The University of Texas at El Paso
College of Engineering
Department of Electrical and Computer Engineering
Syllabus

EE 5373/4395 Introduction to Remote Sensing Systems (Spring 2023)

Credit Hours: 3
MW 1:30 to 2:50 pm
Room CRBL C302

Prerequisite Topics

Computer Programming, Probabilities, Signals and Systems, Linear Algebra, Vector Calculus.

Course Description:

Introduction to imaging principles and system performance parameters for optical systems used in multi/hyperspectral remote sensing. Study and evaluation of existing and proposed ground-based, airborne, and satellite remote sensing platforms. Introduction to the end-to-end information processing chain including algorithms, methodologies and tools for information extraction and management in multi/hyperspectral remote sensing. Discussion of research trends in the area.

Instructor:

Dr. Miguel Velez-Reyes, Profesor
Department of Electrical and Computer Engineering
Office ENGR A-327
Phone (915) 747-5470

Office Hours Tue & Fri 10:00 am-12:00 pm.
E-mail: mvelezreyes@utep.edu

Teaching Assistant

TBD

Learning Outcomes:

After completion of this course, students should be able to:

- Understand the fundamentals of imaging for remote sensing applications using multispectral and hyperspectral imagers.
- Understand the parameters of the imaging system and how they affect the quality of the collected image
- Apply algorithms for atmospheric compensation, geo-referencing to remote sensing imagery
- Apply signal and image processing, and pattern recognition techniques to the analysis of remote sensing imagery.

- Use software tools such as ENVI/IDL or MATLAB for the analysis of remote sensing imagery

Required Materials:

Textbooks (free access)

1. J.A. Richards, **Remote Sensing Digital Image Analysis: An Introduction,** 6th Edition, Springer Verlag, 2022.
   Available free from UTEP Library Electronic Resources (Inside UTEP or using VPM from home) : https://link.springer.com/book/10.1007/978-3-030-82327-6
2. J.A. Cardille, N. Clinton, M.A. Crowley, and D. Saah, editors, **Cloud-Based Remote Sensing with Google Earth Engine: Fundamentals and Applications**, 2022. https://www.eefabook.org/
3. R.A. Schowengerdt, **Remote Sensing: Models and Methods for Image Processing**, 3rd Edition, Elsevier, 2007.
   Available free from UTEP Library Electronic Resources (Inside UTEP or using VPM from home) : https://ebookcentral.proquest.com/lib/utep/detail.action?docID=294338

References

(*Electronic books available from UTEP Library may need to use UTEP VPN)

1. E. Chuvieco, **Fundamentals of Satellite Remote Sensing: An Environmental Approach**, 3rd Edition, CRC Press, 2020.
2. *J.R. Schott, **Remote Sensing: The Image Chain Approach**, 2nd edition, Oxford University Press, 2007
3. *D.A. Landgrebe, **Signal Theory Methods in Multispectral Remote Sensing**, John Wiley & Sons, 2003.
   https://onlinelibrary.wiley.com/ (UTEP A-Z Databases (utep.edu))
   https://onlinelibrary.wiley.com/doi/book/10.1002/0471723800
4. *M. Eismann, **Hyperspectral Remote Sensing**, SPIE Press Monograph, Vol PM210, 2012.
5. *G. Camps-Valls, D. Tulia, L. Gomez-Chova, S. Jimenez, and J. Malo, **Remote Sensing Image Processing**, Morgan & Claypool Publishers, 2011.
6. *L. Alparone, B. Aiazzi, S. Baronti, A. Garzelli, **Remote Sensing Image Fusion**, CRC Press, 2015.
7. *C. Pohl, and J. van Genderen, **Remote Sensing Image Fusion**, CRC Press, 2017.
8. *M.J. Canty, **Image Analysis, Classification and Change Detection in Remote Sensing: with Algorithms for ENVI/IDL and Python**, 3rd Edition, CRC Press, 2014.
9. *S. Liang, editor, **Comprehensive Remote Sensing**, Elsevier, 2018.
10. *S. Liang and J. Wang, editors. **Advanced Remote Sensing: Terrestrial Information Extraction and Applications,** Academic Press, 2019.
11. D.G. Manolakis, R.B. Lockwood, and T.W. Cooley, **Hyperspectral Imaging Remote Sensing: Physics, Sensors, and Algorithms**, Cambridge Press, 2016.

