

**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**

Credit Hours: 3

MW 1:30 to 2:50 pm, Fall 2020

**Prerequisite Topics**

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

Office Hours TR 10:00 am-12:00 pm. See blackboard collaborate for office hours link  
E-mail: mvelezreyes@utep.edu

**Teaching Assistant**

Ms. Pavithra Pochamreddy  
E-mail: ppochamredd@miners.utep.edu  
Office Hours: 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

1. E. Chuvieco, **Fundamentals of Satellite Remote Sensing: An Environmental Approach**, 3<sup>rd</sup> Edition, CRC Press, 2020.
2. R.A. Schowengerdt, **Remote Sensing: Models and Methods for Image Processing**, 3<sup>rd</sup> Edition, Elsevier, 2007.  
Available free from UTEP Library Electronic Resources (Inside UTEP or using VPM from home) :  
<https://www.sciencedirect.com/book/9780123694072/remote-sensing>

### References (Electronic books may require use of UTEP VPN)

1. W. Emery and A. Camps, **Introduction to Satellite Remote Sensing: Atmosphere, Ocean, Cryosphere and Land Applications**, Elsevier, 2017.  
Available free from UTEP Library Electronic Resources (Inside UTEP or using VPM from home) : <https://www.sciencedirect.com/book/9780128092545/introduction-to-satellite-remote-sensing>
2. S. Liang, editor, **Comprehensive Remote Sensing**, Elsevier, 2018.  
Available free from UTEP Library Electronic Resources (Inside UTEP or using VPM from home) :  
<https://www.sciencedirect.com/book/9780128032213/comprehensive-remote-sensing>
3. S. Liang and J. Wang, editors. **Advanced Remote Sensing: Terrestrial Information Extraction and Applications**, Academic Press, 2019.  
Available free from UTEP Library Electronic Resources (Inside UTEP or using VPM from home) :  
<https://0-ebookcentral-proquest-com.lib.utep.edu/lib/utep/detail.action?docID=965002>
4. J.A. Richards, **Remote Sensing Digital Image Analysis: An Introduction**, 5<sup>th</sup> Edition, Springer Verlag, 2013.
5. J.R. Schott, **Remote Sensing: The Image Chain Approach**, 2<sup>nd</sup> edition, Oxford University Press, 2007  
Available from: <http://0-site.ebrary.com.lib.utep.edu/lib/utep/Top?id=10212103>
6. D.A. Landgrebe, **Signal Theory Methods in Multispectral Remote Sensing**, John Wiley & Sons, 2003.
7. D.G. Manolakis, R.B. Lockwood, and T.W. Cooley, **Hyperspectral Imaging Remote Sensing: Physics, Sensors, and Algorithms**, Cambridge Press, 2016.
8. G. Camps-Valls, D. Tulia, L. Gomez-Chova, S. Jimenez, and J. Malo, **Remote Sensing Image Processing**, Morgan & Claypool Publishers, 2011.  
Available free from UTEP Library Electronic Resources (Inside UTEP or using VPM from home) :  
<https://0-ebookcentral-proquest-com.lib.utep.edu/lib/utep/detail.action?docID=881290>
9. M. Eismann, **Hyperspectral Remote Sensing**, SPIE Press Monograph, Vol PM210, 2012.
10. C. Elachi, **Introduction to the Physics and Techniques of Remote Sensing**, 2<sup>nd</sup> edition, Wiley, 2006.  
S. Liang, **Quantitative Remote Sensing of Land Surfaces**, John Wiley & Sons, 2004.

11. H.G. Jones and R.A. Vaughan, *Remote Sensing of Vegetation: Principles, Techniques, and Applications*, Oxford University Press, 2010.
12. K.C. Tan, H.S. Lim, and Mat J.M. Zubir, **Land Cover Changes and Their Relationship with Land Surface Temperature Using Remote Sensing Technique**, Penerbit USM, 2013.  
Available free from UTEP Library Electronic Resources (Inside UTEP or using VPM from home): <https://0-ebookcentral-proquest-com.lib.utep.edu/lib/utep/detail.action?docID=5338950>.
13. L. Alparone, B. Aiazzi, S. Baronti, A. Garzelli, **Remote Sensing Image Fusion**, CRC Press, 2015.
14. C. Pohl, and J. van Genderen, **Remote Sensing Image Fusion**, CRC Press, 2017.
15. U. Braga-Neto, and E.R. Dougherty. **Error estimation for Pattern Recognition**, John Wiley & Sons, 2015.
16. J.R. Jensen, *Introductory Digital Image Processing: A Remote Sensing Perspective*, 4<sup>th</sup> Edition, Prentice Hall, 2015
17. M.J. Canty, *Image Analysis, Classification and Change Detection in Remote Sensing: with Algorithms for ENVI/IDL and Python*, 3rd Edition, CRC Press, 2014.

