SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

(*Formerly University of Pune*)

Two-Year Post Graduate Programme in Geography

Faculty of Science and Technology

Choice Based Credit System (CBCS)

Syllabi for

M.Sc. Geoinformatics

Department of Geography, Savitribai Phule Pune University

Syllabi as per guidelines of National Education Policy 2020

To be implemented from Academic Year 2024-2025

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

Department of Geography

Syllabi as per NEP 2020 for M.Sc. Geoinformatics

Title of the Programme: M.Sc. Geoinformatics

Preamble:

National Education Policy 2020 lays particular emphasis on the development of the creative potential of each individual. It is based on the principle that education must develop cognitive capacities - both the foundational capacities of literacy and numeracy and higher-order cognitive capacities, such as critical thinking and problem-solving - and social, ethical, and emotional capacities and dispositions. On behalf of the new education policy, Savitribai Phule Pune University has decided to change the syllabi of various faculties from June 2023. Taking into consideration the rapid changes in science and technology and new approaches to Geographical Information Systems and Remote Sensing, the Board of Studies in Geography, after a discussion with the teachers of Geoinformatics in the Geography Department, Savitribai Phule Pune University and all stakeholders, have prepared the syllabus of M.Sc. Semester-1 and Semester-II (w.e.f. 2023-2024) Geoinformatics programme under the Choice Based Credit System (CBCS). The model curriculum developed by NEP 2020 is used as a guideline for the present syllabi. The syllabi focus on credits related to major core, major elective, research methodology, internship/On job training and research projects.

Aims and Objectives of the new curriculum:

1. To update the curriculum as per the NEP 2020.
2. To incorporate recent developments in the field of GIS and Remote Sensing.
3. To enhance the quality and standards of knowledge of geospatial technology.
4. To provide a broad common framework for exchange, mobility, and free dialogue across the global GIS and Remote sensing Community.
5. To provide students with a comprehensive understanding of these two interconnected fields and equip them with the necessary knowledge and skills to apply remote sensing and GIS technologies in various applications.
6. To maximise the efficiency of decision-making and planning using GIS and Remote Sensing.

7. Introduce students to spatial programming as a way to automate common GIS tasks, increase accuracy, and reduce drudgery.
8. To strike a balance between proprietary and all-open-source technologies in GIS.
9. Provide job-oriented skills to the students with multiple entry and exit options.
10. To enhance employability and entrepreneurship skills among the students in local and global markets.
11. To develop research and innovative skill among the students blended with the use of geospatial technology.
12. Reinforce the theoretical knowledge, to work on real-world projects and gain practical experience in data collection, analysis, and interpretation.
13. Emphasize the importance of staying updated with the latest developments in GIS programming and explore emerging trends in the field.
14. Introduce students to the basics of programming languages commonly used in GIS, such as C, Python, JavaScript, R, .NET and their application in spatial data manipulation and analysis.
15. Teach students how to write scripts and programs that automate repetitive tasks in GIS, allowing for more efficient and consistent data processing.

Program Outcomes:

By the end of the program the students will be able to:

1. explain relevant terms and concepts of GIS and Remote Sensing including definitions.
2. give better explanation about relevant principles, theories and models in Geoinformatics.
3. understand the basic principles and concepts of GIS, including spatial data representation, coordinate systems, map projections, and spatial analysis techniques.
4. handle GIS software packages such as ArcGIS, QGIS, or other relevant tools. They should gain hands-on experience with data input, data management, cartography, and geospatial analysis using these tools.
5. show clear knowledge and identify the importance of application of GIS and RS in various disciplines.
6. identify the importance of spatial scale and time scale.
7. learn methods for gathering and integrating various types of spatial data from different sources, such as GPS data, satellite imagery, and online data services.

8. identify real-world problems that can be addressed using GIS, formulating appropriate spatial questions, and applying GIS techniques to solve those problems.
9. identify the importance of the resemblances and variance between places, environments and people.
10. develop a spatial mindset, which involves thinking critically about spatial relationships, patterns, and processes in the real world.
11. interpret a variety of types of geographical data and sources and recognize their limitations.
12. demonstrate skill of analysis and synthesis of geographical information.
13. to understand the methods and theories of programming for GIS that will allow students to apply GIS knowledge and skills to everyday life.
14. gain an understanding of the ethical and legal implications of using GIS, including privacy concerns, data sharing, and intellectual property rights.

SAVITRIBAI PHULE PUNE UNIVERSITY

Syllabi as per NEP 2020 for M.Sc. Geoinformatics (Level 6.0)

Department of Geography, Savitribai Phule Pune University

M.Sc. Geoinformatics (Year I, Semester I)

Level	Semester	Group	Course Code	Course Title	Credits		Total Credits
					T	P	
6.0	First Semester	**Major Core**	GIS 501	Fundamentals of Remote Sensing and Photogrammetry	04	--	04
			GIS 502	Practical in Spatial Data Processing	--	04	04
			GIS 503	Fundamentals of GIS	02	--	02
			GIS 504	Applied Statistics - I	02	--	02
			GIS 505	Concepts and Methods in Data Sources Exploration	02	--	02
				Total credits related to Major Core	**10**	**04**	**14**
		Major Electives (Theory is mandatory; select any one of the following practical courses)	GIS 511	Business Communication and Soft Skills	--	02	02
			GIS 512	Cartography and Data Representation	--	02	02
			GIS 513	Basic Programming with Python	02	--	02
				Total credits related to Major Elective	**02**	**02**	**04**
		Research Methodology	GIS 521	Research Methodology	**04**	**--**	**04**
			Sem I Total Credits= (Major Core + Major Elective + RM)		**16**	**06**	**22**

Vertical Group (Semester – I)	**Credits for Theory**	**Credits for Practical**	**Total Credits**
Total Credits related to Major Core	10	04	**14**
Total Credits related to Major Electives	02	02	**04**
Research Methodology	04	--	**04**
Total Credits	**16**	**06**	**22**

M.Sc. Geoinformatics (Year I, Semester II)

Level	Semester	Group	Course Code	Course Title	Credits		Total Credits
					T	P	
6.0	Second Semester	**Major Core**	GIS 551	Digital Image Processing: Theory	02	--	02
			GIS 552	Digital Image Processing: Practicals	--	02	02
			GIS 553	Geospatial Analysis: Theory	02	--	02
			GIS 554	Geospatial Analysis: Practicals	--	02	02
			GIS 555	Database Management Systems	02	--	02
			GIS 556	Advance Surveying and fieldwork: Theory	02	--	02
			GIS 557	Project Management	02	--	02
				Total credits related to Major Core	**10**	**04**	**14**
		Major Electives (Theory is mandatory)	GIS 561	Advanced programming with Python	--	02	02
			GIS 562	Applications of GIS and Remote Sensing	02	--	02
			GIS 563	Applied Statistics - II	--	02	02
			GIS 564	Advance Surveying and fieldwork: Practical	--	02	02
				Total credits related to Major Elective	**02**	**02**	**04**
		On Job Training	GIS 571	**On Job Training** (Students should complete on job training not less than 60 clock hours)			**04**
			Sem II Total Credits = (Major Core +Major Elective + OJT)		**12**	**06**	**22**

Vertical Group (Semester – II)	**Credits for Theory**	**Credits for Practical**	**Total Credits**
Total Credits related to Major Core	10	04	**14**
Total Credits related to Major Electives	02	02	**04**
On Job Training	--	04	**04**
Total Credits	**12**	**10**	**22**

SAVITRIBAI PHULE PUNE UNIVERSITY

Syllabi as per NEP 2020 for M.Sc. Geoinformatics (Level 6.5)

Department of Geography, Savitribai Phule Pune University

M.Sc. Geoinformatics (Year II, Semester III)

Level	Semester	Group	Course Code	Course Title	Credits		Total Credits
					T	P	
6.5	Third Semester	**Major Core**	GIS 601	Advances in Remote Sensing and GIS: Theory	04	--	04
			GIS 602	Practicals in Advance Remote Sensing and GIS		04	04
			GIS 603	Thermal and Microwave Remote Sensing	02	--	02
			GIS 604	Hyperspectral and LASER Remote Sensing	02	--	02
			GIS 605	Web GIS and Google Earth Engine	02	--	02
				Total credits related to Major Core	**10**	**04**	**14**
		Major Electives (Select any two of the following courses)	GIS 611	Machine Learning and Artificial Intelligence	02	--	02
			GIS 612	Programming in HTML Java Script	--	02	02
			GIS 613	Organizational Behavior	02	--	02
				Total credits related to Major Elective	**02**	**02**	**04**
		Research Project	GIS 621	Research Project			**04**
			Sem III Total Credits = (Major Core +Major Elective + RP)		**12**	**06**	**22**

Vertical Group (Semester – III)	**Credits for Theory**	**Credits for Practical**	**Total Credits**
Total Credits related to Major Core	10	04	**14**
Total Credits related to Major Electives	02/04	02/00	**04**
Research Project	--	04	**04**
Total Credits	**12/14**	**10/08**	**22**

M.Sc. Geoinformatics (Year II, Semester IV)

Level	Semester	Group	Course Code	Course Title	Credits		Total Credits
					T	P	
6.5	Fourth Semester	**Major Core**	GIS 651	Water Resources and Hydrological applications	02	--	02
			GIS 652	Remote Sensing of Agriculture	02	--	02
			GIS 653	Remote Sensing and GIS Application to Forest and Biodiversity	02	--	02
			GIS 654	Ocean and Atmospheric Remote Sensing	02	--	02
			GIS 655	Remote Sensing and GIS Applications to Health and Energy	02	--	02
			GIS 656	Data Analysis with Tableau and Power BI	--	02	02
				Total credits related to Major Core	**10**	**02**	**12**
		Major Electives (Select any two of the following courses)	GIS 661	Urban Planning and Settlement Informatics	02	--	02
			GIS 662	Planetary Science Using Remote Sensing	02	--	02
			GIS 663	Natural Disaster Management and Assessment using GIS	02	--	02
				Total credits related to Major Elective	**04**	**00**	**04**
		Research Project	GIS 671	Research Project: Dissertation			**06**
			Sem IV Total Credits = (Major Core +Major Elective + RP)		**14**	**02**	**22**

Vertical Group (Semester – IV)	Credits for Theory	Credits for Practical	Total Credits
Total Credits related to Major Core	10	02	**12**
Total Credits related to Major Electives	04	--	**04**
Research Project: Dissertation	--	06	**06**
Total Credits	**14**	**08**	**22**

Year-I Semester-I

Code: GIS 501 Fundamentals of Remote Sensing and Photogrammetry

No. of Credits: 04 **No. of Lectures: 60**

Course Objectives:

1. To introduce the basic principles of remote sensing.
2. To be familiar with Indian space missions and satellite sensor characteristics.
3. To know the different types of satellite data products and visual interpretation.
4. To provide basic exposure to radiometry and spectroscopy.
5. To understand underlying concepts of aerial photo and photogrammetry.

Sr. No.	Topics	Lectures
1	Introduction to Remote Sensing: Concepts, Definition, Development, Overview of Remote Sensing System.	04
2	Physics of Remote Sensing: Electromagnetic radiation (EMR), Theories of EMR, Laws of Radiation, EM Spectrum, Sources of EMR	08
3	Interaction of EMR: Interaction between radiation and matter, Interaction with Earth's Atmosphere, Atmospheric Window, Reflection, Absorption, and Transmission.	06
4	Spectral Signature: Spectral Signatures for common features, e.g. Snow, Soil, Water and Vegetation.	04
5	Platform and Sensors: Platforms, Sensors, Orbits: Types of Platform, Types of Sensors- Active and Passive, Cameras and Satellite Orbits, Concept of Resolution, Satellite Imaging modes.	08
6	Fundamentals of Radiometry: Concept of solid angle, radiometric measurements, observation geometry in RS.	04
7	Data Products and RS data errors: Satellite Data Generation, Data reception, Type of data products and Aerial Photography Products, FCC and TCC images and their applications, radiometric, geometric and atmospheric errors.	06
8	Photogrammetry: Basic aerial Photography, Basic geometry of aerial photograph, central and orthographic projections, difference between map and aerial photograph, Types of aerial photographs.	04
9	Measurements: Scale and ground coverage of aerial photograph, Geometry of Aerial Photographs, Determination of Scale, Use of Parallax, height measurement.	04
10	Aerial Photo and Image Interpretation: Elements of visual interpretation for aerial photos and satellite imageries: Single, Vertical Stereo Pairs, Derived From PAN, LISS, Wifs, OCM Sensors. Study and Visual Interpretation of Satellite Images for Physical Features, Urban, Forest and Agricultural Uses.	06
11	Stereo Photogrammetry: Introduction, orientation of aerial photographs – inner, relative, absolute orientation, Collinearity and Coplanarity conditions, Concept of Rotation Matrix.	02

12	Digital Photogrammetry: Concept and Techniques of Digital Photogrammetry, Data Generation and Research Application of Cartosat-1 Data, Lidar-altimeter.	03
13	Field Work/Study Tour: Identification of Features in the Field Using Aerial Photographs and Satellite Images	01

Course Outcomes:

On completion of this course, the student shall be able to

1. understand the basic principles of remote Sensing and Photogrammetry.
2. obtain knowledge of the sensor characteristics of various RS Systems
3. acquire knowledge of different missions & their utility
4. understand functioning, data acquisition and orbit operations of missions.

