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# Image Processing For Remote Sensing

## SUR 5386 – Spring 2020

### 1. Overview

**COURSE DESCRIPTION:** This course extends remote sensing concepts and data analysis towards digital image processing topics with natural resources applications. Topics such as radiometric and atmospheric corrections, image formation, image enhancement, and classification are presented. Special emphasis is given to hyperspectral and LiDAR data collection/analysis and machine learning algorithms for image classification.

This course depends heavily on distance education tools. Should you have any complaints about your experience in this course, please visit <http://www.distance.ufl.edu/student-complaints> to submit a complaint.

**Instructor:** Dr. Amr Abd-Elrahman (Phone: 813.757.2283, Email: [aamr@ufl.edu](mailto:aamr@ufl.edu))  
**Office Location:** Plant City Education Center (Room 116B)  
**Office Hours:** Via Zoom by appointment  
**Class Hours:** Online using Zoom (recordings available) for the first two weeks only (Thurs. 3:00-5:30 pm) (recordings available)  
Recorded lectures for the rest of the semester  
**Course Website:** <https://lss.at.ufl.edu> (Canvas)

\*Zoom is a software program used to conduct virtual meetings. More details about Zoom can be found here.

### 2. Learning Outcomes:

At the end of this course, the student will be able to:

- Comprehend the basic and applied principles of remote sensing
- Investigate and select best remote sensing data sources for certain application
- Identify image distortions and apply appropriate radiometric and geometric image correction techniques.
- Evaluate image spatial and spectral transforms and their effect on image quality and data integrity
- Apply stochastic and deterministic image classification techniques including those based on machine vision algorithms
- Analyze high-dimensional remote sensing imagery (hyperspectral imagery and texture transforms)
- Identify the principles of LiDAR data collection and analysis for natural resources applications

### 3. Course Logistics

This course is entirely web-based, and students may access lectures, readings, and supporting materials as they become available each week. Weekly course material may build on previous modules, so you should complete the learning modules in the order presented. Learning material consisting of lectures, readings, discussion boards, student presentations/blogs, assignments, and exam are provided online. Please follow up on released material and assignments frequently on canvas.

### 3.1 Technology Requirements:

- A computer or mobile device with a high-speed internet connection.
- Course assignments require using the ENVI software v. 5.x and ENVI-IDL v 8.x on UFAPPS. Instructions to access UFAPPS ENVI will be released early in the semester. A headset and/or microphone and speakers; a web cam is suggested for office hours and online meetings
- Latest version of web browser. Canvas supports only the two most recent versions of any given browser. [What browser am I using?](#)

### 3.2 Course RESOURCES

**TEXT BOOKS:**

**Required:**

John Jensen (2016). *Introductory Digital Image processing: A Remote Sensing Perspective* (4th edition.). Prentice-Hall - ISBN: 0-13-145361-0

**Recommended:**

Robert Schowengerdt (2007). *Remote Sensing: Models and Methods for Image processing* (3rd edition). Elsevier. ISBN: 0-12-369407-8

**ADDITIONAL MATERIALS:**

Research article handouts  
Links to websites covering different topics

### 3.3 Grading & Grading Scale:

Grading Item	Grade Percentage	Description
Assignments	45%	Lab assignments will be performed as homework assignments
Participation	10%	Through Canvas Discussions and Activities
Exam	10%	A capstone exam will be offered on the last day of classes
Final Project	35%	An individual-based final project is due the last week of classes.