12. U. Braga-Neto, and E.R. Dougherty. **Error estimation for Pattern Recognition,** John Wiley & Sons, 2015.
13. J.R. Jensen, **Introductory Digital Image Processing: A Remote Sensing Perspective**, 4th Edition, Prentice Hall, 2015
14. C. Elachi, **Introduction to the Physics and Techniques of Remote Sensing**, 2nd edition, Wiley, 2006.
15. S. Liang, **Quantitative Remote Sensing of Land Surfaces**, John Wiley & Sons, 2004.
16. H.G. Jones and R.A. Vaughan, **Remote Sensing of Vegetation: Principles, Techniques, and Applications**, Oxford University Press, 2010.

Sample Online Resources

1. Electronic access to multiple remote sensing journals is available online from the UTEP Library.
2. SEOS Project, **Introduction to Remote Sensing**, https://seos-project.eu/remotesensing/remotesensing-c00-p01.html
3. **Landsat Science**. Available from: http://landsat.gsfc.nasa.gov/
4. Landsat 8 (L8) Data Users Handbook. Available from: https://www.usgs.gov/land-resources/nli/landsat/landsat-8-data-users-handbook
5. **The Earth Observations Handbook**. http://www.eohandbook.com/
6. **Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space**, Committee on Earth Science and Applications from Space: A Community Assessment and Strategy for the Future, The National Academies Press, 2018. https://www.nationalacademies.org/our-work/decadal-survey-for-earth-science-and-applications-from-space
7. **Journal of Hyperspectral Remote Sensing**, https://doaj.org/toc/2237-2202
8. **Remote Sensing — Open Access Journal**, http://www.mdpi.com/journal/remotesensing
9. **IEEE Geoscience and Remote Sensing Society**, http://www.grss-ieee.org/
10. **IEEE Geoscience and Remote Sensing Society YouTube Channel** https://www.youtube.com/@IEEEGRSS
11. **AmericaView** https://americaview.org/
12. **Earth Data Science** https://www.earthdatascience.org/

Software Tools

1. ENVI Tutorials. Available from: http://www.harrisgeospatial.com/docs/Tutorials.html
2. **MultiSpec: A Freeware Multispectral Image Data Analysis System** https://engineering.purdue.edu/~biehl/MultiSpec/ https://github.com/larrybiehl/MultiSpec
3. **Python for Remote Sensing:** Available from: http://blog.rtwilson.com/resources-for-learning-python-for-remote-sensing-or-switching-from-idl/

4. **The Remote Sensing and GIS Software Library (RSGISLib)**, http://www.rsgislib.org/
5. **ArcGIS Tutorials:** https://www.youtube.com/playlist?list=PLVFxXUWb3cXXoDNCMjilFngPOZPyrVWg8
6. **Google Earth Engine Tutorials:** https://developers.google.com/earth-engine/tutorials/tutorials
7. **Modern remote sensing image processing with Python** https://gist.github.com/rukku/b87fd23ffe72075509d2
8. **PyGIS - Open Source Spatial Programming & Remote Sensing** https://pygis.io/

Computer Usage

Most homework will require the use of programs such as MATLAB, Octave, or ENVI/IDL.

- **ENVI/IDL** we are reaching out to L3Harris to get free student licenses for the course.
- **MATLAB** is available from My.Apps.UTEP.edu and can be downloaded from https://www.utep.edu/technologysupport/ServiceCatalog/SOFTWARE_PAGES/soft_matlab.html https://www.mathworks.com/academia/tah-portal/university-of-texas-at-el-paso-40735445.html
- **MATLAB tutorials** and books are available online or from from the UTEP Library.
- **ArcGIS:** Some homework may require the use of GIS software. ArcGIS is available in My.Apps.UTEP.edu more info https://www.utep.edu/technologysupport/ServiceCatalog/SOFTWARE_PAGES/soft_arcgis.html
- **GNU Octave** is an open source (free) alternative to MATLAB. Free and very similar functionality. Available from https://octave.org/

Course Delivery and Technology Requirements

Course lectures will be delivered primarily F2F. Some lectures will be pre-recorded when Dr. Velez-Reyes is on travel. You are responsible to watch them before the next F2F class meeting or as needed to complete class work.

