Urban Resilience and Adaptation for India and Mongolia
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National Institute of Urban Affairs
NIRMA UNIVERSITY

Template syllabus of the new/revised courses

Course Name: ECOL 501: REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM

Number of credits: 3

Period: Spring semester

Coordinator	**S Jayakumar**
Credits	3
Lecturers	--
Level	Postgraduate
Host institution	Pondicherry University
Course duration	18 weeks
New/revised	Revised

Summary

This 3 ECTS course provides the students the fundamentals of remote sensing and Geographical information system. It teaches the characteristics of different frequencies of electromagnetic radiation and its interaction with atmosphere and earth's surface. This course introduces the reflective, thermal and microwave remote sensing to students. It also makes the students understand the aerial photography, photogrammetry and global positioning system. It introduces the concept of image interpretation and various sensor characteristics. It makes the students understand the concept of data structures and basic spatial modelling concepts.

Target student audiences

Master students majoring in Ecology and Environmental Sciences, Pollution technology and environmental engineering, geosciences, sociology will be the target audiences.

Prerequisites

Required courses (or equivalents): Basic understanding on Mathematics (school higher level), English language skill, computer operation (Windows/Mac).

Aims and objectives

The main course objective is to make the students understand the fundamentals and applications of remote sensing and Geographical information system in natural resources management. To enable the students understand the different types of remote sensing, sensor characteristics, payload. To make the students understand how EMR interacts with earth's surface. To give

students fundamental and applications of GPS. To introduce the students to the theory of spatial data structure, projections and coordinate systems. To make them understand the thematic maps, weightage and spatial modeling.

The Authentic Tasks are:

General learning outcomes:

By the end of the course, successful students will:

1. Know the principles of remote sensing, GIS and GPS
2. understand the interactions of EMR with earth's materials.
3. Be able to distinguish the significance between reflective, thermal and microwave remote sensing
4. understand the payload characteristics and how to determine different resolutions
5. Know the basics of coordinate system and projections
6. Know the concept of digitalization, and thematic map preparation.
7. Know the basic data structure in GIS and their significance.
8. Be familiar with the data integration and weightages used in spatial modeling.
9. Know the basic concept of modeling and how to conceptualize a model.
10. Understand the applications of RS and GIS in various fields.

Overview of sessions and teaching methods

The course will make most of interactive and self-reflective methods of teaching and learning and, where possible, avoid standing lectures and presentations.

Learning methods

- In class Lectures (face-to-face)
- E-learning materials – Video lectures
- Group work – Fieldtrip, data collection, analysis and report presentation
- Literature review and assignment submission

Course outline

Week -1	Fundamentals of remote sensing
	Components of RS
Week -2	Electromagnetic radiation
	Atmospheric window and effects of atmosphere
	Principles of Scanner and CCD array
Week -3	Types of Sensor and bands

	The pixel
	Spectral reflectance of soil, water and vegetation
Week - 4	Thermal Remote Sensing
	Microwave Remote Sensing
Week - 5	Satellite and Sensors
	Satellite orbits and for different resolution
Week - 6	Digital image processing-mosaicing, histogram equalization
	Image Classification
Week - 7	Air borne and space borne data: Fundamentals of photogrammetry, aerial cameras, planning of aerial photography
Week - 8	Planning of aerial photos and characters of aerial photo
	Types of Aerial photos, Photogrammetry
Week - 9	Elements of aerial photo interpretation
Week - 10	Satellite data availability - Indian space agency - data centre and USGS Earth Explorer
Week - 11	GIS terms and terminologies
Week - 12	GIS components
	How to create a thematic map from satellite image
	Raster and Vector data structure
Week - 13	Map Projection and coordinate system
	Digital Cartography and elements of map
Week - 14	Overlay analysis
	Weighted overlay analysis
Week - 15	Fundamentals and applications of Navigation system
	Classification Methods and RS in forestry
Week - 16	RS in forestry and water
Week - 17	RS in LULC Mineral Disaster
	RS in Forest fire
	RS in Agriculture

Literature

1. Emery W. and Camps A., (2017) Introduction to Satellite Remote Sensing 1st Edition Atmosphere, Ocean, Land and Cryosphere Applications, Elsevier Publications
2. Rees W.G (2013) Physical Principles of Remote sensing (3 rd edition), Scott polar, Research Institute, University of Cambridge, New York.
3. George Joseph (2008) Fundamentals of Remote Sensing (2 nd edition), Universities press, Hyderabad.
4. Lillies T. M. and Kiefer R.W (2003) Remote Sensing and Image Interpretation, John Wiley and Sons.