## 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. **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](http://www.nap.edu/catalog.php?record_id=11820)
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/>

## Software Tools

1. ENVI Tutorials.
2. Available from: <http://www.harrisgeospatial.com/docs/Tutorials.html>
3. **MATLAB Hyperspectral Image Analysis Toolbox (HIAT)** <http://www.censsis.neu.edu/software/hyperspectral/hyperspectral.html>
4. **MultiSpec: A Freeware Multispectral Image Data Analysis System** <https://engineering.purdue.edu/~biehl/MultiSpec/>
5. **Python for Remote Sensing**: Available from: <http://blog.rtwilson.com/resources-for-learning-python-for-remote-sensing-or-switching-from-idl/>

6. **The Remote Sensing and GIS Software Library (RSGISLib)**, <http://www.rsgislib.org/>
7. **ArcGIS Tutorials:**  
<https://www.youtube.com/playlist?list=PLVFXUWb3cXXoDNcMjilFngPOZPyrVWg8>
8. **Google Earth Engine Tutorials:**  
<https://americaview.org/program-areas/education/google-earth-engine-tutorials/>

## Computer Usage

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

- ENVI/IDL student version can be purchase from [https://www.harrisgeospatial.com/Portals/0/pdfs/Student\\_Edition\\_DataSheet.pdf](https://www.harrisgeospatial.com/Portals/0/pdfs/Student_Edition_DataSheet.pdf)
- 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.utep.edu/technologysupport/ServiceCatalog/SOFTWARE_PAGES/soft_matlab.html)
- MATLAB tutorials and books are available online or from from the UTEP Library.
- 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](https://www.utep.edu/technologysupport/ServiceCatalog/SOFTWARE_PAGES/soft_arcgis.html)
- GNU Octave is an open source alternative to MATLAB. Free and very similar functionality. Available from <https://www.gnu.org/software/octave/>

## Course Delivery and Technology Requirements

Course lectures will be delivered primarily synchronous online using Blackboard Collaborate at the scheduled time or by pre-recorded video. There might be some F2F meetings for tests and project presentations if the COVID-19 situation allows it. We will provide accommodations to students who may not be able to participate in the synchronous lectures or the face-to-face activities.

Course content and the link for the lectures is provided via the Internet through the Blackboard learning management system. Ensure your UTEP e-mail account is working and that you have access to the Web and a stable web browser. Google Chrome and Mozilla Firefox are the best browsers for Blackboard; other browsers may cause complications. When having technical difficulties, update your browser, clear your cache, or try switching to another browser.

You will need to have access to a computer/laptop, scanner, a webcam, and a microphone. You are expected to participate in the live online sessions.

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.

If you do not have a word-processing software, you can download Word and other Microsoft Office programs (including Excel, PowerPoint, Outlook and more) for free via UTEP's Microsoft Office Portal. Click the following link for more information about [Microsoft Office 365](#) and follow the instructions.

**IMPORTANT:** If you encounter technical difficulties beyond your scope of troubleshooting, please contact the UTEP Help Desk as they are trained specifically in assisting with technological needs of students. Please do not contact me for this type of assistance. The Help Desk is much better equipped than I am to assist you!

### **Course Communication: How we will stay in contact with each other**

Because the class lectures will be online, we may not see each other in the ways you may be accustomed to: during class time, small group meetings, and office hours. However, there are a number of ways we can keep the communication channels open:

- **Office Hours:** We will not be able to meet on campus, but I will still have office hours for your questions and comments about the course. My office hours will be held on Blackboard Collaborate or Microsoft Teams and during the following times:  
Tuesdays & Thursdays: 10 am to 12:00 pm Mountain Time  
Because of my duties as department chair, I highly recommend to make an appointment via [ECEFrontDesk@utep.edu](mailto:ECEFrontDesk@utep.edu).
- **Email:** UTEP e-mail is the best way to contact me or the TA. We will make every attempt to respond to your e-mail within 24-48 hours of receipt. When e-mailing me, be sure to email from your UTEP student account and please put the course number in the subject line. In the body of your e-mail, clearly state your question. At the end of your e-mail, be sure to put your first and last name, and your university identification number.
- **Discussion Board:** If you have a question that you believe other students may also have, please post it in the Help Board of the discussion boards inside of Blackboard. Please respond to other students' questions if you have a helpful response.
- **Announcements:** 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 (40%), homework (25%), literature review assignment (10%) 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.

