and the laboratory exercises. Make-up exams will only be available for University excused absences. Excused absences are covered in the Texas A&M University Student Rules (http://student-rules.tamu.edu), Section 7.1. If you know *a priori* (i.e., ahead of time) that you will be unable to take an exam on the scheduled date, consult the instructor prior to the exam to make alternative arrangements. An unexcused absence from an exam will yield a score of zero for that exam. Further information regarding the laboratory exercises is given below. The weights for the grading schedule are as follows:

1) Midterm Exam:	30%
2) Final Exam:	30%
3) Laboratory Exercises:	40% of total grade for the course

Grades will be assigned according to following scale:

A (≥90%); B (80-89%); C (70-79%); D (60-69%); and F (<60%)

Laboratory Sections

Students will receive a separate syllabus for the laboratory section of the course. For the laboratory sections, students will meet and work on assigned laboratory exercises in the Dept. of Geography GIS Labs, located in **CSA 307 and CSA 311.** The tentative list and schedule of laboratory assignments for the semester is given below. The laboratory exercises are intended to introduce fundamental and advanced remote-sensing digital image processing methods/algorithms, designed to reinforce the lecture material. The functionality of the ENVI® (The Environment for Visualizing Images®) remote-sensing

digital image processing software package will be emphasized in lab. ENVI® software (https://www.nv5geospatialsoftware.com/Products/ENVI) is available on all computers in the Dept. of Geography GIS lab rooms (CSA 307 and CSA 311). The teaching assistant will introduce the lab exercise during the scheduled laboratory session and will be available for additional assistance during his/her office hours (and by appointment). Laboratory assignment policies will be provided by the teaching assistant in lab. Scores for late labs will be deducted 10% per day they are late.

Late Work Policy

As noted above, scores for late labs or other assignments (i.e., those deliverables submitted after the established deadline) will be deducted 10% per day they are late.

Work submitted by a student as makeup work for an excused absence is not considered late work and is exempted from the late work policy. (See Student Rule 7.)

Tentative Lecture Schedule*:

Week	Topic
01	Course Introduction; Remote Sensing and Digital Image Processing (Jensen, Chpt 1)
02	Remote Sensing and Digital Image Processing (continued); Remote-Sensing Data Collection (Jensen, Chpt 2)
03	Digital Image Processing Hardware and Software (Jensen, Chpt 3)
04	Image Quality Assessment and Statistical Evaluation (Jensen, Chpt 4)
05	Display Alternatives and Scientific Visualization (Jensen, Chpt 5)
06	Image Enhancement (Jensen, Chpt 8)
07	**Midterm Exam** and Electromagnetic Radiation Principles and Radiometric Correction (Jensen, Chpt 6)
08	Electromagnetic Radiation Principles and Radiometric Correction (continued)
09	**Spring Break (March 10-14, 2025)—No class**
10	Geometric Correction (Jensen, Chpt 7)
11	**AAG Annual Meeting (March 24-28, 2025)—No class**
12	Thematic Information Extraction: Pattern Recognition (Jensen, Chpt 9)
13	Information Extraction using Imaging Spectroscopy (Hyperspectral Remote Sensing) (Jensen, Chpt 11)
14	Change Detection (Jensen, Chpt 12)
15	Remote Sensing-Derived Thematic Map Accuracy Assessment (Jensen, Chpt 13); Review for Final Exam
16	**Final Exam**

* *This is a tentative list of topics. I reserve the right to make changes to the course schedule at any time.*

Exam Dates

Midterm Exam:	**Tuesday, February 25, 2025 (in class)**
Final Exam:	**Tuesday, May 6, 2025, 8:00 – 10:00 a.m.**

Other Important Dates

March 10-14, 2025	Spring Break (no classes)
April 18 (Friday), 2025	Reading day (no classes)
April 29 (Tuesday), 2025	Last day of spring semester classes; Redefined day, students attend their **Friday** classes.
April 30 (Wednesday), 2025	Reading day (no classes)

Tentative Laboratory Topical List*:

Week 1: First lab meeting; Introduction to Digital Image Processing (DIP) Lab Sections (no lab assignment)

Week 2: Introduction to RS Computing Environment; ENVI® Software Overview (no lab assignment) (Lab 0)