Suggested Readings:

1. Campbell, J. (2002): Introduction to Remote Sensing, Taylor & Francis, London
2. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall, New Jersey
3. Joseph, G. (2004): Fundamentals of Remote Sensing, Universities Press, Hyderabad, India
4. Lillesand, T. M., Kiefer, R. W. and Chipman, J. W. (2008): Remote Sensing and Image Interpretation, John Wiley & Sons, New Delhi
5. Sabins, F. F. (1996): Remote Sensing: Principles and interpretation, W.H. Freeman and Company, San Francisco

Code: GIS 502 **Practicals in Spatial Data Processing**

No. of Credits: 04 **No. of Practicals: 30**

Course Objectives:

1. To develop an understanding of the basic skills necessary to work with Geographic Information Systems (GIS) using ESRI's ArcGIS software.
2. To learn about GIS data types.
3. To learn spatial data visualization techniques, cartography, aerial photos, and stereo pairs in 3D.
4. To learn geoprocessing tools and Spatial query and data extraction.

Sr. No.	Topics	Practicals
1	Overview of GIS software: ArcGIS Desktop, Arc Pro, Arc catalogue, Arc tool Box.	02
2	Attribute Data: Creation of Schema, Tables, Data Definition, Data Input, Data Updating, Queries on Tables, Simple-Complex Query with two or more tables using SQL; Queries in Arc GIS and QGIS.	04
3	Spatial Data: Generation of Vector Layers (Point, Line, Polygon) Compute geometry - line and area measurements, convert coordinates between reference systems, Topology creation and editing in Arc GIS and QGIS.	06
4	Geodatabase: Feature Dataset, Feature Classes, Import of Data, Spatial Data Formats, Shape/Coverage Files, and Layers in Arc GIS and QGIS.	02
5	Georeferencing: Image georeferencing, Coordinate Systems, Datum Conversions, Map Projections, Types, Image to Image georeferencing, vector to raster georeferencing in Arc GIS and QGIS.	04
6.	Study of Satellite imagery: Visual Interpretation in different bands, study with B/W images, B/W IR, Color IR mages, TCC, FCC in Arc GIS and QGIS.	04
7	Spatial Processes: Spatial Joins with Tabular data, Clip Raster to Polygon, Extract values of raster from a point shape file, Clip vectors, Distance Computations on feature data, Editing Data: Selecting Features, Simple Editing Functions, Creating New Features, Modifying, Schema Changes, Spatial Analysis: Query by Attribute and Location in Arc GIS and QGIS.	06
8	Map Composition in ArcGIS and QGIS	02

Course Outcomes:

On completion of this course, the student shall be able to

1. understand basic spatial analysis techniques: georeferencing, spatial statistics.
2. create datasets in GIS using ESRI ArcGIS Software.
3. identify key concepts related to GIS/Remote Sensing and explore how to apply them to solve real-world problems.
4. identify required data sources, design data preparation and advanced techniques in order to achieve a geospatial solution.

Note: a) For 4 credits 4 hours practical twice a week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

- Bailey, T. C., & Gatrell, A. C. (1995). *Interactive spatial data analysis* (Vol. 413, No. 8). Essex: Longman Scientific & Technical.
- Bao, J., Tsui, Y. (2005): Fundamentals of Global Positioning System Receivers, John Wiley Sons, Inc., Hoboken.
- Environmental Systems Research Institute, Inc. (1998): Understanding GIS: The ARC/INFO Method, ESRI Press, Redland
- Fotheringham, S., & Rogerson, P. (Eds.). (2013). *Spatial analysis and GIS*. Crc Press.
- Longley, P. (2003). *Advanced spatial analysis: the CASA book of GIS*. ESRI, Inc.

Code: GIS 503 **Fundamentals of GIS**

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To understand the core concepts of Geographic Information Systems.
2. To get acquainted with popular GIS software and their functionalities.
3. To learn about various data models (vector and raster), data types, and data structures used in GIS.
4. To learn about spatial analysis methods, including spatial query, buffering, overlay, interpolation, and network analysis.
5. To understand how to apply these techniques to solve spatial problems.

Sr. No.	Topics	Lectures
1	Introduction to GIS: Definitions, Evolution, Components and Objectives	03
2	Overview of GIS Software Packages	02
3	Spatial Data: Concepts of Space and Time, Layers Coverage, Spatial Data Models, Representation of Geographic Features in Vector, Raster Data Models, Concept of Arc, Node, Vertices and Topology	05
4	Object Oriented Models: Advantages and Disadvantages, Computer Representation for Storing Spatial Data: Block Code, Run-Length Encoding, Chain Coding, Quadtree, Issues Governing Choice of Models	05
5	Non-Spatial Data: Advantages of Data Base Management System. Conceptual Implementation Models, Hierarchical, Network, and Relational Models	05
6	Relational Database Management System: Components, Concept, Database Schema, Tables and Relationships, Database Design Normalization (1NF, 2NF, 3NF Forms) Data Definition Manipulation using SQL, SQL-Query Processing, Operations on Tables, Integrity Constraints, Database Security, Role of Database Administrator (DBA), Metadata	05
7	Spatial Data Input: Digitization, Error Identification, Errors: Types, Sources, Correction; Editing and Topology Building	05

Course Outcomes:

On completion of this course, the student shall be able to

1. equip with a comprehensive understanding of GIS theory
2. understand data concepts and spatial analysis techniques, preparing them to apply GIS knowledge effectively in a wide range of applications and pursue more advanced GIS studies or professional opportunities.

Suggested Readings:

1. Chang, K. T. (2008): Introduction to Geographic Information Systems, Avenue of the Americas, McGraw-Hill, New York
2. Demers, M. N. (2000): Fundamentals of Geographic Information Systems, John Wiley and Sons, New Delhi
3. Korte, G. B. (2001): The GIS Book, Onward Press, Bangalore
4. Lo, C. P., Yeung, A. W. (2002): Concepts Techniques of Geographical Information Systems, Prentice-Hall of India, New Delhi

5. Longley, P. A., Goodchild, M. F., Maguire, D. J., Rhind, D. W. (2002): Geographical Information Systems and Science, John Wiley & Sons, Chichester

Code: GIS 504 Applied Statistics – I

No. of Credits: 02 **No. of lectures: 30**

Course Objectives:

1. To learn the theoretical part of statistical techniques.
2. To learn the advantages and application of different statistical techniques for analysis.
3. To study comparison and conclusions of data.
4. To learn about the concepts related to geographical data and its types.

Sr. No.	Topics	Lectures
1	Geographic Data: Sources, Types, Discrete and Continuous Series, Scales of Measurements	04
2	Organization of Data: Graphical representation of frequency distribution: Histogram, frequency curve, ogive curve.	05
3	Measures of Central Tendency: Athematic mean, median and mode; Measures of Dispersion: Absolute and relative measures	08
5	Correlation and Regression: Concept of Bivariate correlation Regression: Bivariate linear and exponential	08
6	Matrix algebra: Matrix operations, types of matrices	05

Course Outcomes:

On completion of this course, the student shall be able to

1. understand the analysis of data and conclude it.
2. understand the distribution of spatial data, how things are changing over time, and planning, designing, collecting data, analyzing, drawing meaningful interpretations and reporting of the research findings.

Suggested Readings:

1. Ebdon, D. (1977): Statistics in Geography, Basil Blackwell, Oxford
2. Frank, H. and Althoen, S.C. (1994): Statistics: Concepts Applications, Cambridge University Press,Cambridge.
3. Gregory, S. (1978): Statistical Methods for Geographers, Longman, London
4. Hammond, R. and McCullagh, P. (1991): Quantitative Techniques in Geography, Clarendon Press, Oxford
5. Rogerson, P. A. (2010): Statistical Methods for Geography, Sage Publications, London

Code: GIS 505 Concepts and Methods in Data Sources Exploration

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. How it is allowing interoperability for general people.
2. Learning data quality assurance and security.
3. Knowledge of available resources and tools for educating people.

Sr. No.	Topic	Practical
1	Types of Data sources: Opensource, freely available, Paid Advantages, and Limitations of overall data sources available on the web.	04
2	Demonstration of various geospatial data portals and hands-on training on data downloading techniques.	10
3	Recent trends and applications of various data portals. Data Exploration using Governmental data portals, and national-international/Global data portals.	06
4	Data download using data portals, command prompts, widgets, program codes, etc., Downloading Climate data from the Internet into ArcGIS	04
5	Lab assignment	06

Course Outcomes:

On completion of this course, the student shall be able to

1. Data integration and accessibility.
2. Will study Metadata management.
3. Gain knowledge of scalability and collaboration.

Reference Material

https://bhuvan.nrsc.gov.in/home/index.php
https://www.surveyofindia.gov.in/
https://www.usgs.gov/
https://www.earthdata.nasa.gov/
https://www.diva-gis.org/
https://www.esri.com/en-us/arcgis/about-arcgis/overview
https://bhoonidhi.nrsc.gov.in/
https://sedac.ciesin.columbia.edu/data/collection/spatialecon

Code: GIS 511 Business Communication and Soft Skills

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To introduce the concept of Business Communication.
2. To learn communication and interaction with clients.
3. To learn how to write emails, cover letters, and resume
4. To develop professionalism and time management.

Sr. No.	Topics	Practicals
1	Introduction to Business Communication, Communication Process, 7Cs of Effective Communications and Writing Skills	02
2	Etiquette and Interview: Body Language Introduction, Body Language, Advantages of Knowing Body Language, Importance of Body Language in General, Body Language Examples and What They Show, Sending the Right Messages with Your Body Language	03
3	Personality development: Characteristics, Factors, Roles of Personality - An overview, Approaches to Studying Personality, Characteristics of Personality, Factors of Personality, Roles of Personality in Organizational Behavior	02
4	Professionalism (Dressing and Grooming) Introduction, Professionalism (Dressing and Grooming) : An explanation, The Importance of Professionalism in Business, Corporate Dressing and Personal Grooming, Corporate Dressing for Success at Workplace, Personal Grooming	03
5	Interview Preparation and Curriculum Vitae / Resume Writing: Types of Interview, the purpose of the interview, Dos and Don'ts in CV/Resume Writing	03
6	Group Discussion and Time Management	02

Course Outcomes:

On completion of this course, the student shall be able to

1. understand all aspects of handling geographical information, also it provides a simple platform to understand most of the geographical phenomena and the occurrence of these phenomena.
2. perform map making and understand how to apply patterns and colors when representing features on a map.

Suggested readings :

1. Jethwaney, J. (2010). Corporate Communications: Principles and Practices. *OUP Catalogue*.
2. Kaul & Asha, Effective Business Communication, PHI 2nd Edition, 2006.
3. Lesikar R.V & Flately M V, Basic Communication Skills for empowering the internet generation, Tata-McGraw Hill, 2009.
4. Kuczerawy, A. (2017). The Power of Positive Thinking. *J. Intell. Prop. Info. Tech. & Elec. Com. L.*, *8*, 226.
5. Parker, Y., & Brown, B. (2012). *The damn good resume guide: A crash course in resume writing*. Ten Speed Press.

Code: GIS 512 Cartography and Data Representation

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To learn the representation of the region on a short scale.
2. To understand and display/represent graphic information using a GIS system.
3. To learn easier data symbolization.
4. To learn different types and components of geographical maps.
5. To develop a map in a detailed manner easily and digitally.

Sr. No.	Topics	Practicals
1	Introduction to Cartography and Elements of Map Design	02
2	Map Projection and Coordinate System: Concepts, Types, and Uses	04
3	Scales of Measurement: Nominal, Ordinal, Interval, Ratio; Graphical Representation of Statistical Data: Two- and Three-dimensional diagrams	04
4	Map types: Thematic, Topographical, Cadastral; Interpretation of SOI Topographical Maps: Identification and Visualization of different Physical and Manmade Features	03
5	Digital Cartography and Digital Data Representation	02

Course Outcomes:

On completion of this course, the student shall be able to

1. understand all aspects of handling geographical information, also it provides a simple platform to understand most of the geographical phenomena and the occurrence of these phenomena.
2. perform map making and understand how to apply patterns and colors when representing features on a map.

Note: a) For 2 credits 2 hours practical twice a week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Gupta, K. K. Tyagi, (1992): Working with maps, Survey of India Publication, DST, New Delhi
2. Monkhouse, F. J., & Wilkinson, H. R. (1963). Maps and diagrams: their compilation and construction. Egmont Books Ltd
3. Ramamurthy, K. (1982): Map Interpretation, Rex Printers, Madras
4. Robinson, A. H., Morrison, J. L., Muehrcke, P. C., Kimerling, A. J. Guptill, S. C. (1995): Elements of Cartography, Wiley, New York
5. Singh, R. L. (1979): Elements of Practical Geography, Kalyani Publishers, New Delhi
6. Understanding Map Projection (2003-2004): GIS by ESRI, Redlands.

Code: GIS 513	**Basic Programming with Python**	
No. of Credits: 02		**No. of Practicals: 15**

Course Objectives:

1. To master the fundamentals of writing Python scripts.
2. To learn core Python scripting elements such as variables and flow control structures.
3. To understand the object-oriented program design and development.
4. To work with Python data types like integers, floats, strings, characters, and lists.
5. To understand basic flow control, including loops and conditionals.