#### **Letter grade award policy:**

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

### **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 scheduled Blackboard Collaborate lecture sessions
- Viewing of recorded lectures in case you miss a synchronous lecture.
- Reading/Viewing all course materials to ensure understanding of assignment requirements
- Participating in engaging discussion with your peers on the discussion boards (grading rubric provided in the “grading information” area of each forum)
- 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, please let me know and then contact the [Registrar's Office](#) to initiate the drop process. **The deadline for the student initiated drop process in October 30, 2020.** If you do not, you are at risk of receiving an “F” for the course.

### **BlackBoard Collaborate Lectures**

This class requires that you participate in the scheduled Blackboard Collaborate lectures. These sessions will be held at the scheduled class time MW 1:30-2:50 pm Mountain Time.

Students are expected to, at least occasionally, participate in these sessions with a webcam and microphone. The sessions will be recorded and provided so that they can be reviewed by classmates at a later time. **Per FERPA regulations, students should not record the sessions and post them to any sites outside of Blackboard.**

If you are unable to attend a Collaborate lecture, you can look at the recorded session in blackboard.

### **Deadlines, Late Work and Absence Policy**

#### Homework Assignments

- Homework assignments will be due at the time stated in the homework handout. No late work will be accepted if the reason is not considered excusable.

#### Quiz and Blog/Discussion Assignments

- All quiz, blog, and discussion board assignments will be due on Sundays at midnight (11:59 PM). 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* emergency. 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 Word 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 the course website, 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 after you have completed at least 60% 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 747-5148, or by email to [cass@utep.edu](mailto: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](http://www.sa.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](#).

### **Class Recordings**

The use of recordings will enable you to have access to class lectures, group discussions, and so on in the event you miss a synchronous or in-person class meeting due to illness or other extenuating circumstance. Our use of such technology is governed by the Federal Educational Rights and Privacy Act (FERPA) and UTEP's acceptable-use policy. A recording of class sessions will be kept and stored by UTEP, in accordance with FERPA and UTEP policies. Your instructor will not share the recordings of your class activities outside of course participants, which include your fellow students, teaching assistants, or graduate assistants, and any guest faculty or community-based learning partners with whom we may engage during a class session. **You may not share recordings outside of this course.** Doing so may result in disciplinary action.

### **Test Proctoring Software**

We are planning to give two face-to-face exams but it may not be possible due to COVID-19 development. Online exams, assessments, and quizzes will make use of Respondus Lock Down Browser and Respondus Monitor inside of Blackboard to promote academic integrity. You are encouraged to learn more about how to use these programs prior to the first test.

Please review the following guidelines:

- The assessments will only be available at the times identified on the course calendar.
- You may take the test at any time during the allocated time window.
- A reliable Internet connection is essential to completing the assessment. If you must go to a location to take the exam (such as the library), be sure to follow their health and safety requirements.
- You have 2 attempts to take the assessment. Once the window closes, your answers will be saved, and no changes can be made. The higher score will be recorded.
- Respondus Lockdown Browser will require that all internet tabs are closed prior to the start of the test.
- Respondus Monitor requires a webcam and microphone.
- You will be required to show the webcam your student ID prior to the start of the test.
- Your face should be completely visible during the test. Blocking the camera will disable the test.
- No notes or textbook materials are permitted during the test. Respondus Monitor requires you to take a video of your surrounding area (desk, chair, walls, etc.)
- You should not have conversations with other people and/or leave and return to the area during the test.

### **Plagiarism Detecting Software**

Some of your course work and assessments may be submitted to SafeAssign, a plagiarism detecting software. SafeAssign is used to 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.

### **Required COVID-19 Training**

Before the semester starts, the ECE Department requires all its students to complete a training module, which includes a video developed in large part by students and hosted by the President of the Student Government Association. Follow the link to this module: <https://covidstraining.questionpro.com/>

### **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. Reports should be made at [screening.utep.edu](https://screening.utep.edu). 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](mailto:COVIDaction@utep.edu).

For each day that you attend campus—for any reason—you must complete the questions on the UTEP screening website ([screening.utep.edu](https://screening.utep.edu)) prior to arriving on campus. The website will verify if you are permitted to come to campus. Under no circumstances should anyone come to class when feeling ill or exhibiting any of the known COVID-19 symptoms. If you are feeling unwell, please let me know as soon as possible, and alternative instruction will be provided. Students are advised to minimize the number of encounters with others to avoid infection.

