

Course Title: Digital Image Processing				
Course code: UES 310	No. of credits: 3	L-T-P: 28-10-14	Learning hours: 45	
L: Lecture; T: Tutorial; P: Practical				
Pre-requisite course code and title (if any):				
Department: Department of Natural and Applied Sciences				
Course coordinator:		Course instructor:		
Contact details:				
Course type: Minor		Course offered in: Semester 6		
Course Description				
<p>This course provides an in-depth introduction to digital image processing techniques. Emphasizing the principles and applications of image enhancement, analysis, and interpretation, the course equips students with the skills necessary to process and analyze remotely sensed data effectively. Topics covered include image acquisition, geometric and radiometric corrections, image enhancement methods, classification techniques, and change detection. By the end of the course, students will be capable of applying digital image processing techniques to solve real-world geospatial problems, supporting applications in environmental monitoring, urban planning, agriculture, and disaster management.</p>				
Course objectives				
<ul style="list-style-type: none"> • To familiarize students with various image processing techniques and methods for image enhancement to improve visual interpretability. • To develop skills in image rendering, and classification methods for applications of geoinformatics. 				
Course content				
Module	Topic	L	T	P
1.	Fundamentals of Digital Image Processing: Concepts, Formats, and Applications			
	<p>This module introduces the core principles and techniques of digital image processing, laying the foundation for understanding how images are captured, represented, and manipulated in digital systems.</p> <p>Digital Image Processing: Basic Concepts and Terminology - Image dimensions, intensity values, histograms; Concepts about digital image and its characteristics; Types of image displays– Black and White (B/W) Image, Grayscale Image, True color Image, Pseudo Color Image, and Standard FCC; Color Models; Data storage and retrieval; Application and scope</p>	6	2	
2.	Introduction to Image Correction Techniques and Interpolation Methods			
	<p>This module offers a foundational understanding of image correction and interpolation techniques, essential for improving image quality and preparing data for advanced image processing tasks.</p> <p>Overview of corrections in satellite imagery: Orthorectification, Radiometric, Atmospheric, and Geometric; Interpolation methods – Nearest Neighbor, Bilinear Interpolation, Cubic Convolution</p>	4	2	
3.	Image Rendering and Enhancement Techniques			
	<p>This module focuses on the methods used to render digital images and improve their visual quality through enhancement techniques.</p> <p>Look-up Tables (LUT) and Image display, Image enhancement techniques; Contrast stretching: Linear and non-linear methods contrast stretching</p>	4	2	
4.	Image Filtering and Edge Detection			
	<p>This module explains how filtering techniques are used to reduce noise, enhance image features, while edge detection methods identify object boundaries critical for segmentation, recognition, and interpretation in image processing applications.</p>	4	2	

	Low pass filtering - Image smoothing; High pass filtering, adaptive filtering and nonlinear filtering, frequency domain filtering - Edge enhancement and Edge detection			
5.	Spectral Indices			
	This module covers the theoretical foundations, computational methods, and practical applications of widely used spectral indices. Index Normalization for Temporal/Spatial analysis, Normalized Difference Vegetation Index (NDVI), Normalized Difference Built-up Index (NDBI), Enhanced Vegetation Index (EVI), Soil Adjusted Vegetation Index (SAVI), Normalized Difference Snow Index (NDSI),	4	2	
6.	Image Classification Techniques			
	The module covers both supervised and unsupervised classification approaches, exploring algorithms, accuracy assessment, and practical applications in fields such as land cover mapping Unsupervised and Supervised classification methods, Accuracy Assessment: User and Producer accuracy, Kappa accuracy	6	0	
	Total	28	10	14
	Practical Modules			
1.	Study of the various contrast enhancement techniques			2
2.	Haze and Noise reduction			2
3.	Geometric and radiometric correction			2
4.	Spectral indices: NDVI calculation			2
5.	Supervised and Unsupervised classification and Accuracy Assessment			6
	Total			14
Evaluation criteria				
<ul style="list-style-type: none"> • Minor Test 1: Written test [at the end of teaching of modules 1 and 2] -- 20% • Minor Test 2: Written test [at the end of teaching of module 3 and 4] -- 20% • Practical Exam with Viva: [at the end of the semester, full syllabus] -- 20% • Major Test: Written test [at the end of the semester, full syllabus] -- 40% 				
Learning outcomes				
By the end of the course, students will be able to:				
<ul style="list-style-type: none"> • understand the fundamental concepts of digital image processing, identify various image formats and their characteristics, and analyze common applications of digital image processing across different domains. [Module 1] • apply image correction techniques and interpolation methods to enhance image quality. [Module 2] • implement image enhancement methods such as histogram equalization, filtering, and sharpening. [Module 3] • apply linear and non-linear filters for noise removal and image enhancement. [Module 4] • understand and apply various spectral indices and band ratio techniques to analyze and interpret remote sensing data. [Module 5] • apply fundamental principles of image classification and pattern recognition techniques in real-world applications. [Module 6] 				
Pedagogical approach				
<ul style="list-style-type: none"> • The course engages in digital image processing and facilitates student discussion through classroom lectures, practical classes, tutorials and case studies. • The course allows students to actively engage with the image enhancement and image classification techniques through real-world applications. 				
Reading Resources (* = compulsory readings)				
<ul style="list-style-type: none"> • Jensen, J. R., & Lulla, K. (1987)*. Introductory Digital Image Processing: A Remote Sensing Perspective. Pearson • Jain, A. K. (1989). Fundamentals of digital image processing 				

- Gonzalez, R. C. (2009). Digital image processing. Pearson education. India.
- Solomon, C., & Breckon, T. (2011). Fundamentals of Digital Image Processing: A practical approach with examples in Matlab. John Wiley & Sons.

Journals:

- Journal of Indian Society of Remote Sensing (JISRS)
- International Journal of Applied Earth Observation and Geoinformation
- ISPRS Journal of Photogrammetry and Remote Sensing
- Remote Sensing of Environment
- Geocarto International
- International Journal of Remote Sensing

Student Responsibilities

The students must come prepared with the readings given in the class. The students are required to participate in the discussion.

Course Designed by:

- Dr Ayushi Vijhani, Assistant Professor, Department of Natural and Applied Sciences, TERI School of Advanced Studies, New Delhi

Course Reviewers:

The course is reviewed by following reviewers:

- Dr. Sameer Saran, Dy General Manager (DGM) & Scientist/Engineer 'SG', Regional Remote Sensing Centre - North, NRSC/ISRO
- Dr. Ram Avtar, Associate Professor, Graduate School of Environmental Science Hokkaido University, Japan