BE 485/585

Remote Sensing Data and Methods

Lecture: MW: 10:00 –10:50AM
Lab F: 10:00 –10:50AM
(Shantz 338)

Description of Course

Remote Sensing Data and Methods is a course designed to provide an in depth overview of practical topics about land remote sensing with big spatial data, data discovery, data characterization, science algorithms, **advanced analysis and visualization techniques and an intro to machine learning with python**, and much more. Students will learn about a variety of global to regional remote sensing data records and time series, learn about the various sensors/platforms collecting these data, learn how to interpret and analyze these data **using Python** and other image analysis techniques.

The course is aimed at all students of environmental sciences, natural resources & management, and engineering students interested in big spatial data and data analytic with focus on Earth science data algorithms.

Upon completing this course, the student will become well versed in a variety of remote sensing big data, time series analysis methods, the underlying science algorithms and general image analysis.

Any prior courses in Remote Sensing, Image Processing, Geographic Information Systems, Geospatial Analysis, Geostatistics, or general statistics will be helpful.

Course Prerequisites or Co-requisites

Any courses in Remote Sensing, Image Processing, Geographic Information Systems, Geospatial Analysis, Geostatistics, or general statistics are strongly advised. Nevertheless, highly motivated students from allied disciplines and without this formal background will perform well in the course if they invest time in understanding and exploring the more advanced and unfamiliar topics.

If the student is still not sure, please check with the Instructor or the BE academic advisor before registering.

Instructor and Contact Information

Kamel Didan, Ph.D.
Associate Professor, Biosystems Engineering
Office: Shantz Building, Room 501A and Forbes Room 134
Phone: 520-621-8514, didan@email.arizona.edu, https://vip.arizona.edu
Office Hours: Open door policy but prior arrangement is strongly advised
Web: https://vip.arizona.edu/VIP_Teaching.php

Course Format and Teaching Methods

The course follows a traditional quasi-interactive lecture format, with some live computer

activities and exercises. Topics are presented using power point slides (available on D2L), the white board, and explored live. Students will be encouraged to interact, work in groups, and practice the presented concepts during the weekly lab session.

The course will revisit many basic concepts about remote sensing, but prior acquaintance with remote sensing data, GIS, python or other programming and general data analysis. will help while not necessary to succeed in the course.

- No Fees
- Offered only in the SPRING

Course Objectives and Expected Learning Outcomes

Course Objectives

This course will provide the students with an opportunity to develop practical experience and real world skills for the understanding, acquisition, and manipulation of remote sensing data in the context of global to regional natural and managed ecosystems monitoring, change detection, fundamental research and application.

Course Learning Outcomes

Upon completing the course, students will be able to:

1) **Define** and **explain** the concepts of remote sensing systems, data records and generating Algorithms,
2) **Recognize**, **describe**, and **review** the historical, current, and future National and International Earth observing systems,
3) **Discover**, **identify,** and **distinguish** the various Data Active Archive Centers,
4) **Locate**, **assemble**, **integrate**, and **manage** remote sensing data to support research and application topics
5) **Develop** the skills to **analyze** and **synthesize** new value added data and results to answer science, application, and operational questions,
6) **Interpret, visualize,** and **verify** the results,

In addition, graduate students are expected to work on a class project to learn how to:

7) **Propose, Design,** and **Model** a research topic or question using big remote sensing and time series data, science analysis methodologies, and the learned skills.
8) **Write a report and present** science findings and results to an audience

In accordance with the Accreditation Board for Engineering and Technology (ABET) goals of preparing graduates to meet the quality standards of their profession and global workforce, the course also supports many ABET ***Program Educational Outcomes***:

- **ABET Criterion 2:** *An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors*
- **ABET Criterion 5:** *An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives*
- **ABET Criterion 7:** An ability to acquire and apply new knowledge as needed, using appropriate learning strategies
- **ABET Criterion 3:** An ability to communicate effectively with a range of audiences (graduate students' projects presentation)

Absence and Class Participation Policy

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop.

The UA policy regarding absences for any sincerely held religious belief, observance or

practice will be accommodated where reasonable, http://policy.arizona.edu/human-resources/religious-accommodation-policy.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: https://deanofstudents.arizona.edu/absences

Participating in the course and attending lectures, lab. Computer exercises and other course events are vital to the learning process. As such, attendance is required at all lectures and meetings. Students who miss class due to illness or emergency are required to bring documentation from their health-care provider or other relevant, professional third parties. Failure to submit third-party documentation will result in unexcused absences.

Unexcused and reoccurring absence will be a sufficient reason for the instructor to recommend that the student be administratively dropped from the course. You are fully responsible for all course materials, lab. work, reading assignments, and any topic covered during the class or lab. if you miss without prior arrangement.

Makeup Policy for Students Who Register Late

Given the class nature, lab. requirements, and limited space, no late registration will be entertained. However, the instructor may accept a late registration if the student shows a strong and compelling need to take the class during the ongoing semester.

