

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

Course Prefix and Number: EE 4395/EE 5390 Special Topics

Topic Title: Introduction to Remote Sensing Systems

Credit Hours: 3

Prerequisite Courses: (EE 3384 and EE 2353 and MATH 3323) or Permission of the instructor.

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.

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:

Textbook

1. R.A. Schowengerdt, **Remote Sensing: Models and Methods for Image Processing**, 3rd Edition, Elsevier, 2007. Available from UTEP Library Electronic Resources:
<http://0-www.netlibrary.com.lib.utep.edu/urlapi.asp?action=summary&v=1&bookid=196149>

References

1. F. Tupin, J. Inglada, J.M. Nicolas, **Remote Sensing Imagery**, Wiley 2014. Available from:
http://www.utep.ebib.com/EBLWeb/patron/?target=patron&extendedid=P_1652042_0
2. J.A. Richards, **Remote Sensing Digital Image Analysis: An Introduction**, 5th Edition, Springer Verlag, 2013.
3. M. Eismann, **Hyperspectral Remote Sensing**, SPIE Press Monograph, Vol PM210, 2012.
4. J.R. Schott, **Remote Sensing: The Image Chain Approach**, 2nd edition, Oxford University Press, 2007
5. G. Camps-Valls, D. Tulia, L. Gomez-Chova, S. Jimenez, and J. Malo, **Remote Sensing Image Processing**, Morgan & Claypool Publishers, 2011.
Available from: <http://www.utep.ebib.com/patron/FullRecord.aspx?p=881290>
6. B.E. Saleh, ed., **Introduction to Subsurface Sensing and Imaging Systems**, Cambridge University Press, 2011.
7. D.A. Landgrebe, **Signal Theory Methods in Multispectral Remote Sensing**, John Wiley & Sons, 2003.
8. K. Tempfi, N. Kerle, G.C. Huurneman, and L.L.F. Janssen, **Principles of Remote Sensing**, 4th edition, ITC Educational Textbook Series, The Netherlands, 2009. Available free from http://www.itc.nl/library/papers_2009/general/PrinciplesRemoteSensing.pdf
9. J.B. Campbell, **Introduction to Remote Sensing**, 5th Edition, The Guilford Press, 2011.
10. J.R. Jensen, **Introductory Digital Image Processing: A Remote Sensing Perspective**, 4th Edition, Prentice Hall, 2015
11. M.J. Canty, **Image Analysis, Classification and Change Detection in Remote Sensing: with Algorithms for ENVI/IDL and Python**, 3rd Edition, CRC Press, 2014. Available from:

<http://0-proquest.safaribooksonline.com.lib.utep.edu/9781466570375>

12. C. Ünsalan and K.L. Boyer, **Multispectral Satellite Image Understanding: From Land Classification to Building and Road Detection**, Springer, 2011.
13. R.G. Congalton and K. Green, **Assessing the Accuracy of Remotely Sensed Data: Principles and Practices**, 2nd Edition, CRC Press, 2008.
14. G. Camps-Valls and L. Bruzzone, **Kernel Methods for Remote Sensing Data Analysis**, Wiley 2009.
15. P. Mather and B. Tso, **Classification Methods for Remotely Sensed Data**, 2nd Edition, CRC Press, 2009.
16. J. Jensen, **Remote Sensing of the Environment : An Earth Resource Perspective**, 2nd edition, Prentice Hall, 2007.
17. C.H. Chen, **Signal and Image Processing for Remote Sensing**, 2nd edition, CRC Press, 2012.
Available from: <http://www.utep.ebib.com/patron/FullRecord.aspx?p=863106>
18. C. Elachi, **Introduction to the Physics and Techniques of Remote Sensing**, 2nd edition, Wiley, 2006.
19. F.D. van der Meer and S.M. de Jong, **Remote Sensing Analysis: Including the Spatial Domain**, Springer, 2006.
20. K. Navulur, **Multispectral Image Analysis Using the Object-Oriented Paradigm**, CRC Press, 2006.
21. R.C. Olsen, **Remote Sensing from Earth and Space**, SPIE Press, 2005.
22. S. Liang, **Quantitative Remote Sensing of Land Surfaces**, John Wiley & Sons, 2004.
23. P.K. Varshney and M.K. Arora, **Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data**, Springer 2004.
24. C.I. Chang, **Hyperspectral Data Processing : Algorithm Design and Analysis**, Wiley, 2013.
Available from: <http://www.utep.ebib.com/patron/FullRecord.aspx?p=832589>
25. C.I. Chang, **Hyperspectral Imaging: Techniques for Spectral Detection and Classification**, Kluwer Academic/Plenum Publisher, 2003.
26. F.D. van der Meer and S.M. de Jong, **Imaging Spectrometry: Basic Principles and Prospective Applications**, Kluwer Academic Publishers, 2003.
27. A. Ennr, **Remote Sensing : Techniques, Applications and Technologies**, Nova Science Publishers, Inc., 2013.
Available from: <http://0-site.ebrary.com.lib.utep.edu/lib/utep/detail.action?docID=10687787>
28. Q. Weng, **Scale Issues in Remote Sensing**, Wiley 2014. Available from: <http://UTEP.ebib.com/patron/FullRecord.aspx?p=1602767>
- 29.