Wear face coverings when in common areas of campus or when others are present. You must wear a face covering over your nose and mouth at all times in this class. If you choose not to wear a face covering, you may not enter the classroom. If you remove your face covering, you will be asked to put it on or leave the classroom. Students who refuse to wear a face covering and follow preventive COVID-19 guidelines will be dismissed from the class and will be subject to disciplinary action according to Section 1.2.3 *Health and Safety* and Section 1.2.2.5 *Disruptions* in the UTEP Handbook of Operating Procedures.

Please note that if COVID-19 conditions deteriorate in the City of El Paso, all course and lab activities may be transitioned to remote delivery.

### **Synchronous Session 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. You are expected to be in class and prepared to participate at the scheduled start time.

When communicating you should always:

- Treat presenter with respect
- Avoid interrupting others

- Use clear and concise language
- Raise your hand and wait to be acknowledged before speaking
- If your camera is off, identify yourself before you speak

If participating in a chat room during the synchronous session:

- Avoid using the caps lock in a chat room AS IT CAN BE INTERPRETED AS YELLING
- Limit and possibly avoid the use of emoticons
- Be cautious when using humor or sarcasm as it can be sometimes lost in a chat room—your message might be taken seriously or be offensive to others
- Be careful with personal information (both yours and others')

When your microphone and/or camera is on, you should always:

- Avoid eating
- Limit drinking and be aware of the container you are using
- Be aware of your surroundings
- Dress appropriately—you never know when you may have to unexpectedly get up
- Be aware of your manners and facial expressions
- Turn on your microphone when called upon to cut down on feedback and/or interference in the call. Mute yourself when not speaking

Privacy

- You are encouraged to share your camera view but it is not required
- If you have a concern about the privacy, communicate it, and share a profile picture or avatar
- **Class sessions will be recorded**

Managing interruptions while on class

- If you need to engage with someone at your location while in class, please mute your microphone and turn off your video.
- Please return to class once you are done.

**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, 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.

**Course Schedule (Tentative):**

Topic	Recommended Reading Chu→ Chuvieco Sch. → Schowengerdt,	Assignments
Introduction to remote sensing and a brief historical overview, course introduction	Chu & Sch: Ch. 1	TBD
Physics of remote sensing: introduction to radiometry, fundamental equation in different regions of the electromagnetic spectrum	Chu & Sch: Ch. 2	TBD
Sensing systems: camera systems, EO systems, detectors, samples of existing systems, sensor resolution	Chu & Sch: Ch.3	Hwk: Presentation on an existing multispectral or hyperspectral imaging system
Analyzing EO Satellite Images	Chu: Ch. 4	TBD
Visual Interpretation	Chu: Ch 5	Hwk: Visualization of MSI/HSI.
Data Models: Statistical models for multi/hyperspectral imagery. Simple visualization techniques using scatterplots and scattergrams. Noise models. Spatial statistics. Topographic and sensor effects.	Sch: Ch.4	Feature extraction. Extraction of histograms. Determination of image partial statistics.
Digital Image Processing: Enhancements and Corrections Contrast enhancement: single band, color composites.	Chu: 6.1-6.5 Sch: 5.6	Hwk: Contrast stretching single band images. Hwk: Color image contrast enhancement.

Topic	Recommended Reading Chu→ Chuvieco Sch. → Schowengerdt,	Assignments
Geometric and Radiometric Correction and Generation of Basic Variables	Chu: 6.6-6.8 Sch. Ch. 7	TBD
Spectral transforms. Feature extractions from MSI/HSI	Chu: Ch. 7.1 Sch: Sections 5.1→5.5	TBD
Image Classification	Chu: 7.2, 8.6 Sch: Sections 9.1→9.8	Hwk: Classification of MSI
Multitemporal analysis	Chu: 7.3	Hwk: Change detection analysis
Spatial processing: Linear and nonlinear filters. Edge detection. Fourier transforms. Scale-Space representations.	Chu: 7.4 Sch: Ch. 6	Hwk: per pixel processing Hwk: spatial processing.
Validation	Chu: Ch. 8	TBD
Hyperspectral Image (HSI) Processing: extension of multispectral methods and dimensionality issues, unmixing, spectroscopy	Sch.9.8→9.9 Professor notes	Hwk: HSI classification Hwk: HSI unmixing and soft classification
Registration and Fusion	Sch. Ch. 8	Hwk: Spatial enhancement TBD
Introduction to GIS	Chu: Ch. 9	TBD