Sr. No.	Topics	Practicals
1	Introduction to Python: Comparison of Python with other programming languages, the execution model of Python, Salient features of Python, Areas where Python is in use, Industries that are using Python	01
2	Installing Python, Learning the syntax and semantics of Python, Using the Python interpreter, Python Keywords, Identifiers, Comments, Expressions, Statements, Input and Output, Type Conversion, Debugging, executing a Script, Structuring with Indentation, Editors.	01
3	Data types and Variables: Naming convention of variables, Basic Input-Output Operations, Basic Operators	01
4	Control structures: Boolean Values, Conditional Execution, If/Else Statements, For/while Statements, Range () function, Break and continue statements, Else clauses on Loops, Pass statements, Operations and Assignment statements	01
5	Functions: Define Function Statements with Parameters, Return Values and Return Statements, The None Value, Keyword Arguments, and print (), Local and Global Scope, The Global Statement, Lamda function	02
6	Data structures: List Data Type, Working with Lists, Augmented Assignment Operators, Methods, Stack, operations on the stack (push and pop), Tuples, Set, Dictionaries, and Structuring Data	02
7	Strings and String Methods: Working with Strings, Useful String Methods	01
8	File Handling: Files and File Paths, os. path Module, File Reading/Writing Process, Introduction to files, types of files (Text file, Binary file, CSV, excel file), relative and absolute paths	01
9	Modules and Packages: Standard modules, Packages, Defining Classes, defining functions, Creating Modules and Packages, importing a module, Import the names, Executing modules as scripts	01
10	Data Visualization: Basic data visualization with Matplotlib, Line Charts, Bar Graphs, Histograms, Scatter Plots, 3D plots, Heat maps	02

11	Finding and Fixing Code Bugs: Error handling and fixing bugs	01
12	Object-oriented design: Object-Oriented Approach, Classes, Methods, Standard Objective Features, Exception Handling, and Working with Files	01

Course Outcomes:

On completion of this course, the student shall be able to

1. develop algorithmic solutions to simple computational problems.
2. demonstrate programs using simple Python statements and expressions.
3. Explain control flow and function concepts in Python for solving problems.
4. use Python data structures lists, tuples and dictionaries for representing compound data.
5. explain files, exceptions, modules and packages in Python for solving problems.

Suggested Readings:

1. Barry, P. (2016). *Head first Python: A brain-friendly guide*. " O'Reilly Media, Inc.".
2. Chun, W. (2001). *Core Python programming* (Vol. 1). Prentice Hall Professional.
3. Lutz, M. (2013). *Learning Python: Powerful object-oriented programming*. " O'Reilly Media, Inc.".
4. Phillips, D. (2010). *Python 3 object-oriented programming*. Packt Publishing Ltd.
5. Sweigart, A. (2019). *Automate the boring stuff with Python: practical programming for total beginners*. No Starch Press.

Code: GIS 521 **Research Methodology**

No. of Credits: 04 **No. of Lectures: 60**

Course Objectives:

1. To understand the fundamental principles of the research.
2. To differentiate between different types of research.
3. To evaluate research design.
4. To set or develop a hypothesis.
5. To select the appropriate data collection method.
6. To apply research methodology to real-world problems.

Sr. No.	Topics	Lectures
1.	Methods of Geospatial Studies, Research: Definition, Types, Classification, Literature Review, Case Studies	10
2.	Methods of Explanation: Inductive, Deductive, Empiricism, Positivism, Hempel	04
3.	Hypothesis, Theories, Laws, and Models	04
4.	Research Question, Objectives, Significance of Research, Research Design	06
5.	Data Collection: Types, Methods, Tools and Techniques	05
6.	Recent Trends in RS and GIS Research	04
7.	Ethics in Scientific Research and Plagiarism	04
8.	Scientific Journals: Impact Factor, Citation,	03
9.	Introduction to useful online platforms: Mendeley, Google Scholar, ResearchGate, Shodhganga	04
10.	Research Proposal	04
11.	Presentation of Research Findings: Report Writing, Presentation and Formatting	04
12.	Citations, References, Bibliography and various referencing styles	04
13.	Evaluation of Research: Criteria of evaluation	04

Course Outcomes:

On completion of this course, the student shall be able

1. equip with the foundation skills and competencies needed to embark on their research journey successfully.
2. master research methodology.
3. to conduct meaningful research in their academic and professional endeavors.

Suggested Readings:

1. Gomez, B. and Jones, J. P. III (2010): Research Methods in Geography: A Critical Introduction, John Wiley and Sons
2. Goudie, A. (Ed) (2004): Encyclopedia of Geomorphology, Routledge, London

3. Gregory, D., Johnston, R., Pratt, G., Watts, M. and Whatmore, S. (2009): The Dictionary of Human Geography, Wiley-Blackwell, Singapore
4. Montello, D. and Sutton, P. (2013): An Introduction to Scientific Research Methods in Geography and Environmental Studies, SAGE Publications
5. Warf, B. (Ed) (2006): Encyclopedia of Human Geography, SAGE Publications, London

Year-I Semester-II

Code: GIS 551 **Digital Image Processing: Theory**

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To learn the interpretation of remote sensing images,
2. To understand numerous image processing and analysis techniques
3. To understand methods or algorithms to use is determined by the objectives of each specific requirement.
4. To learn the creation of new themed maps by combining multiple data layers in a computer.

Sr. No.	Topics	Lectures
1	Introduction to Digital Image Processing: Digital images, Types Sources of Errors, Atmospheric, Radiometric and Geometric; Image Rectification: Geometric Correction, Radiometric, Correction, Noise Removal	10
2	Image Enhancement Techniques: Contrast Enhancement, Linear, Non-Linear, Spatial Filtering, Edge Enhancement, Band Ratio and Band Combination	07
3	Digital Image Classification: Classification Scheme, Supervised Classification, Training Sites Selection, Classifier types, Unsupervised Classification, Accuracy Assessment	10
4	Object-oriented classification, Object-oriented vs. pixel-based classification, Algorithms for classification	03

Course Outcomes:

On completion of this course, the student shall be able to

1. extract additional information from geographical data that might not be obvious simply by looking at a map.
2. understand how efficiently they can encode, save, retrieve, overlay, correlate, alter, analyse, query, and display geographical data. Digital image processing and visual inspection are crucial components, and the results of these methods also help to gather data from the images.

Suggested Readings:

1. Cha, B., Dattaa, D., Majumdar (2001): Digital Image Processing Analysis, Prentice-Hall of India, NewDelhi
2. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall,NewJersey
3. Lillesand, T. M., Kiefer, R. W.Chipman, J. W.(2008): Remote Sensing and Image Interpretation, JohnWiley & Sons, New Delhi
4. Nag, P. Kudrat, M. (1998): Digital Remote Sensing, Concept Publishing Company, New Delhi
5. Richards, J. A, Jia,X.(1999):Remote Sensing and Digital Image Processing, Springer, Verlag Berlin

Code: GIS 552 **Digital Image Processing: Practicals**

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To learn the interpretation of remote sensing images,
2. To understand numerous image processing and analysis techniques
3. To understand methods or algorithms to use is determined by the objectives of each specific requirement.
4. To learn the creation of new themed maps by combining multiple data layers in a computer.

Sr. No.	Topics	Lectures
1	Introduction to ERDAS	1
2	Familiarization with Image Processing Systems: Loading of Image Data, Identification of Objects on Visual Display, Study of Histograms and Layer Information	2
3	Image Enhancement Techniques: Contrast Enhancement, Linear, Non-Linear, Spatial Filtering, Edge Enhancement, Band Ratio and Band Combination	2
4	Image Registration: Registration of Bases Map/ Topomap, Image to Map, Image to Image	2
5	Image Classification: Supervised, Unsupervised and Use of Different Algorithms, Change Detection	3
6	Accuracy Analysis: Producer, User Accuracy, Overall and Mapping Accuracy, Kappa Coefficient	2
7	Vector Layers: Generation of Vector Layer, Editing, and Area and Perimeter Estimation; Map Composition	3

Course Outcomes:

On completion of this course, the student shall be able

1. extract additional information from geographical data that might not be obvious simply by looking at a map.
2. understand how efficiently they can encode, save, retrieve, overlay, correlate, alter, analyze, query, and display geographical data. Digital image processing,
3. visual inspection is a crucial component, and the results of these methods also help to gather data from the images.

Note: a) For 2 credits 2 hours practical twice a week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Cha, B., Dattaa, D., Majumdar (2001): Digital Image Processing Analysis, Prentice-Hall of India, NewDelhi
2. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall,NewJersey
3. Lillesand, T. M., Kiefer, R. W.Chipman, J. W.(2008): Remote Sensing and Image Interpretation, JohnWiley & Sons, New Delhi
4. Nag, P. Kudrat, M. (1998): Digital Remote Sensing, Concept Publishing Company, New Delhi
5. Richards, J. A, Jia,X.(1999): Remote Sensing and Digital Image Processing, Springer, Verlag Berlin

Code: GIS 553 **Geospatial Analysis: Theory**

No. of Credits:02 **No. of Lectures: 30**

Course Objectives

1. To learn spatial data visualization techniques and cartography.
2. To learn geo-processing tools.
3. To learn about GIS and decision-making.
4. To learn about surface analysis.
5. To learn about 3D modelling and analysis.

Sr. No.	Topics	Lectures
1	Introduction to Spatial Analysis: Significance of Spatial Analysis, Overview of Tools for Analysis	03
2	Vector Analysis, Overlay Operations, Single Layer, Operations, Multilayer Operation	03
3	Raster Analysis: Map Algebra, Grid Based Operations, Cost Surface Analysis, and Proximity Analysis	04
4	Spatial Network and Location Analysis: Concepts, Evaluation of Network Complexity Using Alpha-Gamma Indices, C-Matrices for Evaluating Connectivity of the Network, Network Data Model, Path Analysis, Types of Network Analysis, Optimum Cyclic Path, Vehicle, Routing, Path Determination and Cost-Path Analysis	05
5	Point Pattern Analysis: Methods for Evaluating Point Pattern, Clustered. Geocoding and Reverse geocoding.	05
6	Surface and Grid Analysis, Creating 3D data, Mapping, Animation	04
7	Spatial Modeling: Role of Spatial Model, Explanative, Predictive and Normative Models, Correlation-Regression Analysis in Model Building, Handling Complex Spatial Query and case Studies	04
8	Big Data and Geospatial Analysis: Types and Challenges	02

Course Outcomes:

On completion of this course, the student shall be able to

1. apply a range of geospatial analysis techniques using remote sensing and GIS tools toward solving quantitative problems in one or more core disciplinary areas such as geography, ecology, environmental sciences, bio-geosciences, urban planning, natural resources management etc.
2. quantitatively analyze data to evaluate scientific hypotheses and arguments in remote sensing and geographic information science.

Suggested Readings:

1. Booth, B., Shaner, J., MacDonald, A., Sanchez, P. Pfaff, R. (2004): ArcGIS, Geodatabase Workbook, Redlands
2. Environmental Systems Research Institute, Inc. (1998): Understanding GIS: The Arc/Info Method, ESRI Press, Redlands.
3. ESRI (2003): Introduction to ArcGIS- I, Course Lectures, GIS Education Solutions
4. Makrewski, J. (1999): GIS Multi-criteria Analysis, John Wiley and Sons, New York
5. Melania, H. M., Rhonda, P., Minami, M., Hatakeyama, A. M. (2004): ArcGIS, Using ArcMap, ESRI Press, Redlands

Code: GIS 554 **Geospatial Analysis: Practical**

No. of Credits:02 **No. of Practical: 15**

Course Objectives

1. To learn spatial data visualization techniques and cartography.
2. To learn geo-processing tools.
3. To learn about GIS and decision-making.
4. To learn about surface analysis.
5. To learn about 3D modelling and analysis.

Sr. No.	Topics	Lectures
1	Editing Data: Selecting Features, Simple Editing Functions, Creating New Features, Modifying, Schema Changes	3
2	Spatial and Non-Spatial Data: Spatial: Linking Features Attributes, Ways to View Data, Metadata Non-Spatial: Understanding Tables, Field Types, Table Manipulations, Table Relationship, Joins, Relates, Creation of Graphs and Reports	3
3	Spatial Analysis: Query by Attribute and Location, Identifying Spatial and Non-Spatial Data, Geoprocessing Wizard, Spatial Analysis Functions, Multi Criteria Analysis using Boolean Logic	3
4	Network Analysis: Network Utility, Creating Network Model, Shortest Path, Geocoding	2
5	Surface and Grid Analysis: DEM, DSM and DTM, Creating 3D data, Animation	3
6	Presenting Data: Map Design, Map Composition	1

Course Outcomes:

On completion of this course, the student shall be able to

1. apply a range of geospatial analysis techniques using remote sensing and GIS tools toward solving quantitative problems in one or more core disciplinary areas such as geography, ecology, environmental sciences, bio-geosciences, urban planning, natural resources management, etc.
2. quantitatively analyze data to evaluate scientific hypotheses and arguments in remote sensing and geographic information science.

Note: a) For 2 credits 2 hours practical twice a week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Suggested Readings:
2. 1. Mitchell, A. (1999): The ESRI guide to GIS analysis, Redlands
3. 2. Zeiler, M. (1999): The ESRI guide to Geodatabase design, Redlands
4. 3. ESRI (2003): Introduction to ArcGIS- I, Course Lectures,GIS Education Solutions
5. 4. Booth, B., Shaner, J., MacDonald, A., Sanchez, P. Pfaff, R. (2004): ArcGIS,Geodatabase Workbook, Redlands
6. 5. Melania, H. M., Rhonda, P., Minami, M., Hatakeyama, A. M. (2004): ArcGIS, Using ArcMap, ESRI Press, Redlands
7. 6. Environmental Systems Research Institute, Inc. (1998): Understanding GIS: The Arc/Info Method, ESRI Press, Redland.

