	Document Code	RG-711	Written by	Name	Dr. Saleem Ullah
				Date	
	Title	Advanced Remote Sensing & Digital Image Processing	Reviewed by	Name	
				Date	
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				Date	

INSTITUTE OF SPACE TECHNOLOGY

COURSE SYLLABUS

Program: RS & GISc
Department: Space Science (SS)
Course Code: RG-711
Course Name: Advanced Remote Sensing & Digital Image Processing
Credits: CR 3-0
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Course Description:

This is a graduate-level course on remote sensing data processing. The primary focus of this course is optical and infrared remote sensing datasets. It presents an overview of remote sensing in the optical and infrared regime, image interpretation, major data pre-processing and processing modules, and discusses some specific applications as case studies.

The course lectures will be accompanied by regular lab work, with a lab being held nearly every week along with theory classes. Students are expected to master both theory and lab classes. It is expected that students will develop a quantitative understanding of remote sensing datasets and processing methods.

A course project will let students work on a remote sensing dataset and application of their choice, design the data processing flow according to their requirement and objective, and present their results to the class in the form of a presentation and project report. More details about the project will be provided during the course.

Prerequisites: Basic knowledge of mathematics and physics is required. Knowing basics of programming will help students to gain more from this course. Students who don't have the recommended skills should be prepared to work and study extra.

Reading/Reference Materials:

Recommended Textbooks:

- Gao (2009), Digital Analysis of Remotely Sensed Imagery
- Lillesand & Kiefer (2007 6th ed. / 2003 5th ed.), Remote Sensing & Image Interpretation

Supporting & Reference Books and Readings:

- Gonzalez & Woods (2002 2nd ed. / 2007 3rd ed.), Digital Image Processing
- Mather & Koch (2011, 5th ed.), Computer Processing of Remotely Sensed Images
- Jensen (2004, 3rd ed.), Introductory Digital Image Processing
- Campbell & Wynne (2011, 5th ed.), Introduction to Remote Sensing
- Sabins (2007, 3rd ed.), Remote Sensing
- Petty (2006, 2nd ed.), A First Course in Atmospheric Radiation
- Lectures
- Relevant papers
- Assigned readings

COURSE PLAN:

Week	Theory	Lab	
1	- Intro to Remote Sensing - Fundamentals of Remote Sensing (LillesandKiefer Ch. 1) - Atmospheric interactions: Scattering / Absorption (LillesandKiefer Ch. 1) - Resolutions: Spatial, Temporal, Radiometric, Spectral (Gao Ch. 1)	-	
2	- Remote Sensing Satellite Orbits - Major RS Softwares - Remote Sensing Platforms: Along-Track, Across-Track - Spectral Signatures: Basis, Examples (Vegetation, Landcover, etc.)	-	
3	- Blackbody radiation - Thermal emission - Emissivity - Brightness temperature - Remote sensing in the thermal IR	- Basic RS Software Functions - Deriving Spectral Signatures from Images - Stacking - Subsetting - Band Combinations and Feature Identification	

4	- Geometric Errors & Distortions
	  - Errors associated with Earth
	  - Errors associated with Platform
	  - Errors associated with Sensor
	- Basics of geometric rectification
		- Polynomial-based Image Rectification	

5	- Geometric Corrections & Image Rectification	-	

	- Geometric transformations - GCPs and GCP selection - Image rectification models - Polynomial-based image rectification - Polynomial order - Error Analysis through RMSE - Polynomial-based image rectification - Intensity interpolation: nearest neighbor, bilinear, cubic - Project discussion		
6	- Orthorectification (Gao Ch. 5) - GCPs and Tie Points - Use of DEM in orthorectification - Direct georeferencing	- Orthorectification	
7	- Radiometric Measurement & Terminologies - Atmospheric Correction	-	
8	- Radiometric Calibration - Radiance and Reflectance	- Atmospheric Correction - Radiometric Calibration	
	***** No Class ***** - Visual Interpretation (Assignment 4)	-	
9	***MIDTERM EXAM*** - Image Enhancement: Contrast Enhancement / Greylevel Transformations - Image Enhancement: Histogram Processing	-	
10	- Image Enhancement: Filtering - Kernel and Convolution - Image Filtering in the Spatial Domain - Low-pass Filters - High-pass Filters - Image Transformations: - Band Ratios - Indices	-	
11	- Image Transformations: - PCA - Decorrelation Stretch - HIS - Soil Line - Tesselated-Cap (Kauth-Thomas) - Basics of Image Classification	- Image Enhancement - Image Filtering - Image Transformations - Image Fusion	
12	- Image Fusion - Mathematical/Geometrical Basis of Image Classification - Spectral Distance - Unsupervised Classification: - k-Means Algorithm - ISODATA Algorithm	- Exploring Feature Space - ISODATA Unsupervised Classification - Advanced ISODATA Manipulation	

13	- Supervised Classification:
	  - Basic Idea of Supervised Classification
	  - Supervised Classification Algorithms
	  - Training Set Selection & Refinement
	  - Classification Step
		-	

14	- Supervised Classification (continued):
	  - Maximum Likelihood Algorithm
	  - Validation Set Generation
	  - Post-classification
	  - Accuracy Assessment
		- ML Classification
		- Signature Refinement
		- Accuracy Assessment	

15	- Student Course Project Presentations	-	

Extra	- Fuzzy Classifiers
	- Sub-pixel Classifiers
	- Non-parametric Classifiers:
	  - Object-oriented Classification
	  - Neural networks
	  - Support Vector Machines
	  - Decision-Trees
	- Expert Classifiers
	- Image Filtering in the Frequency Domain
	- Spatial Analysis:
	  - Texture
	  - Context
	  - Segmentation
	- Change Detection & Multitemporal Image Analysis (Gao Ch. 13)
	- Morphology
	- Batch Processing
	- Time-series Analysis
	- Remote Sensing Image Storage Formats: BIL, BIP, BSQ
	- Extraction of Biophysical/Geophysical Information from Remote Sensing:
	  - Case Study: Above-ground Biomass
	  - Case Study: Phenological Curves
		-	

17	**Final Examination**		

TEACHING METHODOLOGY

The course will be taught using lectures, in-class discussions, homework assignments, lab work, and individual research projects.

ASSESMENT:

The general grading distribution is as follows (subject to change):

Assignments	15%
Course Project	15%
Quizzes (Announced/Unannounced)	10%
Mid-term Exam	25%
Final Exam	35%
Total	100%

General Course Policies:

- Attendance will be MANDATORY in both theory and lab classes
- It is MANDATORY to read the reading material given with the lectures; exams and assignments will require study of lecture content + reading material.
- IST follows a strict policy of 80 % overall attendance in the course. Any student below 80 % attendance will not be allowed to sit in the final exam.
- The Course Grading percentage distribution is loosely defined and may be changed by the end of the course. Students will be notified if such changes take place.
- The classroom environment shall preferably be active and open discussions are very much favored, but please try to stick to the topic under discussion.
- In assignments, any/all references must be PROPERLY quoted and cited and this must be STRICTLY followed. Marks will be deducted if this strict rule is not attended to.
- All graded work must be the original effort of the student. Plagiarism (either copying from another student or writing text without proper referencing) will NOT be tolerated. Severe grading loss may result, so please be careful. A quick search on Google will show you what plagiarism is and how to avoid it. It is your responsibility to avoid plagiarism.
- Do NOT take assignment deadlines lightly. If you have a problem, come to the instructor before the deadline, not after it. Deadlines will not be relaxed unless in case of an emergency. Marks will be deducted, as deemed suitable, for late submissions.