Online Resources

1. Electronic access to multiple remote sensing journals is available online from the UTEP Library.
2. SEOS Project, **Introduction to Remote Sensing**,
<http://www.seos-project.eu/modules/remotesensing/remotesensing-c00-p01.html>
3. Short, N., **The Remote Sensing Tutorial**, 2010. Available from
<http://rst.gsfc.nasa.gov/>
4. **ENVI Tutorials**.
<https://www.exelisvis.com/language/en-US/ProductsServices/ENVI/Tutorials.aspx>
5. **The Earth Observations Handbook**. <http://www.eohandbook.com/>
6. **A Plan For A National Land Imaging Program**.
http://www.whitehouse.gov/sites/default/files/microsites/ostp/fli_iwg_report_print_ready_low_res.pdf
7. **Earth Science and Applications from Space:National Imperatives for the Next Decade and Beyond**, Committee on Earth Science and Applications from Space: A Community Assessment and Strategy for the Future, The National Academies Press, 2007. Available from http://www.nap.edu/catalog.php?record_id=11820
8. **MATLAB Hyperspectral Image Analysis Toolbox (HIAT)**
<http://www.censsis.neu.edu/software/hyperspectral/hyperspectral.html>
9. **MultiSpec: A Freeware Multispectral Image Data Analysis System**
<https://engineering.purdue.edu/~biehl/MultiSpec/>

Software Tools

- Most homework will require the use of programs such as MATLAB or ENVI/IDL.
- ENVI/IDL student version can be purchase from
<http://www.exelisvis.com/Industries/Academic/Students/StudentLicenses.aspx>
- MATLAB is available from My.Apps.UTEP.edu.
- MATLAB tutorials and books are available from the UTEP Library.

- Some homework may require the use of GIS software. ArcGIS is available in My.Apps.UTEP.edu

Course Policies:

Grading:

The final grade will be based in two tests (50%), homework (20%), literature review (5%) and a project (25%). You need to complete and hand in all work to pass the course. An incomplete grade is given only for a valid reason when arrangements have been made with me and only if the student was passing the course. Late course work will not be accepted. No make-up work will be given.

Grading Policy:

- A: 90%-100%
- B: 80%-89.99%
- C: 70%-79.99%
- D: 60%-69.99%
- F: 0-59.99%

Classroom Etiquette:

Part of being a professional is being on time and being prepared to do your job. This applies to your career as a student as much as it does to your future career as an engineer. You are expected to be in class and prepared to participate at the scheduled start time. Wireless devices (cell phones, PDA's, MP3 players, Smart phones, etc.) are allowed in the classroom. It is recognized that devices of this sort provide emergency access for your family and loved ones. However, please use professional discretion with these devices. This includes shutting them off or setting them in the silent mode before coming to class. Do not use text messaging or web browser features while you are in class. If you must answer the phone, please do so after discretely leaving the room. You may return to class once your call is finished.

Cheating and Plagiarism:

Cheating is unethical and not acceptable. Plagiarism is using information or original wording in a paper without giving credit to the source of that information or wording: it is also not acceptable. Do not submit work under your name that you did not do yourself. You may not submit work for this class that you did for another class. If you are found to be cheating or plagiarizing, you will be subject to disciplinary action, per UTEP catalog policy.

Course Statements: (Civility, disability, military, etc.)

Center for Accommodations and Support Services (CASS):

If you have a disability and need classroom accommodations, please contact the Center for Accommodations and Support Services (CASS) at 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 www.sa.utep.edu/cass.

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 policy.

Course Schedule (Tentative):

Topic	Recommended Reading Sch. → Schowengerdt,	Lectures Best estimate & Hwk
Introduction to remote sensing and a brief historical overview,	Sch: Ch. 1	1
Physics of remote sensing: introduction to radiometry, fundamental equation in different regions of the electromagnetic spectrum	Sch: Ch. 2	2→4
Sensing systems: camera systems, EO systems, detectors, samples of existing systems, sensor resolution	Sch: Ch.3	5→6 Hwk: Simulation of loss of spatial and spectral resolution using MATLAB.
Multispectral imaging sensors: basic configurations, imaging spectroscopy	Professor Notes	7→9 Hwk: Presentation on an existing multispectral or hyperspectral imaging system
Digital image processing for remote sensing: image enhancement and color composites for visual interpretation, local and global operators, edge detection.	Sch. Ch. 4 & 5.6 & 6	10→14 Hwk 1: per pixel processing Hwk 2: spatial processing. Hwk: Journal paper analysis.
Midterm Exam		
Correction and Calibration	Sch. Ch. 7	15→17 Hwk: use of ENVI-FLAASH for atmospheric correction and georeferencing Project proposal is due
Multispectral Image (MSI) Processing: per pixel processing, classification, transformations	Sch. Ch. 5.1→5.5 & 9.1→9.8	18 → 25 Hwk: Visual analysis of MSI using RGB composites. Hwk: Classification of MSI
Hyperspectral Image (HSI) Processing: extension of multispectral methods and dimensionality issues, unmixing, spectroscopy	Sch.9.8- 9.9 Professor notes	26 →28 Hwk: HSI classification Hwk: HSI unmixing and soft classification
GIS/Research topics	Professor notes	29
Project Presentations		30
Final Exam		