#### GRADING Scale

Letter Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
Corresponding Course Score	95-100	90-95	85-90	80-85	75-80	70-75	65-70	60-65	55-60	50-55	45-50	0-45
Grade Points	4	3.67	3.33	3	2.67	2.33	2	1.67	1.33	1	0.67	0

## 4. Course Content & Readings

Week & dates	Topic	Readings
Week 1	Review of Remote Sensing Concepts: spatial and radiometric characteristics – spectral and temporal characteristics	<i>Schwengerdt: Chapter 1: Jensen: Chapter 1</i>
Week 2	Optical Radiation Model: The wave/ particle models - energy/matter interaction – Radiometric Correction – Atmospheric Correction	<i>Schwengerdt: Chapter 2&amp;7pp. (309-350) Jensen: Chapter 6 (pp. 185-232)</i>
Week 3	Digital Image Formation: point spread functions – sampling and quantization	<i>Schwengerdt: Chapter 3</i>
Week 4	Digital Image Characteristics: Univariate and multivariate image statistics – noise models- power spectral density- co-occurrence matrix	<i>Schwengerdt: Chapter 4</i>
Week 5	Image Enhancement and Spectral Transforms: contrast enhancement – band rationing – principal component analysis – vegetation transforms – texture transforms	<i>Schwengerdt: Chapter 5 Jensen: Chapter 8</i>
Week 6	Spatial Transforms: convolution concept - low and high pass filtering – spatial transformations – Fourier transform – wavelet transforms	<i>Schwengerdt: Chapter 6</i>
Week 7	Geometric Correction: sensor geometry and empirical models for geometric corrections	<i>Schwengerdt: Chapter 7 (pp.285-300) Jensen: Chapter 7</i>
Week 8	Thematic Information Extraction: review of supervised and unsupervised image classification – Maximum Likelihood and Bayesian classification	<i>Schwengerdt: Chapter 8 (pp.285-300) Jensen: Chapter 9</i>
Week 9	Spring Break	
Week 10	Machine Learning: neural networks – expert systems – support vector machine	<i>Jensen: Chapter 10</i>
Week 11	Machine Learning: neural networks – Deep Learning	<i>Miscellaneous handouts</i>
Week 12	Hyperspectral Image Preprocessing: atmospheric correction – dimensionality reduction - minimum noise fraction transformation – endmember determination – pixel purity index – orthogonal sub-space projection	<i>Jensen: Chapter 11 (pp. 459-479)</i>
Week 13	Hyperspectral Image Classification: spectral angle mapper – linear spectral un-mixing – spectroscopic library matching – Hyperspectral vegetation Indices	<i>Jensen: Chapter 11 (pp. 479 – 496)</i>
Week 14	LiDAR data acquisition- multiple returns vs. full-waveform data– feature extraction from LiDAR data	<i>Misc. handouts</i>
Week 15	<i>Final Exam - Final Project Presentations and Discussion</i>	

**NOTE - This syllabus is tentative; thus, changes may occur. You are responsible for knowing the course content and follow up schedule, reading, and lab changes as published in the course e-learning website.**

## 5. Policies and Requirements

This syllabus represents current plans and objectives for this course. As the semester progresses, changes may need to be made to accommodate timing, logistics, or to enhance learning. Such changes, communicated clearly, are not unusual and should be expected.

### 5.1 Late submissions and make-up requests:

It is the responsibility of the student to access online lectures, readings, assignments, discussions, and exams and to maintain satisfactory progress in the course.

- A 25% penalty per week will be applied to late assignments. A late submission on the due date also results in a 10% deduction.
- Assignments will not be accepted if handed in more than two weeks after the due date.
- Exams cannot be taken past the deadline.
- Exceptions to the late policy are only allowed per university policy.

Computer or other hardware failures, except failure of the UF canvas system, will not excuse students for missing assignments. Any late submissions due to technical issues **MUST** be accompanied by the ticket number received from the Helpdesk when the problem was reported to them. The ticket number will document the time and date of the problem. You **MUST** e-mail your instructor within 24 hours of the technical difficulty if you wish to request consideration.

For computer, software compatibility, or access problems, call the HELP DESK phone number—352-392-HELP = 352- 392-4357 (option 2).

Requirements for class attendance and make-up exam, assignments, and other work are consistent with university policies that can be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>.

### 5.2 Semester Evaluation Process

Student assessment of instruction is an important part of efforts to improve teaching and learning.

**At approximately the mid-point of the semester**, the School of Forest Resources & Conservation will request anonymous feedback on student satisfaction on various aspects of this course. These surveys will be sent out through Canvas and are not required, but encouraged. This is not the UF Faculty Evaluation!