The Blackboard learning management system will be used for course management. Ensure your UTEP e-mail account is working and that you have access to the Web and a stable web browser. Google Chrome is the recommend browser for Blackboard. Firefox also works well. Safari will work for Mac OS devices. Microsoft Edge and Microsoft Explorer are not recommended. When having technical difficulties, update your browser, clear your cache, or try switching to another browser. If that does not work reach out to UTEP helpdesk@utep.edu.

You will need to download or update the following software: Microsoft Office, Adobe Acrobat Reader, Windows Media Player, QuickTime, and Java. Check that your computer hardware and software are up-to-date and able to access all parts of the course.

Students can use and download the Office 365 apps through the Microsoft Office Portal. Microsoft Office 365 and follow the instructions.

Check the Blackboard announcements frequently for any updates, deadlines, or other important messages.

Course Policies:

Grading:

The final grade will be based in two tests (20% each), homework (25%), literature review assignment (10%) and a Project (25%). See course policy section for make-up and incomplete course policies.

Letter grade award policy:

A: [90, 100]
B: [80, 90)
C: [70, 80)
D: [60, 70)
F: [0, 60)

This is what I commit to award you. I reserve the right to curve if needed or award a higher letter grade to students whose average are in the boundary region. Awarding of a higher letter grade may be granted for students whose class average is in the boundary, if the student shows a steady improvement in course performance. This is an elective course so undergraduate students need at least a D to pass the course. Graduate students need at least a C. D is not a passing grade for a graduate courses per UTEP policy.

Attendance and Participation

Attendance in the course is required and determined by participation in the learning activities of the course. Your participation in the course is important not only for your learning and success but also to create a community of learners. Participation is determined by completion of the following activities:

- Participating in lecture sessions
- Viewing of recorded lectures when a F2F session cannot be held.
- Reading/Viewing all course materials to ensure understanding of assignment requirements
- Participating in engaging discussion with your peers but not copying your peers work and handing it as your own.
- Submission of homework, literature review assignment and project.
- Other activities as indicated

Because these activities are designed to contribute to your learning each week, they cannot be made up after their due date has passed.

Excused Absences and/or Course Drop Policy

I will not drop you from the course. However, if you feel that you are unable to complete the course successfully, I would like to meet and talk with you about it BEFORE you make

a final decision. **The deadline for the student initiated drop process in March 30, 2023.** If you do not, you are at risk of receiving an "F" in the course.

Deadlines, Late Work and Absence Policy

Assignment will be due at the time stated in the assignment handout. No late work will be accepted if the reason is not considered excusable.

Make-up Work

Make-up work will be given *only* in the case of a *documented* acceptable excuse. Note that make-up work may be in a different format than the original work, may require more intensive preparation, and may be graded with penalty points. If you miss an assignment and the reason is not considered excusable, you will receive a zero. It is therefore important to reach out to me—in advance if at all possible—and explain with proper documentation why you missed a given course requirement. Once a deadline has been established for make-up work, no further extensions or exceptions will be granted.

Alternative Means of Submitting Work in Case of Technical Issues

I strongly suggest that you submit your work with plenty of time to spare in the event that you have a technical issue with the course website, network, and/or your computer. I also suggest you save all your work in a separate document as a back-up. This way, you will have evidence that you completed the work and will not lose credit. If you are experiencing difficulties submitting your work through blackboard, please contact the UTEP Help Desk. You can email me your back-up document as a last resort.

Incomplete Grade Policy

Incomplete grades may be requested only in exceptional circumstances (described in the UTEP Catalog) after you have completed at least 75% of the course requirements. Talk to me immediately if you believe an incomplete is warranted. If granted, we will establish a contract of work to be completed with deadlines.

Accommodations Policy

If you have a disability and need classroom accommodations, please contact The Center for Accommodations and Support Services (CASS) at (915) 747-5148, or by email to cass@utep.edu , or visit their office located in UTEP Union East, Room 106. For additional information, please visit the CASS website at utep.edu/cass

COVID-19 Accommodations

Students are not permitted on campus when they have a positive COVID-19 test, exposure or symptoms. If you are not permitted on campus, you should contact me as soon as possible so we can arrange necessary and appropriate accommodations.