Recommended:

1. Raizer, V (2017) Advances in Passive Microwave Remote Sensing of Oceans 1st Edition CRC Press

2. Solimini, D., (2016) Understanding Earth Observation: The Electromagnetic Foundation of Remote Sensing (Remote Sensing and Digital Image Processing) 1st Edition, Springer;
3. Estes J. E., and Senger, L.W. (1973), Remote Sensing Techniques for Environmental Analysis, John Wiley and Sons New York.
4. Fischer, and Nijkamp, P (1993). Geographic Information Systems – Spatial Modeling and Policy Evaluation, Springer – Verlag.

Revised Syllabus
REMOTE SENSING AND GIS

ECOL: 501 **CREDITS: 3**

COURSE OBJECTIVE: To make students understand the fundamental principles, sensors characteristics and applications of different types of remote sensing. To introduce students the importance of spatial mapping and modeling in GIS for natural resources management.

UNIT I: Principles of Remote Sensing: Concepts of Remote Sensing, Electromagnetic spectrum – visible, infrared and thermal, microwave regions, effects of atmosphere – absorption, scattering, reflection; Principle of scanner and CCD array, Spectral reflectance of earth's surface features in different wavelength region of electromagnetic spectrum: spectral characteristics of surface features (soil, vegetation, water). (a) Thermal remote sensing: Basic principles, Radiation laws, Sensing radiant energy, Thermal sensors, characteristics of image and their uses. (b) Microwave remote sensing: Basic definitions and principles, advantages, Types of microwave systems - RADAR, SLAR, SAR. **(8 Hours)**

UNIT II: Satellite and Sensors - Landsat, SPOT, IRS, NOAA, Seasat, ERS, RADARSAT, INSAT, IKONOS; Orbital characteristics, Data products. General characteristics, spectral resolution spatial resolution, temporal resolution and radiometric resolution; Digital Image Processing- Principles, Image rectification and restoration, Image enhancement and Mosaicing. Image classification - Supervised, Unsupervised, Ground truth data, Classification accuracy assessment – commission error, omission error and Kappa statistics. **(8 Hours)**

UNIT III: Air borne and space borne data: Fundamentals of photogrammetry, aerial cameras, planning of aerial photography, principles of stereo-photography, parallax; characteristics of aerial photographs; Elements of image interpretation - visual interpretation of aerial photographs and satellite imageries, instruments used in interpretation. Satellite data availability – United States Geological Survey (USGS), Bhuvan, India, European Space Agency (ESA), National Oceanic and Atmospheric Administration (NOAA), National Aeronautics and Space Administration (NASA). **(8 Hours)**

UNIT IV: Geographical Information System (GIS): Basic principles, components and terminologies, Raster and vector data structure, attribute data, Map projection, Digital cartography, elements of map, thematic map, proximity analysis, overlay analysis, GIS software – commercial

and open source, Global Positioning System (GPS) - Basic principles, satellite constellation, control segment and user segment, AGPS and DGPS and applications. **(8 Hours)**

UNIT V: Applications of Remote Sensing and GIS: Forest resources - forest type mapping, forest density mapping, change analysis, matrix analysis; water resources - mapping surface waterbody, flood and inundation mapping; agriculture – crop area and yield estimation, damage detection, plant disease detection; disaster mapping – forest fire, fire frequency mapping, fire trend analysis, landslide, land use and land cover mapping, land cover dynamics. **(8 Hours)**

Course workload

The table below summarizes course workload distribution:

