THE UNIVERSITY OF BURDWAN

SYLLABUS FOR TWO-YEAR M.SC.

IN

GEOSPATIAL SCIENCE

Under

Curriculum and Credit Framework for Postgraduate Programme (CCFPP), as per N.E.P. 2020

w.e.f. 2026 – 2027

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DIVISION OF MARKS

Total Marks: 1250

SEM I Marks: 375
SEM II Marks: 375
SEM III Marks: 250
SEM IV Marks: 250

Theoretical Marks: 600 (SEM I: 225, SEM II: 225, SEM III: 150)

Practical Marks: 400 (SEM I: 150, SEM II: 150, SEM III: 100)

Dissertation: 150 marks (SEM IV)

Presentation and Viva-voce : 100 marks (SEM IV)

2- Year PG Programme

Semester-wise and Course-wise Distribution of Credit & Marks under CCFPP as per NEP, 2020

SEMESTER	Course Type	Code & Level	Name of the Course	Credit	L – T - P	Marks	Marks Dist. Th. – Pr. - IA
I	Major/Core Course	**PG2GEOS1011**	Fundamentals of Remote Sensing	6	4-2-0	75	60 –00 – 15
	Major/Core Course	**PG2GEOS1012**	Introduction to GIS & Mathematics for GIS	6	4-2-0	75	60 – 00 – 15
	Major/Core Course	**PG2GEOS1013**	Digital Cartography & Global Satellite Navigation System	6	0-0-6	75	00 – 60 – 15
	Major/Core Course	**PG2GEOS1014**	Geo-statistics & Computer Programming	6	0-0-6	75	00 – 60 – 15
	Minor Course	**PG2GEOS1021**	Basics of Geoinformatics and Applications	4	4-0-0	75	60 – 0 – 15
	Total			**28**		**375**	
II	Major/Core Course	**PG2GEOS2011**	Digital Image Processing	6	4-2-0	75	60 – 00 – 15
	Major/Core Course	**PG2GEOS2012**	Research Methodology & Indian Knowledge System	4	4-0-0	75	60 – 00 – 15
	Major/Core Course	**PG2GEOS2013**	Advanced Photogrammetry, UAV & Geo-AI Modelling	4	0-0-4	75	00 – 60 – 15
	Major/Core Course	**PG2GEOS2014**	GIS Data Analysis & DBMS	4	0-0-4	75	00 – 60 – 15
	Minor Course	**PG2GEOS2021**	GIS, GNSS, Surveying & Projection	4	2-2-0	75	60 – 00 – 15
	Total			**22**		**375**	

Coursework in the 3rd Semester & Research Thesis/Project in the 4th Semester

SEMESTER	Course Type	Code & Level	Name of the Course	Credit	L-T-P	Marks	Marks Dist. Th. – Pr. - IA
III	Major/Core Course	**PG2GEOS3011**	Thermal, Microwave, Hyperspectral & LIDAR Remote Sensing	4	2-2-0	50	40 – 00 – 10
	Major/Core Course	**PG2GEOS3012**	Regional Planning & Disaster Management	4	2-2-0	50	40 – 00 – 10
	Major/Core Course	**PG2GEOS3013**	AI Based Geospatial Modelling	4	2-2-0	50	40 – 00 – 10
	Major/Core Course	**PG2GEOS3014**	Web GIS Technology and Applications	4	0-0-4	50	00 – 40 – 10
	Major/Core Course	**PG2GEOS3015**	Field Work & Community Engagement	4	0-0-4	50	00 – 40 – 10
	Total			**20**		**250**	
IV	Research Thesis/ Project / Patent	**PG2GEOS4031**	Research Thesis/ Project/ Patent	20	0- 0- 20	250	0-250-0 Preparation & Submission of Research Thesis/ Project Report (150 Marks, 12 Credits) + Seminar, Presentation (50 Marks, 4 Credits) + Viva-voce (50 Marks, 4 Credits)
	Total			**20**		**250**	

Explanation of the Codes

PG2GEOS1014 stands for: PG2: 2-year PG
Subject Code: GEOS
1: Semester – I
0: Common digit to all courses
1: Major/ Core Course
4: Number of Course(s) offered

PG2GEOS1021 stands for: PG2: 2-year PG
Subject Code: GEOS
1: Semester – I
0: Common digit to all courses
2: Minor Course
4: Number of Course(s) offered

PG2GEOS2024 stands for: PG2: 2-year PG
Subject Code: GEOS
2: Semester – II
0: Common digit to all courses
1: Major/Core Course
4: Number of Course(s) offered

PG2GEOS2021 stands for: PG2: 2-year PG
Subject Code: GEOS
2: Semester – II
0: Common digit to all courses
2: Minor Course
1: Number of Course(s) offered

PG2GEOS3015 stands for: PG2: 2-year PG
Subject Code: GEOS
3: Semester – III
0: Common digit to all courses
1: Major/ Core Course
5: Number of Course(s) offered

PG2GEOS4031 stands for: PG2: 2-year PG
Subject Code: GEOS
2: Semester – IV
0: Common digit to all courses
3: Research Project / Dissertation
1: Number of Course(s) offered