Code: GIS 555 Database Management Systems

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To present an introduction to database management systems.
2. To organize, maintain and retrieve - efficiently, and effectively - information from a DBMS.
3. To understand the relational database design principles.
4. To master the basics of SQL and construct queries using SQL.

No.	Topics	Lectures
1	Database concepts: introduction to database concepts and its need, relational databases, database architecture, Database Security.	03
2	Data Models: The importance of data models, Basic building blocks, The evolution of data models, and degrees of data abstraction; DBMS, RDBMS, Advantages and Disadvantages of DBMS	05
3	Database Design and ER-Diagram: overview, ER-Model, ER-Diagrams, ERD Issues, weak entity sets, Codd's rules, Relational Schemas, Introduction to UML; Relational database model: Logical view of data, keys, and integrity rules, Relational Database design and Normalization (1NF, 2NF, 3NF, BCNF)	05
5	Constraints and Views: Types of constraints, Concept of Backup Recovery, Concepts of views	04
7	Manipulating Dataset using SQL Statement: Basic Select Statement, Selecting Specific Column, Using Arithmetic Expressions, Defining Column Alias, using Where Clause	03
8	Restricting & Sorting Data: using Comparison Condition (=, <=, >=); Using Logical Operator: AND, OR, NOT, using BETWEEN, LIKE Conditions, Rule of Precedence, using Order by Clause	04
9	SQL Function: Sub-Query, Nested queries Concept of Function, Types, Group Functions, Use of Group by, Having Clause, Types of Joins	03
10	Spatial database systems and application: Exploring Spatial Geometry Organizing spatial data – spatial data relationships and functionalities– Application program and user Interfaces, Overview of NoSQL for spatial data handling	03

Course Outcomes:

On completion of this course, the student shall be able to

1. describe the fundamental elements of relational database management systems.
2. explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.
3. design ER models to represent simple database application scenarios.
4. extract data from the database using SQL.
5. understand the basic concept of spatial databases.

Suggested Readings:

1. Connolly, T. M., & Begg, C. E. (2005). *Database systems: a practical approach to design, implementation, and management*. Pearson Education.
2. Deshpande, P. S. (2008): SQL & PL/SQL for Oracle 10g, Blackbook, Dreamtech Press, New Delhi
3. Ramakrishnan, R., Gehrke, J., & Gehrke, J. (2003). *Database management systems* (Vol. 3). New York: McGraw-Hill.
4. Silberschatz, A., Korth, H. F., & Sudarshan, S. (2011). Database system concepts.
5. Ullman, J. D. (1983). *Principles of database systems*. Galgotia publications.

Code: GIS: 556 Advance Surveying and Fieldwork: Theory

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To understand advanced surveying concepts.
2. To utilize modern surveying instruments.
3. To plan and execute field survey.
4. To analyze and process survey data.
5. To apply surveying in various domains.

Sr. No.	Topics	Lectures
1	Introduction to GPS: GPS Survey, Data Import, Processing and Mapping	2
2	Introduction to Differential GPS (DGPS): Principle and Function, Data Collection and Data Processing	3
3	Single and Dual Frequency DGPS, RTK, and Static Surveys in DGPS, Use of DGPS in Topographical Survey	6
4	Introduction to Total Station: Principle and Function	3
5	REM, RDM, Use of Total Station for data processing and analysis	6
6	Comparison of Total Station with DGPS in Topographical Surveying	5
7	Introduction to Unmanned Aerial Vehicle (UAV): Principles and Functions	3
8	Types of UAV, DGCA directions and rules	2

Course Outcomes:

On completion of this course, the student shall be able to

1. handle advanced survey instruments such as Total Station, DGPS, and UAVs.
2. conduct surveys and collect the required data.
3. analyze the data and produce the results.
4. Correlation and compare the data from various sources.
5. integrate remote sensing data, such as aerial and satellite imagery, LiDAR and other remote sensing technology into surveying projects for enhanced spatial information.

Suggested Readings:

1. Jeff, H. (1995): Differential GPS Explained, Trimble Navigation
2. Lawrence, L. and Alex, L. (2008): GPS Made Easy: Using Global Positioning Systems in the Outdoors, Rocky Mountain Books, Calgary
3. Mohinder, S. G., Lawrence, R. W. and Angus, P. A. (2001): Global Positioning Systems, Inertial Navigation and Integration, John Wiley and Sons Inc., New York
4. Satheesh, G., Sathikumar, R. and Madhu, N. (2007): Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education, Delhi
5. Stinespring, B. M. (2000): The Experimental Evaluation of a DGPS Based Navigational System for the ARIES AUV, Monterey, California: Naval Postgraduate School; Springfield.

Code: GIS 557	**Project Management**	
No. of Credits: 02		**No. of Lectures: 30**
Course Objectives: 1. To understand the project's goals, deliverables, and constraints. 2. To understand work acceptance criteria.		
Sr. No.	**Topic**	**Lectures**
1	Project scope and limitations, Availability of resources, and collecting requirements.	05
2	Project phases, timelines, and schedules. Project monitoring and control. Budget	05
3	Resource optimization and schedule analysis, Techniques for prioritizing requirements, Milestones, and understanding dependencies.	05
4	Product/ work quality checks, Risk analysis, and management, Cost estimation budget, and release planning.	05
5	Presentation of Research Findings: Progress Report, Report Writing, Formatting and Presentation	10
Course outcomes: **On completion of this course, the student shall be able to** 1. Gain knowledge of expectations, delivering value, and ensuring client satisfaction. 2. Understand a comprehensive project plan that includes tasks, timelines, resource allocation, dependencies, and milestones. 3. Gain the project management knowledge and skills, necessary to manage an entire project		

Suggested Readings:

1. Stanley E. Portny (2013). Project Management for Dummies. 4th ed. New Jersey: John Wiley & Sons, Inc. 408. ISBN-13: 978-1118497234
2. Project Management Institute (2021). A Guide to the Project Management Body of Knowledge: PMBOK® Guide. Seventh Edition. Pennsylvania: Project Management Institute, Inc. ISBN: 978-162825664
3. Newell, M., & Grashina, M. (2003). The project management question and answer book. Amacom.
4. Nokes, S. (2007). The definitive guide to project management. Pearson Education India.
5. Schwalbe, K. (2009). Introduction to project management. Boston: Course Technology Cengage Learning

Code: GIS 561 Advance Programming with Python

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To master the numeric data processing with Python scripts.
2. To learn geospatial data analysis using Python.
3. To learn to create API and web applications using Python.
4. To work with GUIs and web browsers with Python.

Sr. No.	Topics	Practicals
1	NumPy and SciPy: Introduction to NumPy, Creation of vectors and matrices, Matrix manipulation	02
2	Pandas: Introduction, Pandas data structures – Series and DataFrame, Data wrangling, loading a dataset into a DataFrame, Selecting Columns, Selecting Rows, Adding/ Deleting new data in a DataFrame, manipulation of tabular data	02
3	Data Visualization: Matplotlib and Seaborn	01
4	GeoPandas: Introduction, Installation, Vector data processing, reading/writing shapefile, plotting, clip, overlay, spatial join, choropleth maps, classification	02
5	Rasterio: Introduction, Installation, opening data, reading, saving, georeferenced and visualizing raster files, spatial indexing, creating data	02
6	Scikit-Learn: for machine learning, model fitting, predicting, cross-validation, for predictive data analysis, Tensor Flow, Pytorch	02
8	Web Scraping: Beautiful Soap, python web browser Module, Downloading Files from the Web with the requests Module, Saving downloaded Files to the Hard Drive, HTML	01
9	Introduction to Django framework: Component structure	01
10	Arcpy for ArcGIS Pro	02

Course Outcomes:

On completion of this course, the student shall be able to

1. understand the concept of numerical python, manipulate and extract data from pandas DataFrames.
2. write Python code according to standard style guidelines.
3. master basic processing of Raster and vector data in python.
4. understand the concept of Django and Arcpy for ArcGIS Pro.

Note: a) For 2 credits 2 hours practical twice a week.

b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Beazley, D., & Jones, B. K. (2013). *Python Cookbook: Recipes for Mastering Python 3*. " O'Reilly Media, Inc."
2. Kanetkar, Y. (2019). *Let Us Python*. BPB Publications
3. Lutz, M. (2010). *Programming Python: powerful object-oriented programming*. " O'Reilly Media, Inc."
4. McKinney, W. (2012). *Python for data analysis: Data wrangling with Pandas, NumPy, and IPython*. " O'Reilly Media, Inc".

Code: GIS 562 Applications of GIS and Remote Sensing

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To learn the applications of remote sensing data and GIS techniques in different fields.
2. To understand periodic updates in various fields.
3. To monitor the environment and human activities using RS and GIS techniques.

Sr. No.	Topics	Lectures
1	Geosciences: Landform Analysis, Drainage Basin Morphometry, Slope Mapping, Integrated Approach for Landslide Hazard Zonation Models and Mapping	5
2	Water Resources: Watershed Hydrology, Physical Processes in Watershed, Hydrological Modeling	5
3	Forest: Image Processing for Forest, Vegetation Classification Mapping, Forest Inventory, Forest Management	5
4	Fundamental of Climatology: Meteorological Satellites, Forecasting of Natural Calamities, Climate change detection	5
5	Agriculture and Soils: Spectral Characteristics of Crop, Crop Inventory, Crop Yield Modeling, Soil Mapping, Crop Water Management, Agro-Ecological Zoning	5
6	Biodiversity: Assessment of Biodiversity Hotspots, Wildlife Habitat Suitability Analysis, Species Inventory	5

Course Outcomes:

On completion of this course, the student shall be able to

1. understand how remote sensing data and GIS techniques are efficient to find and analyze real world problem in the different fields and it will help for decision making to minimize problem and for their management.
2. understand Satellite imaging helps detect environmental and structural changes in various sites.

Suggested Readings:

1. Deekshatulu, B. L. (1990): Description and useofLand use/Landcover, NRSA, Hyedrabad
2. Harris, J. E. (1990): Earthwatch – The Climate from space, Ellishorwood Ltd., Midsower Norton
3. Lal, D. S. (1998): Climatology, Chaitanya Publishing House, Allahabad
4. SPRS Technical Commission VII (2002): Symposium on Resource Environmental Monitoring, ISRS Annual Convention, IIRS, Dehradun
5. Roy, P.S., Dwivedi, R. S. (2010): Remote Sensing Application www.nrsc.gov.in/Learning-Center, E Book. html

Code: GIS 563 Applied Statistics – II

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To understand GIS and geo-statistical techniques, tools and approaches for spatial analysis.
2. To enhance the knowledge about the distribution of spatial data.
3. To learn how to make predictions to better understand the available information.

Sr. No.	Topics	Practicals
1	Geographical Data and Multivariate Analysis	01
2	Trend Surface Analysis: Computation of Linear Trend and Ideas of Quadratic and Cubic Surfaces	04
3	Principal component analysis (PCA), Factor Analysis	03
4	Introduction to R software: Exploratory data analysis, Probability, and statistical operations, Regression, and least squares using R	04
5	Geostatistics: Point data interpolation techniques including kriging methods - Simple kriging, Ordinary kriging, Universal kriging	03

Course Outcomes:

On completion of this course, the student shall be able to

1. understand the geostatistical methods and their application in different GIS domain, spatial trends in the data, or whether the features form spatial patterns.
2. analyze and predict the values associated with spatial or spatio-temporal phenomena.
3. enhance their knowledge about recent trends in geostatistics and it will offer convenient management in the related field.

Note: a) For 2 credits 2 hours practical twice a week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Acevedo, M. F. (2012). *Data Analysis and Statistics for Geography, Environmental Science and Engineering*. London: CRC Press.
2. Hammond, R. and McCullagh, P. (1991): Quantitative Techniques in Geography, Clarendon Press, Oxford
3. Johnston, R. J. (1978). *Multivariate Statistics in Geography*. London: Longman.
4. Rogerson, P. A. (2010). *Statistical Methods for Geography*, London: Sage Publications

Code: GIS: 564 Advanced Surveying and Fieldwork: Practicals

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To understand advanced surveying concepts.
2. To utilize modern surveying instruments.
3. To plan and execute field survey.
4. To analyze and process survey data.
5. To apply surveying in various domains.

Sr. No.	Topics	Practicals
1	GPS: GPS Survey, Data Import, Processing and Mapping	03
2	Introduction to Total Station: REM, RDM, Use of Total Station for data collection, processing, and analysis	04
3	Introduction to Differential GPS (DGPS): DGPS setting of Instruments at base and rover, DGPS Survey and Data Processing	04
4	Introduction to Unmanned Aerial Vehicle (UAV): Drone Survey, Data Collection, Data processing	04

Course Outcomes:

On completion of this course, the student shall be able to

1. handle advanced survey instruments such as Total Station, DGPS, UAV.
2. conduct survey and collect the required data.
3. analyze the data and produce the results.
4. corelate and compare the data from various sources.
5. integrate remote sensing data, such as aerial and satellite imagery, LiDAR and other remote sensing technology into surveying projects for enhanced spatial information.