Students who are considered high risk according to CDC guidelines and/or those who live with individuals who are considered high risk may contact Center for Accommodations and Support Services (CASS) to discuss temporary accommodations for on-campus courses and activities.

Scholastic Integrity

Academic dishonesty is prohibited and is considered a violation of the UTEP Handbook of Operating Procedures. It includes, but is not limited to, cheating, plagiarism, and collusion. Cheating may involve copying from or providing information to another student, possessing unauthorized materials during a test, or falsifying research data on laboratory reports. Plagiarism occurs when someone intentionally or knowingly represents the words or ideas of another as ones' own. Collusion involves collaborating with another person to commit any academically dishonest act. Any act of academic dishonesty attempted by a UTEP student is unacceptable and will not be tolerated. All suspected violations of academic integrity at The University of Texas at El Paso must be reported to the Office of Student Conduct and Conflict Resolution (OSCCR) for possible disciplinary action. To learn more, please visit HOOP: Student Conduct and Discipline.

Plagiarism Detecting Software

Some of your course work and assessments may submitted to SafeAssign, a plagiarism detecting software. SafeAssign is used review assignment submissions for originality and will help you learn how to properly attribute sources rather than paraphrase.

Copyright Statement for Course Materials

All materials used in this course are protected by copyright law. The course materials are only for the use of students currently enrolled in this course and only for the purpose of this course. They may not be further disseminated.

COVID-19 Precautions

You must STAY AT HOME and REPORT if you (1) have been diagnosed with COVID-19, (2) are experiencing COVID-19 symptoms, or (3) have had recent contact with a person who has received a positive coronavirus test. If you know of anyone who should report any of these three criteria, you should encourage them to report. If the individual cannot report, you can report on their behalf by sending an email to COVIDaction@utep.edu.

Civility

We expect course business to be conducted in a civil manner. Disrespectful behavior towards the instructor or classmates is not acceptable. Any uncivil behavior in class will be subject to disciplinary actions per UTEP HOOP policy.

Additional Resources

UTEP provides a variety of student services and support:

Technology Resources

- Help Desk: Students experiencing technological challenges (email, Blackboard, software, etc.) can submit a ticket to the UTEP Helpdesk for assistance. Contact the Helpdesk via phone, email (helpdesk@utep.edu), chat, website, or in person if on campus.

Academic Resources

- UTEP Library: Access a wide range of resources including online, full-text access to thousands of journals and eBooks plus reference service and librarian assistance for enrolled students.
- University Writing Center (UWC): Submit papers here for assistance with writing style and formatting, ask a tutor for help and explore other writing resources.
- Math Tutoring Center (MaRCS): Ask a tutor for help and explore other available math resources.
- RefWorks: A bibliographic citation tool; check out the RefWorks tutorial and Fact Sheet and Quick-Start Guide.

Individual Resources

- Military Student Success Center: Assists personnel in any branch of service to reach their educational goals.
- Center for Accommodations and Support Services: Assists students with ADA-related accommodations for coursework, housing, and internships.
- Counseling and Psychological Services: Provides a variety of counseling services including individual, couples, and group sessions as well as career and disability assessments.

Tentative Topics Outline

- Introduction to remote sensing and a brief historical overview, course introduction
- Physics of remote sensing: Introduction to radiometry, Radiative transfer equation in different regions of the electromagnetic spectrum.
- Sensing systems: introduction to imaging systems, EO systems, detectors, samples of existing systems, resolution concepts.
- Geometric and Radiometric Correction and Generation of Basic Variables. Spectral transformations.
- Visual Analysis EO Satellite Images: Visual image Interpretation, Color composites
- Statistical models for multi/hyperspectral imagery. Simple visualization techniques using scatterplots and scattergrams. Noise models. Spatial statistics. Topographic and sensor effects.
- Digital Image Processing: Enhancements and Corrections, Contrast enhancement: single band, color composites. Spatial processing: Linear and nonlinear filters. Edge detection. Fourier transforms. Scale-Space representations. Image registration.
- Machine learning for Remote Sensing: Feature extraction, Image Classification, clustering, Regression problems. Model testing and validation
- Hyperspectral Image (HSI) Processing: extension of multispectral methods and dimensionality issues, unmixing, spectroscopy
- Data Fusion
- Introduction to GIS