COURSE INFORMATION
SEMESTER – I

Code & Level	Name of the Course
PG2GEOS1011	***Fundamentals of Remote Sensing***
Credits: 6 **Marks: 75**	
PG2GEOS1011 (Theory) [75 Marks]	
	UNIT-I
1.	**Earth System Dynamics**: Interfaces of the terrestrial surface, terrain matrices, drainage basin morphometry, and biosphere dynamics. Ocean surface configurations: bottom relief structures, planetary currents, and wave mechanics.
2.	**Remote Sensing Frameworks & Evolution**: Basic Principle of Remote Sensing Mechanism, Kepler's Laws of Planetary Motion.
3.	**Scope & Definition**: Scope & definition of Remote Sensing related terminologies, chronological evolution, physical bases, structural classifications, and multi-disciplinary applications of Geospatial Science.
4.	**Platform Systems:** Airborne architecture, spaceborne sun-synchronous/geostationary tracking, and sensor array engineering.
	UNIT-II
5.	**Resolution Science & Satellite Constellations**: The resolution matrix and definition, complete mechanics of spatial, spectral, radiometric, and temporal dimensions. Orbital configurations and tracking parameters. Sensor characteristics and band structures of different multi-spectral and high-resolution space systems, CMOS vs CCD based sensors.
6.	**Mechanics of Electromagnetic Radiation (EMR)**: The electromagnetic spectrum: wavebands, metrics, and energy properties.
7.	**Physics of Remote Sensing:** Physics of energy sources: radiant properties, wave-particle duality, and the mathematical framework of EMR propagation through vacuum and physical media.
8.	**Atmospheric Scattering & Surface Boundary Interactions**: Atmospheric scattering regimes: Rayleigh scattering mechanics, Mie scattering, and non-selective scattering behaviour. Energy interactions at the surface boundary: specular and diffuse scattering reflections.

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To introduce students to the fundamental concepts, architecture, and data structures of GIS, along with methods of spatial data capture, storage, and cartographic output. (ii) To build a strong mathematical foundation (set theory, calculus, matrices, and interpolation methods) needed to understand and apply spatial analysis techniques in GIS.
Course Outcomes: (i) Students will be able to design, manage, and interpret GIS databases, including topology, metadata standards, and map symbolization/layout for effective geospatial communication. (ii) Students will be able to apply mathematical tools such as differentiation, integration, matrix operations, and interpolation methods (IDW, Kriging) to solve spatial and geostatistical problems.
Professional Skill Development: (i) The course develops technical proficiency in GIS software, data modeling, and geospatial database management, preparing students for careers in mapping, planning, and spatial analysis. (ii) It strengthens analytical and quantitative reasoning skills through mathematical modeling and interpolation techniques, enhancing employability in research, remote sensing, and geoinformatics sectors.

Text & Reference Books:

1. Joseph, George and Jeganathan, C. (2017). "Fundamentals of Remote Sensing", 3rd Edition, Universities press (India) Pvt. Ltd., Hyderabad.
2. Jensen, J.R. (2015). "Remote Sensing of the Environment – An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pvt. Ltd., 3rd edition.
3. Jensen, J.R. (1996). Introductory Digital Image Processing A remote sensing perspective. Prentice Hall Series in GIS, USA
4. Lillesand, Thomas M. and Kiefer, Ralph, W. (2015). "Remote Sensing and Image Interpretation", 7th Edition, John Wiley and Sons, New York.
5. Sabins, F.F. Jr. (2007). 'Remote Sensing – Principles and Interpretation", W.H. Freeman & Co.
6. Reeves, Robert G. (1991), "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA
7. Dimitris G. Manolakis, Ronald B. Lockwood, Thomas W. Cooley (2016). Hyperspectral Imaging Remote Sensing. Cambridge Press. ISBN: 9781316017876.
8. Iain H. Woodhouse (2005). Introduction to Microwave Remote Sensing. CRC Pr I Llc. ISBN-0415271231.
9. Ruiliang Pu, Qiuyan Yu (2026). Thermal Infrared Remote Sensing-Principles and Applications. CRC Press. ISBN 9781032231808

Code & Level	Name of the Course
PG2GEOS1012	***Introduction to GIS & Mathematics for GIS***