Activities	Learning outcomes	Assessment	Estimated workload (hours)
In-class activities (45 hours)			
Lectures	Understanding basic concepts, fundamentals and applications of RS and GIS	Class participation	20 hours
Moderated in-class discussions	Understanding to select relevant satellite data, classification technique and scale of mapping for natural resources management	Class participation and preparedness for discussions	10 hours
In-class assignments, field assignment	Understanding satellites and sensors available and preparedness for field study, data collection, and data quality standards and ground truth verification	Class participation and preparedness for assignments	5 hours
Reading and discussion of assigned papers for seminars and preparation for lectures	Understanding the level of RS and GIS technique integrated in the study, debate the novel approach in the methodology, need for such studies, data and tools utilized.	Class participation, creative and active contribution to discussion	5 hours
Group project presentation	Ability to make presentation, effective communication, critical interpretation of data, response to audience	Quality of group assignments and individual presentations	5 hours
Independent work (100 hours)			

Group work: - Contribution to the group case-study projects - Contribution to the preparation and delivery of individual presentation	Ability to conceptualize the data collection framework, collect and interpret data, team work, contribution to data integration, problem solving, discussion with members of the group, convey the ideas clearly	Quality of group assignments and individual presentations	30 hours
Course group assignment	Ability to select and process appropriate satellite data, band combinations, conceptualize research strategy	Quality of developed strategy and their presentation	20 hours
Group presentation	Ability to interpret data, to analyze audience, and to use the concepts, tools, and methods for communicating the strategy developed	Quality of group assignments and individual presentations	25 hours
Individual study	Understanding of concepts, application framework and, comprehensive knowledge on application of RS and GIS in natural resources management	Quality of answers to questions in the final examination	25 hours
Total			***145 hours***

Grading

The students' performance will be based on the following:

Assessment

- Progress assessment (40%):
  - Exercise (10%): students have to complete the quiz or seminar of each topic.
  - Homework (10%): 1. Journal paper review (5%), 2. Write-up on reflective remote sensing/thermal remote sensing/microwave remote sensing (5 %) or one essay on application of RS and GIS (5 %).
  - Group report (20%): The entire class will be divided into groups of 5-6 students and be given an option to choose any one of the following topics for group project report.
    - Mapping of agriculture and its dynamics

- Mapping of urban sprawl and its dynamics
- Development of interpretation elements for Land use/land cover mapping
- Mapping of forest cover and its dynamics
- Preparing a conceptual research frame work for vulnerability model
- Preparing a habitat suitability model framework.

- Final assessment (60%):
  - Final examination (60%)

Evaluation

Performances of students in each paper are expressed in terms of marks as well as in Letter Grades. In case of fractions the marks shall be rounded off to nearest integer. The class interval for the purpose of awarding the grades can be arrived at by dividing the difference between the highest mark secured and the minimum pass mark by 6 as there are six passing grades. The formula is given below:

K = (X-50)/6

Where, K = class interval, X= the highest mark in the subject.

The grades may be awarded as given in the following Table II.

Table II

Range of Marks in %	Letter Grade	Points for Calculate of CGPA
X to (X-K)+1	O	10
(X-K) to (X-2K)+1	A+	9
(X-2K) to (X-3K)+1	A	8
(X-3K) to (X-4K)+1	B+	7
(X-4K) to (X-5K)+1	B	6
(X-5K) to 50	C	5
Below 50	F	0
Failure due to lack of attendance	FA	0

K should not be rounded off to less than two decimal places. The numbers given in Range of Marks column, (X-K), (X-2K), (X-3K), etc., can be rounded off to the nearest whole number.

In courses where the number of students who have secured 50 marks and above is less than 10 then grading may be given based on the Table III.

Table III

Range of Marks in %	Letter Grade	Points for Calculate of CGPA
81-100	O	10
71-80	A+	9
66-70	A	8
61-65	B+	7
56-60	B	6
50-55	C	5
Below 50	F	0
Failure due to lack of attendance	FA	0

In order to declare the pass, a Student should get
a) A minimum of 40% marks in end-semester exam, and
b) A minimum of 50% marks in aggregate when Internal Assessment and End-Semester marks are added.

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