Course Title: Principles of Remote Sensing			
Course code: NRG169	**No. of credits:** 4	**L-T-P:** 36-08-32	**Learning hours:** 60
Pre-requisite course code and title (if any): None			
Department: Department of Natural and Applied Sciences			
Course coordinator: Dr Chandrashekhar Azad Vishwakarma		**Course instructor:** Dr Chandrashekhar Azad Vishwakarma	
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Course type: Core		**Course offered in:** Semester 1	

Course Description

It introduces the participants to the basic concepts and the operational skills necessary to acquire remote sensing data and extract geo-information from them. The course links the theoretical physical principles and interpretation in form of remotely sensed images, and thereafter develops understanding of different applications in resource management. The course will provide the insights in wider domain of monitoring and applications in environmental sciences and studies.

Course objectives

- To congregate the basic concepts and fundamentals of physical principles of remote sensing and EM radiations
- To develop technological understanding of different remote sensing platforms- ground, air-borne and satellite
- Processing of Remote sensing data and some studies in various domains of remote sensing applications

Course content

Module	Topic	L	T	P
1				
	The objective of this module is to gain familiarity with remote sensing. The module introduces evolution of the discipline as science. The students are made aware of space programs around the globe. How development of various scientific inventions led to the discipline of remote sensing. The topics in this module are: 1. Introduction to Remote Sensing, 2. History of Remote Sensing. 3. History of Space programs of India and World	4		
2	**Physical Basis of Remote Sensing: Concepts and Principles of Electromagnetic Radiation**			
	This module introduces the concepts of electromagnetic radiation, its interaction with atmospheric components. Laws associated with matter and energy are detailed and discussed. The students are made to understand use of EM radiation in remote sensing. They are introduced to concepts of various kinds of resolutions and image interpretation. This module addresses the concepts of: 1. EMR wavelength regions and their applications, 2. Atmospheric windows, 3. Interaction of EMR with matter 4. Fundamentals of Radiometry: Concept & Laws, radiance, reflectance, emittance 5. Resolutions–spatial, spectral, radiometric, temporal 6. Elements of image interpretation	10		
3	**Remote Sensing Platforms and Sensors**			
	The details of different remote sensing platforms are discussed along with different types of remote sensing data acquisition sensors. The operation of sensors and technology used in data capture are introduced. Different satellite data products and sensors are discussed. The following topics are introduced in this module: 1. Remote Sensing Systems (Active & Passive; Imagining & Non-imaging), Orbit and Platforms of earth Observation, sensors, and scanners; Cameras and Sensor classification: Opto-Mechanical & Push-	6	4	

	broom. 2. Introduction to commonly used multi-spectral remote sensing satellite systems (IRS Series of satellites, Landsat, Spot, Ikonos, Quickbird, MODIS, Radarsat, NOAA, TERRA, Sentinel Family, RISAT, Resourcesat etc)			
4	**Remote Sensing of Vegetation, Soils, Minerals and Geomorphology**			
	The module creates a discussion around application of remote sensing in the domains of forestry, vegetation, agriculture, soil, and geological and geomorphological landscapes. The students will be exposed to reflectance characteristics of various components of earth surface. 1. Understanding vegetation spectra and factors affecting it, temporal characteristics of vegetation, vegetation indices 2. Soil spectral characteristics, remote sensing of soil properties, rocks, and minerals. 3. Landforms-fluvial, karst, glacial, igneous, horizontal, and folded strata, fault-controlled landform	10	4	
5	**Advanced Technologies in Remote Sensing: LiDAR, Hyperspectral and Microwave and UAV**			
	Some advanced technologies would be discussed in the module and the students would be exposed to basic understanding of LIDAR and Drone and UAV (UAS, RPA, RPAS, and Drone) techniques is remote sensing. 1. LiDAR principles, Laser and scanning system, Laser location, Orientation, first, intermediate, and last return. Applications for DSM and DEM. 2. Principles of Hyperspectral and Microwave remote sensing 3. Imaging History of manned and unmanned aircraft, platforms, sensors aerial mapping- manned and unmanned aircraft systems (UAV, UAS and others)	6		
	Total	36	8	32
Practical Modules				
Lab 1. Introduction to ERDAS IMAGINE 2011				4
Lab 2. Plotting Spectral Signature using spectroradiometer data				2
Lab 3. Exploring earth explorer and Copernicus for various data sources				2
Lab 4. Satellite image; season, location, sensor, download				4
Lab 5. Display, analysis and interpretation of black & white images, grey image, pseudo image and FCC				2
Lab 6. File formats. Import / Export of files using ERDAS IMAGINE				2
Lab 7. Pre-processing satellite data (stacking, subsetting, mosaicking)				4
Lab 8. Map rectification of Toposheet using Keyboard or GPS data and Geo-referencing of the toposheet and imageries				4
Lab 9. Collection of GPS points. Ground data collection.				2
Lab 10. Image analysis for urban pattern, vegetation, geomorphology.				6
		36	**8**	**32**