Week 3: Image Display and Fundamental Operations in ENVI® Software (Lab 1); Lab 1 reports due the week of February 10

Week 4: Data Storage Formats, Contrast Stretching, and Density Slicing (Lab 2); Lab 2 reports due the week of February 17

Week 5: Work on prior lab assignment; optional open-help session

Week 6: Band Ratioing and Image Filtering (Lab 3); Lab 3 reports due the week of March 3

Week 7: No lab meetings (week of midterm exam)

Week 8: Work on prior lab assignment; optional open-help session

Week 9: No lab meetings (week of Spring Break)

Week 10: Training Area Selection and Supervised Image Classification (Lab 4); Lab 4 reports due the week of March 31

Week 11: No lab meetings (AAG Annual Meeting)

Week 12: ISODATA Unsupervised Image Classification (Lab 5); Lab 5 reports due the week of April 7

Week 13: Endmember-based Analysis for Oil-Spill Detection in a Coastal Wetland (Lab 6); Lab 6 reports due April 29)

Week 14: Work on prior lab assignment; optional open-help session

Week 15: Work on prior lab assignment; optional open-help session

* *This is a tentative list of topics. The instructor reserves the right to make changes to the course/lab schedule at any time.*

Email and Canvas

All Texas A&M students should use their TAMU email accounts when emailing the instructor. I may also send out class announcements via the TAMU email system as well. It is your responsibility to check your TAMU email account regularly.

Canvas is the learning management system that will be used for this course, and course materials will be made available on the Canvas site for this course. Lab data will be made available on a course Google Shared Drive/Folder.

-To access Canvas, you can click-on the Canvas button near the top of the main Howdy page, after you login (via your TAMU NetID and Password) to Howdy (howdy.tamu.edu).

-Or, you can access Canvas via the TAMU web address: https://lms.tamu.edu/

Or, you can navigate to: canvas.tamu.edu

Either way, you will need to login with your TAMU NetID and Password.

Other Information

Technology Support
Regarding technology support, please note some available help resources (i.e., Canvas Help and the TAMU College of Arts & Sciences HelpDesk), where whom to contact depends on the nature of the issue encountered:

(1) If you need assistance with CANVAS, you may either call the 24×7 CANVAS helpline at +1-877-354-4821, or open a ticket from the link inside CANVAS; and

(2) If you have non-CANVAS technical questions (e.g., an issue related to your computer account, ENVI installation or performance, etc.), you should contact the TAMU College of Arts & Sciences HelpDesk (by sending an email to the address below to open a service ticket, or by calling the phone number below):

College of Arts & Sciences HelpDesk
Email: ArtSci-Help@tamu.edu
Phone: 979-862-1170 (8am - 5pm, M-F)

University Policies

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" (Student Rule 7, Section 7.4.1).

"The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" (Student Rule 7, Section 7.4.2).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

Academic Integrity Statement and Policy

"An Aggie does not lie, cheat or steal, or tolerate those who do."

"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" (Section 20.1.2.3, Student Rule 20).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact the Disability Resources office on your campus (resources listed below) Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Disability Resources is located in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, a person who is subjected to the alleged conduct will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University's goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns related to mental and/or physical health in a confidential setting are encouraged to make an appointment with University Health Services or download the TELUS Health Student Support app for 24/7 access to professional counseling in multiple languages. Walk-in services for urgent, non-emergency needs are available during normal business hours at University Health Services locations; call 979.458.4584 for details.

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's Title IX webpage.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors influencing a student's academic success and overall wellbeing. Students are encouraged to engage in healthy self-care practices by utilizing the resources and services available through University Health Services. Students needing a listening ear can call the Texas A&M Helpline (979.845.2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends for mental health peer support while classes are in session. The TELUS Health Student Support app provides access to professional counseling in multiple languages anytime, anywhere by phone or chat, and the 988 Suicide & Crisis Lifeline offers 24-hour emergency support at 988 or 988lifeline.org.

Students needing a listening ear can contact University Health Services (979.458.4584) or call the Texas A&M Helpline (979.845.2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends while classes are in session. 24-hour emergency help is also available through the 988 Suicide & Crisis Lifeline (988) or at 988lifeline.org.