Course Communications

Please use your university email account in all communications regarding this course and lab. Emails from other accounts and services will not be accepted for internet security reasons and due to the strict UA spam filters that may prevent certain emails from reaching the instructor on time or at all.

You can contact the Instructor with any questions regarding the course.

Instructor:
Dr. Kamel Didan
Email: didan@.arizona.edu
Office: Shantz 501A/Forbes 134

Required Texts or Readings

The instructor will provide readings, links, and other online or digital material, Open Access research papers, and documents.

The following books are only recommended and not required.

Remote Sensing of the Environment: An Earth Resource Perspective (2nd Edition)
By: John R. Jensen
ISBN-13: 978-0131889507
ISBN-10: 0131889508

Remote Sensing and Image Interpretation (6th edition)
By Thomas M. Lillesand
ISBN13: 978-0470052457

Available online or via library reserve system

Required or Special Materials

A personal computer (running Windows 10, iOS, or any Linux flavor) with an internet (WiFi) connection, is highly recommended for this course. The student will be learning to use Python and access a variety of data archive centers, searching and acquiring data online, using various online and offline tools throughout the semester. Computers are also available in Shantz #338 (lecture room), throughout the UA campus via OSCR labs. or the library system, but we highly suggest a personal computer. Most software tools required for the class will either be special student licensed commercial software, developed by the students, provided by the instructor, or freely available online. A large storage device is highly recommended also to store and transfer

data.

Required Extracurricular Activities

All graduate students are required to select a topic of research for a class project that may take around 20-30 hours of work. We highly encourage team/group work on these projects and expect a high level of collaboration to stimulate scientific discussions and learn to work in teams.

Bibliography

Students will be encouraged to read about ongoing research relevant to the class topics. During the class project discussions students will be exposed to recent research topics and asked to either replicate or advance the topics.

Assignments and Examinations: Schedule/Due Dates

Exams: There will be two midterm examinations and one final exam for all students. Exams will be comprehensive and will cover all topics. Exams are meant to reinforce what the students have learned and help them identify areas they may want to explore and review more. All exams are open book and students are allowed to use their computers.

In-Class live computer work*:* At the weekly lab session computer activity are designed to encourage the student to follow the course material and practice new concepts to encourage class attendance and motivate the students to explore on their own the field of remote sensing data and tools.

Homework and other activities: The instructor will post assignments and other class work on either D2L or handouts during the class with due dates usually two weeks after assignment unless noted otherwise. Homework assignments will build on learned concepts during the class and will require use of a computer, special licensed software, and other tools that will be provided by the instructor. Graduate students may have additional exercises as part of their homework assignments, ranging from reviewing relevant published manuscripts to more elaborate data analysis.

Final Examination and/or Project

The date and time of the final exam or project, along with links to the Final Exam Regulations, https://www.registrar.arizona.edu/courses/final-examination-regulations-and-information, and Final Exam Schedule, http://www.registrar.arizona.edu/schedules/finals.htm

A class project will be assigned to all graduate students. There will be class sessions devoted to discussing and helping the students pick the proper class project. Students are highly encouraged to explore some real world challenges and questions and possibly their ongoing research.

A final comprehensive (closed or open book) exam will be given to all students.

- The instructor will confirm and agree on the exact date

Grading Scale and Policies

Your final grade will be based on:

	Graduate students	Undergraduate students
Activity		
Homework	25%	35%
Midterm exams	25%	40%
Project	25%	N/A
Final Exam	25%	25%
Total	100%	100%

Final letter grades for the course are computed as:

Score	Grade
90-100	A
80-89	B
70-79	C
60-69	D
<60	E

Depending on the overall class performance, the scores for the different final letter grades may be curved.

A make-up exam may be scheduled only when a student has a strong valid excuse. The valid excuses for missing an examination are serious personal illness, or serious illness or death in your family, and pre-approved leave of absence signed by the UA Dean of Students (or Dean Designee) to attend a professional event. If you determine that you will be unable to attend an examination, inform the instructor. If you miss any of the exams without a valid excuse or documentation, you will be assigned a score of zero for the exam(s) missed.

Makeup Policy for Students Who Register Late

Any student, who register in the class late, but within the first two weeks, will be allowed and will have a chance to make up any missed assignments or class work, however, this need to be discussed and approved by the instructor first.

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

Dispute of Grade Policy

Work will only be re-graded when there is clear evidence of grading error. A student can dispute his/her grade within a week if he/she believes there was an error.

In general, and during the lecture/lab. your ideas, comments, suggestions, questions, are all welcome. Your discretion in these matters is expected however. No part of your grade will be based on anything other than your coursework, exams, and lab work.

You are encouraged to take advantage of instructor office hours for help with anything related to the course and your progress.