**At the end of the semester**, students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals.

Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

### 5.3 Netiquette: Communication Courtesy

All members of the class are expected to follow rules of common courtesy in all email messages, threaded discussions and chats. Failure to do so may result in loss of participation points and/or referral to the Dean of Students' Office. <http://teach.ufl.edu/docs/NetiquetteGuideforOnlineCourses.pdf>

### 5.4 Academic Honesty Policy

As a student at the University of Florida, you have committed yourself to uphold the Honor Code, which includes the following pledge: *"We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity."*

You are expected to exhibit behavior consistent with this commitment to the UF academic community, and on all work submitted for credit at the University of Florida, the following pledge is either required or implied: *"On my honor, I have neither given nor received unauthorized aid in doing this assignment."*

It is assumed that you will complete all work independently in each course unless the instructor provides explicit permission for you to collaborate on course tasks (e.g. assignments, papers, quizzes, exams). Furthermore, as part of your obligation to uphold the Honor Code, you should report any condition that facilitates academic misconduct or appropriate personnel. It is your individual responsibility to know and comply with all university policies and procedures regarding academic integrity and the Student Honor Code. Violations of the Honor Code at the University of Florida will not be tolerated.

Violations will be reported to the Dean of Students Office for consideration of disciplinary action. For more information regarding the Student Honor Code, please see: <http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code>.

### 5.5 Inclusive Learning Environment

This course embraces the University of Florida's Non-Discrimination Policy, which reads, *The University shall actively promote equal opportunity policies and practices conforming to laws against discrimination. The University is committed to non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information and veteran status as protected under the Vietnam Era Veterans' Readjustment Assistance Act.*

If you have questions or concerns about your rights and responsibilities for inclusive learning environment, please see the instructor or refer to the Office of Multicultural & Diversity Affairs website: <http://multicultural.ufl.edu>.

### 5.6 Services for Students with Disabilities:

The Disability Resource Center coordinates the needed accommodations of students with disabilities. This includes registering disabilities, recommending academic accommodations within the classroom, accessing special adaptive computer equipment, providing interpretation services and mediating faculty-student disability related issues. Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation. 0001 Reid Hall, 352-392-8565, [www.dso.ufl.edu/drc/](http://www.dso.ufl.edu/drc/)

## 5.7 Software Use

All faculty, staff and students of the university are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

## 6. Campus Helping Resources

For issues with technical difficulties for e-learning in Canvas, please post your question to the Technical Help Discussion in your course, or contact the UF Help Desk at:

- [Learning-support@ufl.edu](mailto:Learning-support@ufl.edu) | (352) 392-HELP - select option 2 | <http://elearning.ufl.edu>
- Library Help Desk support <http://cms.uflib.ufl.edu/ask>
- SFRC Academic Hub <https://ufl.instructure.com/courses/303721>

## 6.1 Student Life, Wellness, and Counseling Help

Students experiencing crises or personal problems that interfere with their general well-being are encouraged to utilize the university's counseling resources. The Counseling & Wellness Center provides confidential counseling services at no cost for currently enrolled students. Resources are available on campus for students having personal problems or lacking clear career or academic goals, which interfere with their academic performance.

- Counseling and Wellness resources <http://www.counseling.ufl.edu/cwc/>
- U Matter, We Care <http://www.umatter.ufl.edu/>
- Career Connections Center <http://career.ufl.edu/>
- Other resources are available at <http://www.distance.ufl.edu/getting-help> for online students.

## 6.2 Student Complaint Process

The School of Forest Resources & Conservation cares about your experience and we will make every effort to address course concerns. We request that all of our online students complete a course satisfaction survey each semester, which is a time for you to voice your thoughts on how your course is being delivered.

If you have a more urgent concern, your first point of contact should be the SFRC Academic Coordinator or the Graduate/Undergraduate Coordinator for the program offering the course. You may also submit a complaint directly to UF administration:

- Students in online courses: <http://www.distance.ufl.edu/student-complaint-process>
- Students in face-to-face courses: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>