Evaluation criteria

- Minor Test 1: Written test [at the end of teaching of modules 1 and 2] -- 15%
- Minor Test 2: Written test [at the end of teaching of module 3 and 4] -- 15%
- Major Test: Written test [at the end of the semester, full syllabus] -- 50%
- Practical: Lab Exercise +Viva 20%

The major exam will be covering the entire syllabus of the course.

Learning outcomes

By the end of the course, students will:

- The student would command understating in technological development in various components of remote sensing and would also acquire skills to understand the satellite data and its parameters through the lens of electromagnetic radiation principles. [Module 1 and 2; Minor Test 1]
- Imparts the skill to understand the remote sensing technology and satellite data. The technical details of the sensors and various technological dimensions of sensors will be understood. Use of satellite datasets in various environmental applications domain will be detailed [Module 3 and 4; Minor Test 2]
- The student will appreciate cutting-edge development in the domain of remote sensing 1, 2 and 3. [All Modules; Major Test]
- Operational skills necessary to acquire remote sensing data and learn to extract information from them. [Practical]

Pedagogical approach

- The course critically evaluates the concepts of remote sensing and builds the discussion in classroom through lectures, case studies, tutorials, practical exercises.
- The course infuses the interest in remote sensing through hands-on on satellite data as well as through the tutorials

Reading Resources (* = compulsory readings)

- Campbell J.B. (2002) Introduction to Remote Sensing, 3rd ed., The Guilford Press.
- Jensen J.R. (2007) Remote Sensing of the Environment: An Earth Resource Perspective, 2nd ed., Pearson
- Lillesand T., Kiefer R.W., Chipman J. (2015) Remote sensing and image interpretation. John Wiley & Sons
- Richards J.A., Richards J.A. (2022) Remote sensing digital image analysis. Berlin/Heidelberg, Germany, Springer
- Sabins F.F., Ellis J.M. (2020) Remote Sensing Principles, Interpretation, and Applications, 4th Edition

Suggested readings

- Jensen J.R. (2005) Digital Image Processing: A Remote Sensing Perspective, 3rd ed., Prentice Hall.
- Joseph G., Jeganathan C. (2018) Fundamentals of Remote Sensing, Universities Press India.
- Kondratyev K.Y., Buznitov A.A. and Pokrovoky O.M. (1996) Global Change and Remote Sensing, John Wiley and Sons.
- Lillesand T., Kiefer R.W., Chipman J. (2015) Remote sensing and image interpretation. John Wiley & Sons

Journals

- 1. Geocarto International
- 2. International Journal of Remote Sensing
- 3. ISPRS Journal of Photogrammetry and Remote Sensing
- 4. Journal of Indian Society of Remote Sensing
- 5. Remote Sensing of Environment
- Additional information (if any)
- Magazines
- 1. Coordinates
- 2. Geospatial today

Student Responsibilities

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

Course Designed by:

- Dr Chander Kumar Singh, Professor, Department of Natural and Applied Sciences, TERI School of Advanced Studies, New Delhi

Course Reviewers:

The course is reviewed by following reviewers:

- Dr. Pawan Kr. Joshi, Professor, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi
- Dr. R.N Sahoo, Principal Scientist, Agriculture Physics Division, IARI, New Delhi