Note: a) For 2 credits, 2 hours practical twice a week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

2. Jeff, H. (1995): Differential GPS Explained, Trimble Navigation
3. Lawrence, L. and Alex, L. (2008): GPS Made Easy: Using Global Positioning Systems in the Outdoors, Rocky Mountain Books, Calgary
4. Mohinder, S. G., Lawrence, R. W. and Angus, P. A. (2001): Global Positioning Systems, Inertial Navigation and Integration, John Wiley and Sons Inc., New York
5. Satheesh, G., Sathikumar, R. and Madhu, N. (2007): Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education, Delhi
6. Stinespring, B. M. (2000): The Experimental Evaluation of a DGPS Based Navigational System for the ARIES AUV, Monterey, California: Naval Postgraduate School; Springfield.

Code: GIS 571 **On Job Training**

No. of Credits: 04

On Job Training (OJT) in the RS and GIS field aims to provide necessary knowledge and practical skills to excel in their RS and GIS roles. The objectives of OJT in RS and GIS are as follows.

1. To understand spatial data management and perform spatial analysis.
2. To interpret remote sensing imagery.
3. To apply RS and GIS in real world problems.
4. To enhance problem solving skills.
5. To foster collaboration and communication.
6. To emphasize data ethics and privacy.
7. To embrace emerging technology.

By considering on these objectives, OJT in the RS and GIS field equips employees with the necessary skills and knowledge to contribute effectively to geospatial projects, making them valuable assets in the organization's geospatial endeavors.

Guidelines

1. For on Job Training, the students will be attached with various institutions and employing establishments, which have laboratory/workshop, other related facilities and where adequate supervision by qualified personnel will be available.
2. A student is expected to spend not less than 60 working hours on On-Job Training and related activities.
3. On Job Training will be carried out in summer vacation after the students complete their second semester examinations.
4. Students need to provide the confirmation letter from the organization or the institute where they have joined for On Job Training.
5. Continuous evaluation of the students' performance in the On-Job Training will be carried out with the assistance of the personnel of training institutions/employing establishments where this training will be imparted.
6. The proof of completion of On Job Training (work experience certificate and field report) should be submitted during examination to the parent institution, duly issued and signed by the concerned training authority.

Course Outcomes:

On completion of this course, the student shall be able to

1. apply the principles of RS and GIS in real-world projects.
2. solve problems and enhance their critical thinking skills.
3. effectively communicate and collaborate with corporate industries.
4. adapt to emerging RS and GIS technology.
5. embrace different pathways of learning, including experiential learning.
6. understand the social, economic and administrative considerations that influence the working environment of different organizations.
7. learn new strategies like time management, multi-tasking and new skills.
8. get an opportunity to meet new people and learn networking skills.

Year-II Semester-I

Code: GIS 601 Advances in Remote Sensing and GIS: Theory

No. of Credits: 04 **No. of Lectures: 60**

Course Objectives:

1) To learn advanced concepts and theories of remote sensing and GIS.
2) To understand advanced sensor technologies in RS and GIS.
3) To understand recent trends in RS and GIS
4) To understand advanced skills for spatial data handling

Sr. No.	Topic	Lectures
1	**Advanced techniques of Digital Image Processing**: Principal Component Analysis, Fourier Transformation, IHS, Texture, Sub-Pixel, and Image Fusion, Image Segmentation, Logistic modeling, Geographically Weighted Regression, Land Cover Change Modelling, Markov Chain Modelling, Advantages and difficulties in Time-series satellite data, Time-Composite Techniques, Temporal Smoothing Techniques - Fourier, Double Logistic, Gaussian, Seasonal Trend, Information Extraction Algorithms, Applications from Time-series.	10
2	**Spatial Data Mining**: Methods for Knowledge Discovery Spatial in Databases, Methods of Clustering, Exploring, Spatial Association, Mining in Raster Database	08
3	**Spatial Decision**: Analysis and Fuzzy Logic, General Suitability and Multicriteria Modelling, Multi-Criteria Decision Analysis, Estimation of Weights. Analytic Hierarchy Process (AHP), Fuzzy Logic, Operations on Fuzzy Sets, Fuzzy Vs. Boolean, Errors, and uncertainty analysis.	10
4	**Decision Support Systems**: Types of Problems, Efficiency, Effectiveness of Decision Making, Architecture of DSS Tools, Significance of DSS, DSS Experts Systems	08
5	**Recent Trends in GIS**, History of Network Technology, Interoperability Specifications. Automation, 3D and Digital Twins, Integrate BIM, CAD, and GIS.	08
6	**Cloud Computing**: Introduction, Types, Types of cloud services, GIS in The Cloud, Subscription-based SaaS, Introduction to Cloud and Server GIS, Cloud Essentials: Intro to Git & Github.	08
7	**Big Data Analysis:** Introduction to Big Data Paradigm and Geospatial Big Data, The V's of data, Real-time and big data and analytics, Hadoop and MapReduce, Big Data Platforms.	04
8	**Crowdsourcing:** Introduction to crowdsourcing, Importance, Types, Examples, Advantages, Challenges and Considerations, Crowdsourcing in RS and GIS,	04

Course Outcomes:

On completion of this course, the student shall be able to

1. demonstrate a comprehensive understanding of the advanced theories and principles underlying remote sensing and GIS technologies.
2. apply advanced techniques in remote sensing, such as image processing, classification, and spatial analysis using GIS software, to interpret and analyze geospatial data effectively.
3. critically assess the quality, accuracy, and reliability of remote sensing data and GIS-generated outputs for various applications.
4. develop critical thinking skills to analyze complex geospatial problems, formulate hypotheses, and apply appropriate methodologies to solve them using remote sensing and GIS theories.

Suggested Reading:

1. Richards, J. A., Jia, X. (2000): Remote Sensing and Digital Image Processing, Springer,Verlag Berlin
2. Chand, B., Majumdar, D. D. (2001): Digital Image Processing AnalysisPrentice- Hall of India, New Delhi
3. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall, New Jersey
4. Lillesand, T. M., Kiefer, R. W.,Chipman, J. W.(2008): Remote Sensing and Image Interpretation, John Wiley & Sons, New Delhi
5. Sabins, F. F. (1996): Remote Sensing: Principles Interpretation, W.H. Freeman Company, New York

Code: GIS 602 Practicals in Advance Remote Sensing and GIS

No. of Credits: 04 **No. of Practicals: 30**

Course Objectives:

1) To acquire practical skills using advanced remote sensing and GIS software tools for data processing, analysis, and interpretation.
2) To develop proficiency in applying advanced image processing techniques such as classification, change detection, and spatial enhancement to remote sensing data.
3) To gain practical experience conducting spatial analysis, modeling, and visualization using GIS software for real-world applications.
4) To learn to integrate and analyze diverse geospatial datasets for comprehensive analysis.

Sr. No.	Topic	Practicals
1	**Advanced Image Enhancement Techniques**: Principal Component Analysis, Fourier Transformation, IHS, Texture and Image Fusion	05
2	**Advanced Spatial Analysis**: Multi-Criteria Analysis, Fuzzy Logic, Classification: Fuzzy, Decision Tree, AHP.	05
3	Data processing and Interpretation of Thermal and OCM Images.	05
4	Data processing and Interpretation of Radar and Hyperspectral Images.	05
5	Data processing and Interpretation of Lidar Images.	05
6	**Time-series data Analysis:** Time-Composite Techniques	05

Course Outcomes:

On completion of this course, the student shall be able to

1) demonstrate proficiency in utilizing advanced remote sensing and GIS software tools for data manipulation, analysis, and interpretation.
2) apply advanced image processing techniques to enhance remote sensing data for various applications.
3) develop the ability to perform complex spatial analyses, including feature extraction, change detection, and terrain modeling using GIS software.
4) integrate and analyze diverse geospatial datasets to solve real-world problems and generate comprehensive geospatial models.
5) apply remote sensing and GIS techniques to assess environmental changes, monitor ecosystems, and analyze natural resources effectively.

Note: a) For 4 credits, 4 hours practical twice a week.

b) The concerned teacher may add some points related to the subject.

Suggested readings:

1. ESRI (2003): Introduction to ArcGIS – II, Course Lectures, GIS Education Solutions, Redlands
2. Bratt, S., Booth, B. (2004): ArcGIS, Using 3D Analyst, ESRI Press, Redlands

3. McCoy, J., Johnston, K., Kopp, S., Borup, B., Willison, J., Payne, B. (2002): ArcGIS, Using Arc GIS Spatial Analyst, Redlands
4. Hodson, T. Clark, K. (2003): Using ArcGIS Spatial Analyst, Redlands
5. Environmental Systems Research Institute, InC.(1998) Understanding GIS: The ARC/INFO Method, ESRI Press, Redlands

Code: GIS 603 Thermal and Microwave Remote Sensing

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To provide learners with knowledge of basic scientific concepts underlying Thermal and Microwave remote sensing.
2. To describe the benefits of Thermal and Microwave remote sensing for observing various surface properties when compared to visible and infrared remote sensing.
3. To understand the application and interpretation of Thermal and Microwave observations and products in Earth Sciences.

Sr. No.	Topic	Lectures
1.	**Thermal Remote sensing:** Fundamental of Thermal Remote Sensing, Thermal infrared radiation properties. Atmospheric effect of thermal remote sensors, Interaction of thermal radiation with terrain element, Thermal scanners, interpreting thermal scanner imagery, Geometric characteristics of thermal imagery, Temperature mapping with thermal scanner data.	06
2.	**Thermal Image Analysis:** characteristics of IR images Image acquisition, segmentation, feature extraction, classification, interpretation. Advantages of thermal imagery.	04
3.	**Microwave Remote Sensing:** Introduction, history of microwave, Concepts, active and passive systems; RADAR: principles and development, Polarization, Doppler shift, Speckle noise filtering; SAR: principles and system parameters; Surface roughness characteristics; Scattering models: surface and volume scattering.	06
4.	**Microwave Image Analysis:** Atmospheric interaction; SAR Interferometry, Differential SAR Interferometry, Polarimetric InSAR/DInSAR; Scattering Matrix, Covariance and Coherency Matrix, overview of PolSAR decomposition model.	06
5.	**Microwave satellites in operation:** Seasat, Radarsat, Shuttle, Imaging Radar (SIR), Sentinel, ERS: Elements of Passive microwave remote sensing, Passive microwave scanner, application of passive microwave remote sensing.	02
6.	**Application of Microwave Remote Sensing:** Applications of active and passive microwave remote sensing data.	03
7.	**Application of Thermal Remote Sensing:** Determination of Emissivity and Land Surface Temperature (LST) using thermal band, Application of LST.	03

Course Outcomes:

On completion of this course, the student shall be able to

1. Understand fundamental concepts of Thermal and Microwave remote sensing and their acquisition.

2. Gain knowledge in the principles of Thermal and Microwave image analysis and interpretation
3. Understand concepts of passive and active microwave systems, Thermal remote sensing.
4. Acquire skills in analyzing Thermal and Microwave Remote Sensing data for various thematic mapping and its applications.

Suggested Readings:

1. Remote Sensing and Image interpretation: Thomas Lille sand & R.W. Keifer, John Wiley and Sons (3rd Ed.).
2. Text Book of Remote Sensing & Cartography Kalyani Publication, D. Nandi, T. Chattrejee..
3. Remote Sensing: Principles and Interpretation: F. Sabins, Freeman Publication.
4. Remote Sensing of the Environment by J.R. Jensen, Pearson Publication
5. Ulaby, F.T., Moore, R.K, Fung, A.K, "Microwave Remote Sensing; active and passive, Vol. 1,2 and 3, Addison – Wesley publication company, 2001.
6. John R.Jensen, Remote Sensing of the Environment: An Earth Resource Perspective, Pearson Education India, 2013.
7. John A. Richards, Remote Sensing with Imaging RADAR, Springer,2009.

Code: GIS 604	**Hyperspectral and LASER Remote Sensing**	
No. of Credits: 02		**No. of Lectures: 30**
Course Objectives: 1. To understand concepts, functions and analysis of Hyperspectral Remote Sensing data and their acquisition. 2. To understand concepts, functions and analysis of LIDAR Remote Sensing data and their acquisition. 3. To understand the application of Lidar and Hyperspectral RS in Earth Observation.		
Sr. No.	**Topic**	**Lectures**
1	**Hyperspectral Remote Sensing:** Basic Concepts, Spectral Radiometry, HS data acquisition, Spectroscopy – Point and Imaging; BDRF and hemispherical reflectance; Airborne and Spaceborne hyperspectral systems; Spectral library. Hyperspectral Sensors: MODIS, EMIT, Hyperion/HYSI, AVRIS/NG, terrestrial and UAV-based hyperspectral remote sensing, Operational and future sensors.	05
2	**Hyperspectral Image Analysis:** Hughes phenomenon, Pre-processing, Feature Reduction, Endmember Collection: Spectral Unmixing, Spectral Matching; Classification Techniques, Image cube, Spectral matching, Digital Spectral Data, Libraries, Hyperspectral feature extraction techniques – Spectral angle mapping (SAM), Spectral Feature Fitting (SFF), Linear feature Un-mixing (LUS), Mixture Turned Matched Filtering (MTFT), cross correlogram, constrained energy minimization, Hyperspectral indices	05
3	**LASER Remote Sensing:** Fundamental of LIDAR remote sensing, LIDAR Data Processing, LIDAR Data Management, and Applications, Terrestrial and Bathymetric Laser Scanner. LASER Sensors: Space, Air, Terrestrial and UAV-based LASER remote sensing, Operational and future sensors.	05
4	**LASER data Analysis:** Retrieval of geophysical parameters using Thermal remote sensing, Laser footprint, multiple footprints, bathymetry lidar, full wave digitization, lidar footprint geo-location, terrain products, extraction from point data, and lidar waveform.	05
5.	**Application of Hyperspectral Remote Sensing:** Geological exploration, detection, and mapping of minerals, mapping and monitoring of mining sites, Soil characterization, and observation, digital soil mapping, quantitative soil spectroscopy quantitative determination of soil parameters (including organic carbon, soil moisture, grain size, iron oxides, carbonates, gypsum): sustainable management of renewable resources, soil erosion and land degradation mapping, soil contamination, Monitoring of dry areas for water management and early detection of ecosystem changes.	05

6.	**Application of LASER Remote Sensing:** in Autonomous Vehicles driving technique, Aerial Inspection of power lines, civil infrastructure, and other industrial assets, Precision Agriculture, Forestry and Land Management, Survey and mapping, Renewable energy - calculate direction and wind speed, Robotics.	05

Course Outcomes:

On completion of this course, the student shall be able to

1. Understand fundamental concepts of Hyperspectral and Laser/Lidar remote sensing and their acquisition.
2. Gain knowledge in the principles of Hyperspectral and Laser/Lidar image analysis and interpretation
3. Acquire skills in analyzing Hyperspectral and Laser/Lidar Remote Sensing data for various thematic mapping and its applications.