Suggestions for success

For most students with basic math, science, and engineering knowledge and who are interested and motivated, this will be a moderately "difficult" course. The key to succeeding in this course is to keep up and explore on your own outside the class. There are lots of online material, videos, tutorials, etc.

Our research lab. will always be open and all class students are welcome to come spend additional time, explore, or catchup with work, provided proper arrangements are made so as not to interfere with other work.

My suggestions for anyone who wishes to enjoy and succeed in this course is to think of the potential skills you will gain while having fun experimenting with data science, image analysis, and more. Grades are also important, but do not let the grade only interfere with your learning experience. This course is designed to provide you with skill that will prepare you for your career and sets you apart from others. If you are organized, work hard, and show interest you will succeed in the class. Your instructor wants you to learn, enjoy the course, and succeed and will address all your questions.

Honors Credit

This course will not be offered for Honors Credit.

Absence and Class Participation Policy

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop.

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, http://policy.arizona.edu/human-resources/religious-accommodation-policy.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: https://deanofstudents.arizona.edu/absences

Participating in the course and attending lectures and computer exercises and other course events are vital to the learning process. As such, attendance is required at all lectures and meetings. Students who miss class due to illness or emergency are required to bring documentation from their health-care provider or other relevant, professional third parties. Failure to submit third-party documentation will result in unexcused absences.

Unexcused and reoccurring absence will be a sufficient reason for the instructor to recommend that the student be administratively dropped from the course. You are responsible for all course materials, computer work, reading assignments, and any topic covered during the class if you miss without prior arrangement.

Scheduled Topics/Activities – Spring Semester

BE 485/585 Remote Sensing Data and Methods

Things will likely change

Week	Topic	Special notes
Week 1	First day of classes Introduction to the course, format, and expectations	First session devoted to discussing expectation, establishing class rules, format, and miscellaneous
	No class	No Lab.
	MLK Day	No classes
Week-2	Why Remote Sensing Introduction to remote sensing and systems	
Lab - Day	Lab 1: Intro to Python	First session will introduce python with few data manipulation, images, and plotting exercises.
Week-2	Active Remote Sensing Platforms and Characteristics Solar Radiation Radiation laws	
Lab - Day	Lab 2: Intro to Data manipulation with python	Continue with Python
Week -3	Spectral, Spatial, Temporal, and Radiometric characteristics	
Lab - Day	Lab. 3	
Week-4	Remote Systems and Earth resources Perspectives	
Lab - Day	Lab. 4	
Week-5	Electromagnetic Spectrum and Interactions with Atmosphere	
Lab - Day	Lab. 5	
Week - 6	Data Storage, Format and geometric considerations	
Exam Day	Midterm 1	
Week -7	Data processing levels	
Lab - Day	Lab 6	
	Spring Break	
Week -8	Current RS Land surface imaging missions and characteristics. Calibration and post-processing	
Lab - Day	Lab 7	
Week -9	Spectral reflectance and Atmosphere correction	
Lab - Day	Lab. 8	
Week -10	Image rectification, Geo-referencing, and transformation	
Exam Day	Midterm 2	
Week - 11	Image registration and	

	enhancements	
Lab - Day	Lab 9	
Week - 12	Evaluate progress of class projects	Optional for Undergrads
	Image projection and geometric transformation	
Lab - Day	Lab 10	
Week -13	Resampling, Enhancement Convolution and Filtering Spectral Signatures	
Lab - Day	Lab 11	
Week -14	Land Products Vegetation indices Compositing Phenology Hyperspectral and Lidar	
Lab - Day	Lab 12	
Week 15	Drone data and precision observations	
	Class Project - Presentations	Students/Teams will have 15 minutes to present their work to the class
Finals Week	**Final Exam**	**We will discuss and agree on the final exam terms**

Bibliography

Students will be encouraged to experiment on their own and directed towards additional online and free resources.

Classroom Behavior Policy

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Students are asked to refrain from disruptive conversations with people sitting around them during lecture. Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave lecture or discussion and may be reported to the Dean of Students.

While Laptops are part of the course work, students are not allowed to use them for activities other than what is assigned or required. Students are not permitted to use other mobile devices during the class period, especially mobile phones, unless instructed to do so or part of the class or lab. activity.

Threatening Behavior Policy

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

Accessibility and Accommodations

Our goal in this classroom is that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center (520-621-3268) to establish reasonable accommodations. For additional information on the Disability Resource Center and reasonable accommodations, please visit http://drc.arizona.edu.

If you have reasonable accommodations, please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Code of Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.

The University Libraries have some excellent tips for avoiding plagiarism, available at http://new.library.arizona.edu/research/citing/plagiarism.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

UA Nondiscrimination and Anti-harassment Policy

The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Additional Resources for Students

UA Academic policies and procedures are available at http://catalog.arizona.edu/policies

Student Assistance and Advocacy information is available at http://deanofstudents.arizona.edu/student-assistance/students/student-assistance

Confidentiality of Student Records

http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa

Subject to Change Statement

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor. Lab.