Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NGLD302	**Hyperspectral Remote Sensing and Its Applications**	3	0	0	3

Course Objective
This course is designed to develop a comprehensive understanding of the principles of Hyperspectral Remote Sensing (HRS) and their diverse applications in geoscience exploration and analysis.
Learning Outcomes
After completing the course, students will be able to: 1. Understand hyperspectral sensors, systems, and platforms used in geosciences. 2. Process and correct hyperspectral data using spectral analysis techniques. 3. Apply classification, unmixing, and machine learning methods for HRS data interpretation. 4. Use hyperspectral indices for mineral, soil, vegetation, and environmental studies. 5. Analyze hyperspectral applications in Earth and planetary exploration.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
	Fundamentals of Hyperspectral Remote Sensing: Introduction to hyperspectral imaging, electromagnetic spectrum, spectral resolution, comparison of multispectral, superspectral, and hyperspectral systems, scope and significance in geosciences.		Understand principles and characteristics of hyperspectral remote sensing systems
	HRS Sensors, Platforms and Missions: Airborne, spaceborne, laboratory, and portable hyperspectral systems; integration of hyperspectral data with LiDAR; major Earth observation missions and sensors including AVIRIS, Hyperion, PRISMA, EnMAP, HyspIRI, PROBA, HYSI, and HIUSI.		Identify major hyperspectral sensors, platforms, and observation missions
	Spectral Libraries and Radiometric Corrections: Spectral databases (USGS, ASTER, field spectral measurements), Hughes phenomenon, noisy and redundant bands, radiometric calibration, irradiance, radiance, reflectance, and atmospheric/topographic correction approaches.		Apply spectral calibration and atmospheric correction techniques effectively
	Spectral Data Structure and Pre-Processing: Construction of hyperspectral cubes, pixel and target spectra, endmember spectra, spectral enhancement techniques including normalization, smoothing, continuum removal, interpolation, derivative analysis, and curve fitting.		Process, enhance, and interpret hyperspectral data cubes accurately
	Hyperspectral Indices and Spectral Features: Absorption characteristics, red-edge analysis, vegetation indices, mineral indices, and soil indices for spectral characterization and material discrimination.		Analyze spectral indices and diagnostic absorption features
	Feature Extraction and Dimensionality Reduction: Feature selection and information extraction methods, spectral transformations including PCA, MNF, PPI, and identification of diagnostic spectral signatures.		Implement feature extraction and dimensionality reduction
	Spectral Unmixing and Quantitative Analysis: Linear and nonlinear spectral mixture modeling, abundance estimation, numerical inversion, endmember extraction, and sub-pixel analysis techniques.		Perform spectral unmixing and quantitative estimation analyses
	Classification and Machine Learning Approaches: Supervised and unsupervised classification, spectral angle mapping (SAM), matched filtering, cross-correlation, clustering techniques, ISODATA, K-		Apply machine learning and hyperspectral image

	means, SoM classifiers, SVM-based approaches, and accuracy evaluation.		classification techniques
	Geoscience and Environmental Applications: Applications of HRS in mineral exploration, lithological mapping, gemstone identification, soil characterization, acid mine drainage detection, environmental stress monitoring, and global change assessment.		Evaluate applications in geoscience and environmental investigations
	Vegetation and Planetary Hyperspectral Studies: Spectral analysis of vegetation health, pigments, nitrogen, water stress, pests, and species mapping; hyperspectral exploration of planetary bodies including the Moon, Mars, Mercury, Jupiter, Saturn, and Titan.		Assess vegetation dynamics and planetary hyperspectral exploration studies
	Total Classes	**42**	

Text Books:

1. Eismann, M. T. (2012). Hyperspectral Remote Sensing. United States: Society of Photo Optical.

Reference Books:

1. Chang, C. I. (2007). Hyperspectral Data Exploitation: Theory and Applications. Wiley.
2. Chang, C. I. (2013). Hyperspectral Data Processing: Algorithm Design and Analysis. Wiley.
3. Borengasser, M., Hungate, W. S., & Watkins, R. (2007). Hyperspectral Remote Sensing: Principles and Applications. CRC Press.
4. Kalacska, M., & Sanchez-Azofeifa, G. A. (2008). Hyperspectral Remote Sensing of Tropical and Sub-Tropical Forests. CRC Press.
5. Sun, D. W. (2010). Hyperspectral Imaging for Food Quality Analysis and Control. Elsevier Science.
6. Thenkabail, P. S., & Lyon, J. G. (2016). Hyperspectral Remote Sensing of Vegetation. CRC Press.