Suggested readings:

1. Remote Sensing and Image interpretation: Thomas Lille sand & R.W. Keifer, John Wiley and Sons (3rd Ed.).
2. Text Book of Remote Sensing & Cartography Kalyani Publication, D. Nandi, T. Chattrejee.
3. Remote Sensing: Principles and Interpretation: F. Sabins, Freeman Publication.
4. Remote Sensing of the Environment by J.R. Jensen, Pearson Publication
5. Lidar: Range-Resolved Optical Remote Sensing of the Atmosphere, edited by Claus Weitkamp.
6. Manual of Airborne Topographic Lidar by Michael S. Renslow.
7. Lidar T echniques and Remote Sensing in the Atmosphere: Understanding the Use of Laser Light in the Atmosphere by Francis Emmanuel Mensah.
8. *Hyperspectral Remote Sensing* (SPIE Press Monograph v. PM210) by Michael T. Eismann.
9. Navalgund, R. R. Ray, S. S. (2011): Hyperspectral Data, Analysis Techniques Application, Indian Society of Remote Sensing, Dehradun

Code: GIS 605 Web GIS and Google Earth Engine

No. of Credits: 02 **No. of lectures: 30**

Course Objectives:

1. Understanding the web solutions to handle growing data volumes and transactions.
2. Learning the advanced web-based spatial analysis capabilities.
3. How to do interactive maps and applications for civilians.
4. To gain proficiency in writing custom Script for Earth Engine.

Sr. No.	Topics	Lectures
1	**Web GIS**: Internet GIS and distributed GIS services, Networking fundamentals of Internet GIS, Technical evolution of web mapping, commercial web mapping programs	03
2	**Mobile GIS**: system and generic architecture of Mobile GIS, Operating systems for Mobile GIS, Wireless web, Samples of programs used in Mobile GIS, real-time applications, customization of Mobile GIS	03
3	**ArcGIS Server ArcSDE**: ArcGIS Server and Architecture, Web, Application Functionality, GIS Web Service. ArcSDE: Introduction, SDE Connection, Configuration Options, SDEfor Developers Data Storage: SDE Geodatabase. ArcSDE Architecture	04
4	Open Street Map, Overpass turbo, Kepler.gl, Post GIS, Mapbox, CartoDB, Mapillary, FME.	04
5	**Google Earth Engine (GEE)**: Fundamentals of GEE, Introduction to GEE data catalog, Accessing vector and Raster data. Introductions to various functions and methods of GEE for geospatial data analysis.	08
6	**GeoServer**: Introduction to Geoserver, Setting up Geoserver, Creation of Workspace, Creation of DataSource, Creation of Layers, Publishing layers, Introduction to GeoExplorer.	06
7	Introduction to Leaflet and GeoJson	01
8	**Utility GIS**: Ericson network engineering software, Arc FM, APDRP, Enterprise GIS, ArcGIS online.	01

Course Outcomes:

On completion of this course, the student shall be able to

1. Web GIS enables you to make informed decisions by web-based analysis, and skill enables you to create custom algorithms.
2. How to provide effective, interactive visualization and representation of spatial data.
3. Integration of spatial data with other data types comprehensive view of information.
4. The integration of real-time data into geographic information.

Suggested Readings:

1. Roland Billen, Elsa Joao, David Forrest (2006): Dynamic and Mobile GIS: Investigating Changes in Space and Time, CRC Press
2. Zhong-RenPeng, Ming-Hsiang Tsou, Peng (2003): Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks, John Wiley & Sons
3. Jonathan Raper (2008): Mobile GIS: The Arcpad Way, EsriPr; Illustrated edition

Code: GIS 611 Machine Learning and Artificial Intelligence

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. Study the concepts of Artificial Intelligence and Machine Learning.
2. Learn the methods of solving problems using Artificial Intelligence and ML.
3. Learn the classification techniques and applications in Earth Sciences.
4. Introduce the concepts of Deep Learning and machine learning.

Sr. No.	Topic	Lectures
1.	**Artificial Intelligence:** Introduction, Philosophy of AI, Definitions	02
2.	AI and Problem Solving by Search, modeling a Problem as a Search Problem, Uninformed Search, Knowledge Representation and Reasoning, Planning and Decision Making, and Reinforcement Learning.	03
3.	**Machine Learning:** Introduction to ML, Performance Measures, Bias-Variance Trade-off, Linear Regression., ML in GIS and Remote Sensing	03
4.	**Introduction to ANN:** back Propagation, training algorithms, classifiers.	01
5.	**Machine Learning and Deep Learning**: Techniques - Bayesian Networks, CNN, RNN/LSTM, VaE, Interpretability, Causality, Support vector machine.	04
6.	**Classification**: Supervised, unsupervised, hybrid, Object-based image classification (OBIA) VS pixel-based image classification Regression Model: theory, Segmentation	03
7.	**Introduction to Deep Neural Networks:** Convolutional Neural Networks, AlexNet, VGGNet, GoogleNet.	03
8.	**Recent Trends in Deep Learning:** Deep Learning Architectures, Transfer Learning, Residual Networks, Skip Connection Networks, Autoencoders and relation to PCA, Recurrent Neural Networks	03
9.	**Geospatial AI:** Introduction, application, Geospatial Big Data Visualization Methods and Tools	03
10.	Prediction in GIS and deep learning for Big Data Analysis	01
11.	**Applications and case studies:** ML - Earth System Process Understanding, applications in different domains.	04

Course Outcomes:

On completion of this course, the student shall be able to

1. Be familiar with Artificial Intelligence, its foundation and principles.
2. Identify appropriate AI methods to solve a given problem.
3. Examine the useful search techniques, knowledge representation techniques,
4. Inference methods; learn their advantages, disadvantages and comparison.
5. Understand important concepts like Expert Systems, AI applications in Earth Sciences.
6. Explain how to apply basic machine learning algorithms and techniques in a meaningful manner to remote sensing data.

Suggested readings:

1. E. Alpaydin, Introduction to Machine Learning, 3rd Edition, Prentice Hall (India) 2015.
2. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, 2nd Edn., Wiley India, 2007.
3. C. M. Bishop, Pattern Recognition and Machine Learning (Information Science and Statistics), Springer, 2006.
4. Patrick Henry Winston, Artificial Intelligence, Third Edition, Addison-Wesley Publishing Company, 2004.
5. Nils J Nilsson, Principles of Artificial Intelligence, Illustrated Reprint Edition, Springer Heidelberg, 2014.
6. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, PHI 2009
7. Handbook of Spatial Statistics, Edited By Alan E. Gelfand, Peter Diggle, Peter Guttorp, Montserrat Fuentes, CRC Press, 2010
8. Deep Learning for the Earth Sciences, Edited by Gustau Camps-Valls, Devis Tuia, Xiao Xiang Zhu, Markus Reichstein

Code: GIS 612 Programming in HTML and JavaScript

No. of Credits: 02 **No. of Practical: 15**

Course objectives:

1. To understand web structure.
2. To create accessible HTML content for building websites that are user-friendly for all.
3. To make web pages responsive and interactive.
4. To understand client-side scripting.
5. To map interactions.

Sr. No.	Topics	Practical
1.	**HTML:** Introduction of HTML, History, Building Block of a web page, Development of a basic HTML document structure, HTML Attributes.	02
2.	HTML Tables, HTML Lists, HTML forms, Various HTML tags for web page designing, Formatting of web page, Concept of CSS, Usage and advantages of CSS in web development.	02
3.	**JavaScript:** Evolution of JavaScript, Features of JavaScript, Advantages and Disadvantages of JavaScript, Importance of Java Script, Creating Sample Program.	02
4.	**JavaScript Data Types, Variables:** Data Types, Types of Operators, Key Difference between var, let, and const.; Basic coding for conditional statements, loops, functions, arrays, objects, Event handling, exception handling, and forms.	02
5.	**Web Document Model:** Understanding document object model (DOM) and browser object model (BOM).	02
6.	**Debugging in Web Application:** Working with Developer Tools in Browser, Layout Engines Used in Various Browsers.	02
7.	Introduction to various geospatial application programming interfaces to visualize and display geographic data.	03

Course Outcomes:

On completion of this course, the student shall be able to

1. Providing a stepping stone to more advanced web development.
2. Understanding the features that support web accessibility.
4. Linking (web pages), Navigation, and Multimedia Integration into the web pages.
3. Generate the foundation for understanding how Geospatial and web technologies work together.

Note: a) For 2 credits, 2 hours practical twice a week.

b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Balagurusamy, E.(2011): Programming with JAVA- a Primer, Tata-McGraw Hill Education Pvt. Ltd.,New Delhi
2. Horton, I. (2008): Beginning Java 2, Wiley-India Inc.,New Delhi
3. Holzner, S. (2008):HTML Black Book, Dreamtech Press, India Paraglyph Press, USA
4. Crockford, D. (2008). *JavaScript: The Good Parts: The Good Parts*. " O'Reilly Media, Inc.".
5. Zakas, N. C. (2010). *High performance JavaScript: build faster web application interfaces*. " O'Reilly Media, Inc.".
6. Mikowski, M., & Powell, J. (2013). *Single page web applications: JavaScript end-to-end*. Simon and Schuster.
7. Fu, P., & Sun, J. (2011). *Web GIS: principles and applications* (pp. 89-114). Redlands: ESRI press.
8. Rubalcava, R. (2017). *Introducing ArcGIS API 4 for JavaScript: Turn Awesome Maps into Awesome Apps*. Apress.

Code: GIS: 613	**Organizational Behavior**	
No. of Credits: 02		**No. of Lectures: 30**
Course Objectives: 1. To study the fundamental concepts of organizational behavior. 2. To understand the impact of individual and group behavior on organizational effectiveness. 3. To learn about the motivation and leadership influence on Behavior and Performance. 4. To learn about Group Dynamics of people management and conflict management. 5. To understand the diverse work culture and essence of Quality Work Life in an Organization.		
Sr. No.	**Topics**	**Lectures**
1	**Focus and Purpose**: Definition, need, and importance of organizational behavior. Nature and scope – Frame work – Organizational behavior models, Organization, and environmental factors. Organizational Theory, Organizational behavior modification. Misbehavior –Types	05
2	**Individual Behavior**: Types and Factors influencing personality Theories. Types of learners, the learning process, and Learning theories. Attitudes, Characteristics, Components, Formation, Measurement-Values. Perceptions – Importance – Factors influencing perception – Interpersonal perception- Impression Management. Emotions and Moods in the Workplace Group Behavior, Organization structure, Groups in organizations, Group dynamics Interpersonal Communication, Team building, Interpersonal relations, and Group decision-making techniques. Conflict and its types, Conflict Redressal process	15
3	**Leadership and Power**: importance, traits, styles, and Theories. Leaders vs. managers, Sources of power, Power centers, Power and Politics. Motivation at work: importance, need, types and its effects on work behavior. Motivation Theories.	05
4	**Organizational culture and climate**: Factors affecting organizational climate Organizational change: Importance, Stability vs. change, Proactive vs. reaction change, the change process, Resistance to change, Managing change. Stress: Work Stressors, Prevention and Management of Stress, Balancing Work and Life. Organizational Development: Characteristics & objectives. Organizational effectiveness.	05

Course Outcomes:

On completion of this course, the student shall be able to

1. Demonstrate how the organizational behavior can integrate in understanding the motivation (why) behind behavior of people in the organization.
2. to analyze and compare different models used to explain individual behaviour related to motivation and rewards
3. to identify the processes used in developing communication and resolving conflicts
4. to explain group dynamics and demonstrate skills required for working in groups (team building)
5. to identify the various leadership styles and the role of leaders in a decision-making process.

Suggested Readings:

1. Robbins, S., Judge, T. A., Millett, B., & Boyle, M. (2013). *Organisational behaviour*. Pearson Higher Education AU.
2. Dailey, R., Keenan, T., & Tayeb, M. H. (1990). *Organisational behaviour*. Pitman.
3. Butler, M., & Rose, E. (Eds.). (2011). *Introduction to organisational behaviour*. Kogan Page Publishers.
4. Ranganayakulu, K. C. S. (2005). *Organisational behaviour*. Atlantic Publishers & Dist.
5. Khanka, S. S. (2002). Organisational Behaviour. *Finance India*, *16*(1), 329-329.
6. Dutt, R. (2009). *Organisational Behaviour*. Krishna Prakashan Media.

Code: GIS 621	**Research Project**
No. of Credits: 04	

Course Objectives:

1. To develop research skills.
2. To develop critical thinking and problem-solving capacity.
3. To learn various tools and techniques of data collection.
4. To build technical and methodological proficiency.
5. To develop presentation skills
6. To develop independent learning and initiative

Guidelines:

1. Each student will perform a research project separately.
2. The project working hours should be 30 hours for each credit.
3. The student should select a topic relevant to his / her field of study that addresses a specific proble or question within the discipline.
4. The student should be regular and include timely updates on data collection, preliminary findings, and any challenges faced by his / her supervisor.
5. Students should complete at least one of the following objectives in their project:
   a. Students can engage in activities like surveys, interviews, field observations, or experiments to achieve their research objectives.
   b. Students can identify and utilize existing datasets and perform preliminary analysis to understand data trends and patterns.
   c. Students may also analyze / critically assess a specific policy or an existing report related to their topic.
   d. The student can also conduct a thorough literature review to understand the current state of research on his / her topic.
   e. The students can apply appropriate statistical methods and/or use GIS software to analyze data and perform spatial analysis.
   f. The student can also provide a detailed description of all the physical and human aspects of a selected study region.
6. The findings of the research work undertaken should be compiled in a report using proper formatting.
7. The student should adhere to ethical principles and standards in all aspects of their research.
8. Students will present their preliminary findings to an internal examiner midway through the semester. Feedback and insights provided by the examiner should be considered for further analysis and incorporated into the final report.
9. For the external assessment, the student should submit a final report, followed by a viva voce.

Course Outcomes:

On completion of this course, the student shall be able to

1. understand how to conduct research scientifically.
2. do critical thinking and build problem-solving capability.
3. develop their technical skills.
4. do project management.

Year-II Semester-II

Code: GIS 651 Water Resources and Hydrological applications

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To disseminate basic concepts and applications of spatial and non-spatial databases of GIS
2. To learn land resource management and Water Resources Management using RS and GIS techniques
3. Develop and implement a watershed management plan by preparation of various thematic maps.
4. To learn GIS & RS application in watershed development, methods of monitoring and evaluation, areas of evaluation

Sr. No.	Topic	Lectures
1	Introduction to Geosciences and Geology.	02
2	Image elements for geological interpretation, Remote sensing image interpretation for identification of different geological provinces, and identification of rock types from remote sensing images.	07
3	Water Resources: Principles of Remote Sensing in Water Resource Assessment.	05
4	Planning, Organization, and Design of Spatial and Non-Spatial Data in Water Resource Engineering. Hydrological Modeling.	05
5	Groundwater system, groundwater potential zoning, integrated surface and groundwater modeling.	05
6	Urban Hydrology: Basics of urban hydrology, the role of RS-GIS in urban hydrological process, urban hydrological and water distribution system modeling	06

Course outcomes:

On completion of this course, the student shall be able to

1. To recognize geological features using image characteristics.
2. To perform image processing and interpret satellite images for possible earth resources.

Suggested readings:

1. SPRS Technical Commission VII(2002): Symposium on Resource Environmental Monitoring, ISRS Annual Convention, IIRS, Dehradun
2. Harris, J. E. (1990): Earthwatch – The Climate from space, Ellishorwood Ltd., Midsower Norton
3. Escalante, R. B. (2012): Remote Sensing- Advances techniques and Plateforms, Intech, Rijeka Croatia
4. Escalante, R. B. (2012): Remote Sensing Application, Intech, Rijeka Croatia
5. Roy, P.S., Dwivedi, R. S. (2010): Remote Sensing Application www.nrsc.gov.in/Learning- Center, E Book. html

Code: GIS 652 **Remote Sensing of Agriculture**

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives

1. To enable the students to understand the application potentialities of remote sensing data separately and in combination with GIS techniques for Agriculture and Soil.
2. The students will be exposed to various Remote Sensing Applications to Agriculture and Soil Sciences.
3. To study various methods of soil and agricultural mapping.
4. To study various RS and GIS-based models of yield estimation, soil moisture estimation etc.,

Sr. No.	Topic	Lectures
1	Introduction to Agriculture and Soils Applications: Land Evaluation, calculation of various indices, Site-Suitability for agriculture. Agro-climatic suitability analysis for land use planning.	07
2	Irrigation water management: Estimating crop water requirement, irrigation scheduling, conjunctive use of surface and groundwater.	05
3	Digital soil mapping: Need, concept & scope, terrain analysis for soil mapping, hyperspectral remote sensing in soil salinity studies.	05
4	Land degradation & Desertification: Visual analysis of satellite data in degraded land mapping, Spectral indices for mapping degraded lands, Digital classification for mapping degraded lands.	06
5	Soil erosion area mapping using satellite data, soil erosion and sediment yield modelling. soil moisture retrieval using satellite data.	07

Course outcomes:

On completion of this course, the student shall be able to

1. Understand the concepts involved in mapping of crop acreage and yield estimation
2. Understand the principles of space-based input for crop damage assessment
3. Gain skills in various applications of agriculture and Irrigation management
4. Understand the concepts involved in Land degradation and desertification.
5. Understand the process of soil erosion and digital soil mapping.
6. Gain skills in various applications of soil moisture and spectral indices.

Suggested Readings:

1. SPRS Technical Commission VII (2002): Symposium on Resource Environmental Monitoring, ISRS Annual Convention, IIRS, Dehradun
2. Deekshatulu, B. L. (1990): Description and use of Land use/Landcover, NRSA, Hyderabad
3. Harris, J. E. (1990): Earthwatch – The Climate from space, Ellishorwood Ltd., Midsower Norton
4. Lal, D. S. (1998): Climatology, Chaitanya Publishing House, Allahabad
5. Escalante, R. B. (2012): Remote Sensing- Advances techniques and Plateforms, Intech, Rijeka Croatia
6. Escalante, R. B. (2012): Remote Sensing Application, Intech, Rijeka Croatia
7. Roy, P.S., Dwivedi, R. S. (2010): Remote Sensing Application www.nrsc.gov.in/Learning-Center, E Book. html

Code: GIS 653 **Remote Sensing and GIS Applications to Forest and Biodiversity**

No. of Credits: 02 **No. of lectures: 30**

Objectives

1. To enable the students to understand the application potentialities of remote sensing data separately and in combination with GIS techniques for Forestry and Biodiversity.
2. To estimate forest and biodiversity assessment techniques using RS and GIS.
3. To understand the techniques for forest and biodiversity mapping.

Sr. No.	Topic	Practical
1	Natural vegetation classification: Geographical distribution types, Hierarchical forest cover classification scheme	05
2	Vegetation Types Mapping: forest information extraction from aerial and satellite images, Visual image interpretation and digital image classification methods for forest cover and type mapping	05
3	Growing Stock Estimation, Biomass Estimation, Fire Risk Zonation, Land Evaluation for Forestry, RS of Forest Ecosystem, Identification of Species	07
4	Forest change monitoring: Forest cover change detection, forest degradation mapping and monitoring	04
5	Biodiversity: Concept of Biodiversity, Biodiversity Management and Conservation Using Geospatial Technology.	04
6	Biodiversity Mapping, Anthropogenic Disturbance and Modeling Species Distribution. Landscape Analysis.	05

Course outcomes:

On completion of this course, the student shall be able to

1. Understand the concepts involved in forest and biodiversity mapping of and biomass estimation
2. Understanding the principles of indices calculation and forest are change detection and assessment.
3. Gain skills in various applications of Forestry, Ecology and Biodiversity management

Suggested Readings:

1. SPRS Technical Commission VII(2002): Symposium on Resource Environmental monitoring, ISRS Annual Convention, IIRS, Dehradun
2. Deekshatulu, B. L.(1990): Description and useofLand use/Landcover, NRSA, Hyedrabad
3. Sudershana, R. Mitra, D. Mishra, Roy, P.S., Rao, D. P.(2000): Subtle Issues in Coastal Management, IIRS, Dehradun
4. Lal, D. S. (1998): Climatology, Chaitanya Publishing House, Allahabad
5. Escalante, R. B. (2012): Remote Sensing- Advances techniques and Plateforms, Intech, Rijeka Croatia
6. Escalante, R. B. (2012): Remote Sensing Application, Intech, Rijeka Croatia
7. Roy, P.S., Dwivedi, R. S. (2010): Remote Sensing Application www.nrsc.gov.in/Learning- Center, E-Book. html
8. David H. White, S. Mark Howden, Climate Change: Significance for Agriculture and Forestry, Springer,1994.

Code: GIS 654	**Ocean and Atmosphere Remote Sensing**	
No. of Credits: 02		**No. of lectures: 30**

Objective:

1. To understand the potential applications of remote sensing data for the ocean and atmosphere.
2. To provide exposure to students in gaining knowledge on concepts and applications leading to modeling of ocean resources management using Remote Sensing.

Sr. No.	**Topic**	**Practical**
1.	Marine and Atmospheric Sciences: Fundamentals of Marine, Oil Spills, Ecology, Ocean Color Mapping, SST Mapping, Potential Fishing Zone Mapping.	06
2.	Coastal landforms and bathymetry: remote sensing application for the study of shoreline configuration, temporal coastal landforms analysis, and shoreline changes, sedimentation, Principle of coastal bathymetry from remote sensing observations: optical and SAR data	07
3	Fundamentals of marine ecology: Elements of oceanic ecosystem, beach and sub-tidal ecology, coastal dunes ecosystem, coastal wetlands, salt marshes, and mangroves.	05
4.	Climate Modeling, Meteorological Satellites. Forecasting of Natural Calamities. Air Pollution Modeling, Urban heat Islands, Thermal comfort indices.	07
5.	Atmospheric aerosols: Concept of aerosols, causes and types, application of satellite data for aerosol studies	05

Course outcomes:

On completion of this course, the student shall be able to

1. To understand how remote sensing data and GIS techniques are efficient in finding and analyze real-world problem in the Ocean and marine fields
2. Gain knowledge for decision-making to minimize problems in coastal regions and for their management.

Suggested Readings:

1. SPRS Technical Commission VII (2002): Symposium on Resource Environmental Monitoring, ISRS Annual Convention, IIRS, Dehradun
2. Deekshatulu, B. L. (1990): Description and useofLand use/Landcover, NRSA, Hyedrabad
3. Sudershana, R. Mitra, D. Mishra, Roy, P.S., Rao, D. P. (2000): Subtle Issues in Coastal Management, IIRS, Dehradun
4. Harris, J. E. (1990): Earthwatch – The Climate from space, Ellishorwood Ltd., Midsower Norton
5. Lal, D. S. (1998): Climatology, Chaitanya Publishing House, Allahabad
6. Escalante, R. B. (2012): Remote Sensing- Advances techniques and Plateforms, Intech, Rijeka Croatia
7. Escalante, R. B. (2012): Remote Sensing Application, Intech, Rijeka Croatia
8. Roy, P.S., Dwivedi, R. S. (2010): Remote Sensing Application www.nrsc.gov.in/Learning- Center, E Book. html
9. David H. White, S. Mark Howden, Climate Change: Significance for Agriculture and Forestry, Springer,1994.

Code: GIS 655 Remote Sensing and GIS Applications to Health and Energy

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1) To develop a foundational understanding of remote sensing principles, GIS technologies, and their applications specifically in the domains of health and energy.
2) To explore the utilization of remote sensing and GIS in public health, epidemiology, disease mapping, health risk assessment, and understanding environmental health factors.
3) To investigate the use of remote sensing and GIS in energy resource management, renewable energy site selection, monitoring energy infrastructure, and assessing environmental impacts.
4) To learn methodologies to assess health risks using remote sensing data, including air quality monitoring, identification of pollution sources, and analyzing spatial patterns related to public health concerns.
5) To utilize remote sensing techniques to map energy resources such as solar potential, wind patterns, biomass, and hydrological features to aid in energy resource assessment and planning.

Sr. No.	Topic	Lectures
1	Health GIS: Identification of Health Trends, Tracking the Spread of Infectious Disease, Improvement in Health Services using GIS, Health Care Geographic, Health care network, Public and personal health using GIS.	7
2	Health data management and monitoring using geospatial technology, Real time GIS based applications for the health care system. GIS in Health: Human Services, immunization. Advantages and limitations of Geospatial technology in the health sector.	6
3	Energy: Renewable energy: mapping of solar potential of rooftops, site suitability for windmills and panels, network of electricity transmission and distribution, decision support system, solar radiation estimation tools	6
4	Geospatial modeling for hydrogen infrastructure, demand, market, and resource analysis, GIS for resource management locating and developing renewable, geothermal resources.	4
5	Environmental Impact Assessment: environmental impacts of energy-related activities, including mining, extraction, and infrastructure development on ecosystems and public health.	3
6	Community Health and Energy Access: Analyze spatial disparities in health services, access to healthcare, and energy access using remote sensing and GIS to address equity issues and support policy interventions.	4

Course Outcomes:

On completion of this course, the student shall be able to

1) demonstrate a comprehensive understanding of the applications and significance of remote sensing and GIS technologies in the health and energy sectors.
2) develop proficiency in using remote sensing data, GIS software, and relevant geospatial analysis tools specifically tailored for health and energy-related applications.
3) apply remote sensing and GIS techniques to analyze health-related spatial data, conduct disease mapping, assess environmental health factors, and identify health risk areas.
4) utilize remote sensing data and GIS tools to assess energy resources, evaluate renewable energy potential, monitor energy infrastructure, and analyze environmental impacts related to energy production.
5) apply geospatial techniques to conduct epidemiological studies, disease surveillance, and spatial analysis of health data to understand the spatial distribution of health outcomes and environmental influences.

Suggested Readings:

1. SPRS Technical Commission VII(2002): Symposium on Resource Environmental Monitoring, ISRS Annual Convention, IIRS, Dehradun
2. Deekshatulu, B. L.(1990): Description and useofLand use/Landcover, NRSA, Hyedrabad
3. Sudershana, R. Mitra, D. Mishra, Roy, P.S., Rao, D. P.(2000): Subtle Issues in Coastal Management, IIRS, Dehradun
4. Harris, J. E. (1990): Earthwatch – The Climate from space, Ellishorwood Ltd., Midsower Norton
5. Lal, D. S. (1998): Climatology, Chaitanya Publishing House, Allahabad
6. Escalante, R. B. (2012): Remote Sensing- Advances techniques and Plateforms, Intech, Rijeka Croatia
7. Escalante, R. B. (2012): Remote Sensing Application, Intech, Rijeka Croatia
8. Roy, P.S., Dwivedi, R. S. (2010): Remote Sensing Application www.nrsc.gov.in/Learning-Center, E Book. html

Code: GIS 656 Data Analysis with Tableau and Power-BI

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. to equip the students with essential skills in data visualization using the powerful tools Tableau and Power BI.
2. to transform raw data into insightful and visually compelling reports and dashboards.
3. To gain hands-on experience with data preparation, calculations, mapping features, and customizations, to effectively communicate information through interactive and captivating visualizations.

Sr. No.	Topic	Lectures
1	Introduction to Data Visualization with Tableau & Power BI – tableau and Power BI installation, Introduction to Public, desktop, online, and server versions.	04
2	Tableau Interface and basics, Power BI Desktop and Query Editor	05
3	Conditions and Functions in Tableau, Text Function date function word cloud. Plots and customization in tableau.	08
4	Date Source connectivity and data models in Power BI.	08
5	Reports and APIs in tableau and Power Bi.	05

Course outcomes:

On completion of this course, the student shall be able to

1. learn the installation and setup of Tableau and Power BI editions
2. Develop proficiency in Tableau's and Power BI core features, including data interpreters, filtering, aggregates, calculations, and dashboard creation
3. Explore advanced Tableau and Power BI techniques.
4. Learn to create and customize various plots, reports, etc.,

Suggested readings:

1. D'Agostino, M., Gabbay, D. M., Hähnle, R., & Posegga, J. (Eds.). (2013). *Handbook of tableau methods*. Springer Science & Business Media.
2. Murray, D. G. (2013). *Tableau your data!: fast and easy visual analysis with tableau software*. John Wiley & Sons.
3. Loth, A. (2019). *Visual analytics with Tableau*. John Wiley & Sons.
4. Carlisle, S. (2018). Software: Tableau and microsoft power bi. *Technology| Architecture+ Design*, *2*(2), 256-259.
5. Ferrari, A., & Russo, M. (2016). *Introducing Microsoft Power BI*. Microsoft Press.
6. Powell, B. (2017). *Microsoft Power BI cookbook: Creating business intelligence solutions of analytical data models, reports, and dashboards*. Packt Publishing Ltd.

Code: GIS 661 Urban Planning and Settlement Informatics

Course Objectives:

1) To comprehensively understand remote sensing principles, technologies, and sensors relevant to urban planning and settlement analysis.
2) To analyze urban spatial patterns, dynamics, and changes using remote sensing data, focusing on factors such as land use, land cover changes, urban expansion, and population dynamics.
3) To learn to use remote sensing techniques to map and monitor urban infrastructure, including roads, buildings, utilities, and transportation networks.
4) To apply remote sensing data and analysis techniques to assess urban growth, monitor changes in land use, and evaluate their impacts on urban environments and settlements.
5) To use remote sensing to study urban environmental factors such as air quality, green spaces, heat islands, and water bodies, aiding in environmental planning and management.

No. of Credits: 02 **No. of Lectures: 30**

Sr. No.	Topic	Lectures
1	Definition: Economic, Population, and Settlement. Concepts: Place, Space, Environment interconnection, Sustainability, Location (Relative / Absolute), Region, Spatial Interaction. Approaches: Systematic, Regional, Environmentalism, and Possibilism.	03
2	Urban Planning and Development: Scale Mapping for Cadastral Database, Characteristics of base maps, scales of base maps, Statistical techniques, and data interpretation, Types of data, charts and graphs, Urban Development indicator.	04
3	Utility Planning, Integrated Development Planning, Urban Conservation, Transportation Planning and Land Information System, Environmental Impact Assessment (EIA)	04
4	3D modeling for urban surface profile: Digital and satellite photogrammetry, DEM/DSM generation for an urban area, modeling and visualization.	05
5	Urban sprawl mapping and consequences, urban growth monitoring, Indices for built-up area monitoring, slum detection.	03
6	Traffic and Parking Surveys, Urban Land Use Classification and Monitoring, Change Detection Analysis	04
7	Census operation and population studies: Basic principles, population estimation through remote sensing, updating of population data, population projection system.	04
8	Urban resources: Definition & concept of urban resources, classification and spatial distribution of resources.	03

Course Outcomes:

On completion of this course, the student shall be able to

1) To demonstrate a comprehensive understanding of remote sensing principles,

technologies, and their application in analyzing urban landscapes, settlement patterns, and planning.
2) To develop proficiency in utilizing remote sensing data and techniques to analyze urban environments, including land use, infrastructure, environmental factors, and spatial dynamics.
3) To apply remote sensing data and tools to conduct spatial analysis of urban areas, including mapping urban expansion, land cover changes, and population dynamics.
4) To use remote sensing techniques to map and monitor urban infrastructure elements such as roads, buildings, utilities, and transportation networks.
5) To evaluate urban growth, land use changes, and their impacts on urban environments and settlements using remote sensing-derived data and analysis.

Suggested Readings:

1. SPRS Technical Commission VII(2002): Symposium on Resource Environmental Monitoring, ISRS Annual Convention, IIRS, Dehradun
2. Deekshatulu, B. L.(1990): Description and useofLand use/Landcover, NRSA, Hyedrabad
3. Sudershana, R. Mitra, D. Mishra, Roy, P.S., Rao, D. P.(2000): Subtle Issues in Coastal Management, IIRS, Dehradun
4. Harris, J. E. (1990): Earthwatch – The Climate from space, Ellishorwood Ltd., Midsower Norton
5. Lal, D. S. (1998): Climatology, Chaitanya Publishing House, Allahabad
6. Escalante, R. B. (2012): Remote Sensing- Advances techniques and Plateforms, Intech, Rijeka Croatia
7. Escalante, R. B. (2012): Remote Sensing Application, Intech, Rijeka Croatia
8. Roy, P.S., Dwivedi, R. S. (2010): Remote Sensing Application www.nrsc.gov.in/Learning- Center, E Book. html

Code: GIS 662 Planetary Science Using Remote Sensing

No. of Credits: 02 **No. of Lectures: 30**

Course Objective:

1. To impart knowledge about the various geological structures of earth and other planets.
2. To explore the various Remote Sensing Applications to Planetary Sciences.

Sr. No.	Topics	Lectures
1	Introduction to planetary science: Nature and scope, Definition and concept, Fundamentals of planetary science.	03
2	Earth as a Planet: General characteristics and origin of the Universe, Solar System and its planets. The terrestrial and Jovian planets. Meteorites and Asteroids. Earth in the solar system - origin, size, shape, mass, density, rotational and revolution parameters.	06
3	Image elements for geological interpretation, Remote sensing image interpretation for identification of different geological provinces; Mineral exploration; Multispectral and hyperspectral remote sensing for mineral exploration.	08
4	Planetary Geology: Overview of planetary geology, Global and Indian planetary mission; remote sensing of planetary surfaces with special emphasis on Moon and Mars; Missions to Moon and Mars and case studies	07
5	Analysis of Lunar and Martian planetary data sets for geological interpretation.	06

Course outcomes:

On completion of this course, the student shall be able to

1. To apply knowledge of GIS software and be able to work with GIS software and their various applications in the field of planetary science.
2. To acquire skills in tools, techniques and modelling while using Remote Sensing Technology.

Suggested Readings:

1. Harry Y. McSween, Jr, Jeffrey E. Moersch (2019), Planetary Geoscience, Cambridge University Press
2. Escalante, R. B. (2012): Remote Sensing- Advances techniques and Plateforms, Intech, Rijeka Croatia
3. Escalante, R. B. (2012): Remote Sensing Application, Intech, Rijeka Croatia
4. Roy, P.S., Dwivedi, R. S. (2010): Remote Sensing Application www.nrsc.gov.in/Learning-Center, E Book. html

Code: GIS 663 **Natural Disaster Management and Assessment using GIS**

No. of Credits: 02 **No. of Lectures: 30**

Objectives:

1. To understand the role of GIS and remote sensing in disaster response and management.
2. To learn the various applications of RS and GIS in disaster management.

Sr. No.	Topic	Lectures
1	Disaster Management: Natural and Man-Made Disasters. Various types of Natural Disasters - earthquakes, land subsidence and Landslides, Forest fires, Drought Desertification with the most well-known Indian examples, Classifications, and nature of impacts	07
2	Risk zone mapping: flood plain mapping, flood inundation mapping and modeling, flood damage assessment and flood hazard zoning, food risk zoning using remote sensing and GIS techniques.	06
3	Drought monitoring and assessment: Types of drought, drought indices, assessment of the meteorological, hydrological, role of remote sensing in drought studies, precipitation, and NDVI relationship.	06
4	Landslides: Causes, factors, and corrective/preventive measures, Landslide mapping and monitoring, Landslide hazard analysis, Vulnerability, susceptibility and risk mapping, debris flow modeling.	04
5	Hazard mapping using indices assessment and monitoring programs, Natural disaster management plans, Shelterbelts, Special structures, Disaster Preparedness and Mitigation. Information needs of Disaster Management, Remote Sensing Applications, GIS applications.	07

Course outcomes:

On completion of this course, the student shall be able to

1. identify and map vulnerable areas, monitor disasters in real-time, plan evacuation routes, and assess damage and plan recovery efforts.

Suggested Readings:

1. Sudershana, R. Mitra, D. Mishra, Roy, P.S., Rao, D. P. (2000): Subtle Issues in Coastal Management, IIRS, Dehradun
2. Harris, J. E. (1990): Earthwatch – The Climate from space, Ellishorwood Ltd., Midsower Norton
3. Lal, D. S. (1998): Climatology, Chaitanya Publishing House, Allahabad
4. Escalante, R. B. (2012): Remote Sensing- Advances techniques and Plateforms, Intech, Rijeka Croatia
5. Escalante, R. B. (2012): Remote Sensing Application, Intech, Rijeka Croatia
6. Roy, P.S., Dwivedi, R. S. (2010): Remote Sensing Application www.nrsc.gov.in/Learning- Center, E Book. html

Code: GIS 671	**Research Project: Dissertation**
No. of Credits: 06	

Course Objectives:

1. To familiarize students with the basics of field research and data collection methods.
2. To develop skills in data analysis using GIS software tools and/or computer programming.
3. To enhance report writing capabilities, following academic standards and formats.
4. To prepare students for more extensive scientific research projects

Guidelines:

1. Each student will perform a research project separately.
2. The project working hours should be 30 hours for each credit.
3. The student should select a topic relevant to his / her field of study that addresses a specific problem question within the discipline.
4. The student should be regular and include timely updates on data collection, preliminary findings, and any challenges faced by his / her supervisor.
5. Students should complete at least one of the following objectives in their project:
    a. Students can engage in activities like surveys, interviews, field observations, or experiments to achieve their research objectives.
    b. Students can identify and utilize existing datasets and perform preliminary analysis to understand data trends and patterns.
    c. Students may also analyze / critically assess a specific policy or an existing report related to their topic.
    d. The student can also conduct a thorough literature review to understand the current state of research on his / her topic.
    e. The students can apply appropriate statistical methods and/or use GIS software to analyze data and perform spatial analysis.
    f. The student can also provide a detailed description of all the physical and human aspects of a selected study region.
6. The findings of the research work undertaken should be compiled in a report using proper formatting.
7. The student should adhere to ethical principles and standards in all aspects of their research.
8. Students will present their preliminary findings to an internal examiner midway through the semester. Feedback and insights provided by the examiner should be considered for further analysis and incorporated into the final report.
9. For the external assessment, the student should submit a final report, followed by a viva voce.

Course Outcomes:

By the end of the course, the student will:

1. be able to identify and articulate a research topic that is relevant to their field of study.
2. be able to achieve their research objective through different methodological approaches
3. be familiar with the utilization of cartographic and computer tools to organize and/or present data.
4. be skilled in organizing their research findings in a structured and comprehensive report that meets academic standards.
5. develop the necessary skills to conduct research effectively and contribute meaningfully to their field of study