Credits: 6
Marks: 75

	PG2GEOS1012 (Theory) [75 Marks]
	UNIT-I
1.	**GIS Concepts & System Architecture**: Definitions, historical evolution, hardware/software architecture and its components. Core data structures: comprehensive conceptual analysis of raster grid models and vector topologies.
2.	**Spatial Data Typologies & Capture Methods**: Data classification: spatial locations vs. attribute matrices (aspatial records). Capture workflows: primary data capture (field surveys, direct sensor inputs) and secondary data capture (digitization, vectorization, translation transformations). System limits and structural fields of application. Vector schema designs: spaghetti models vs. full topological data structures (nodes, edges, faces). Attribute linking mechanisms.
3.	**Database Models & Metadata Standards**: Data storage paradigms: flat files, hierarchical structures, network schemas, and relational databases. Spatial metadata: ISO/FGDC standards, documentation tracking, data accuracy, errors, and spatial interpolation principles. Geodatabase designs: building workspaces, coordinate assignment, image rectification, error identification, edge-matching, and geometric topology checking.
4.	**Symbolization, Layout, & Map Output Production**: Visual variables: quantitative and qualitative notation design. Statistical map layout production: dot maps, choropleth maps, proportional symbols, and isoline maps. Map margin elements: scale bars, north points, legend keys, and metadata tables.
	UNIT-II
5.	**Set Theory:** Sets and their representation, Subsets, Family of Sets, Venn Diagrams, Algebraic Operations on Sets, Cartesian Products of Sets, Relations and Mappings on a Set, Concept of Fuzzy Sets
6.	**Calculus and Differential Equations:** Limit and Continuity, Real Functions, Composite Functions (Monotone, Odd, Even, Polynomial, Exponential, Logarithmic), Differentiation and its Geometric Interpretation, Maxima and Minima, Integration, Definite Integral as a limit of sum with basic properties
7.	**Concept of Matrix and Determinant and Linear Vector Space:** Types of Matrices, Transpose, conjugate, Principle of Matrices, Adjoint, Inverse, Minor and cofactor, Principle of Determinant, Adjoint and Inverse Cramer's Rule, Linear Dependence and independence, Basis and dimension, System of linear equations, Characteristic equations, Eigen Values and Eigen Vectors
8.	**Methods of Interpolation:** Linear, Cubic, Cubic splines, IDW, Kriging

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To provide a comprehensive understanding of GIS concepts, system architecture, core data structures (raster and vector), and spatial data capture methods. (ii) To equip students with the essential mathematical foundations, including set theory, calculus, linear algebra, and interpolation techniques, required for advanced spatial analysis and geodatabase management.
Course Outcomes: Upon completion, students will be able to design and implement a geodatabase, perform spatial data capture and analysis, and produce professional cartographic outputs with proper symbolization and metadata.
Professional Skill Development: (i) Develops technical proficiency in GIS software workflows for digitization, data translation, and topological error checking, alongside critical thinking for database design and metadata documentation. (ii) Enhances quantitative analytical skills through the application of statistical mapping, interpolation, and matrix algebra, enabling data-driven decision-making and problem-solving in geospatial careers.

Text & Reference Books:

1. Burrough, P. A. & McDonnell, R. A. (2000). Principles of Geographical Information Systems, Oxford University Press. Robinson, A. H. et al. (2002).
2. Elements of Cartography, 6th Edition, John Wiley & Sons. Demers, M. N. (2000).
3. Fundamentals of Geographic Information Systems, 2nd Edition, John Wiley & Sons.
4. Bolstad, P., & Manson, S. (2022). GIS Fundamentals: A First Text on Geographic Information Systems (7th ed.). Eider Press Inc.
5. Law, M., & Collins, A. K. (2026). Getting to Know ArcGIS Pro 3.6 (6th ed.). Esri Press.
6. Brewer, C. A. (2016). Designing Better Maps: A Guide for GIS Users (2nd ed.). Esri Press.
7. Chang, K. T. (2019). Introduction to Geographic Information Systems (9th ed.). McGraw-Hill Education.
8. Graser, A. (2022). Learning QGIS: A beginner's guide to getting started with open-source GIS (4th ed.). Packt Publishing.
9. Mitchell, A. (2020). The Esri Guide to GIS Analysis: Geographic patterns and relationships (Vol. 1, 2nd ed.). Esri Press.
10. Zandbergen, P. A. (2020). Python Scripting for ArcGIS Pro. Esri Press.

Code & Level	Name of the Course
PG2GEOS1013	***Digital Cartography & Global Satellite Navigation System***
Credits: 6 **Marks: 75**	
PG2GEOS1013 (Practical) [75 Marks]	
	UNIT-I
1.	**Fundamentals of Digital Cartography:** Introduction to cartography and digital cartography Manual vs. digital cartography, Types and components of maps, Scale, coordinate systems, datums, and geoid, Map projections: types, properties, and selection, Cartographic generalization and map composition.
2.	**Geospatial Data Sources and Map Visualization:** Sources of geospatial data (satellite imagery, GPS, UAV, Survey of India maps, field surveys), Raster and vector data models, Cartographic databases, Symbolization, color schemes, typography, and map layout, Thematic mapping and visualization techniques, 2D, 3D visualization
3.	**Digital Map Production:** Digital map creation and editing, Georeferencing and digitization, Spatial data integration and quality assessment, Cartographic accuracy, precision, and metadata, Geospatial data updating and database management, Map outputs for print and digital media
4.	**Applications and Recent Trends in Digital Cartography:** Web GIS and interactive mapping Mobile cartography and location-based services, Real-time mapping and dashboards, Virtual Reality (VR) and Augmented Reality (AR) in cartography, National Geospatial Policy and data dissemination, Applications in urban planning, disaster management, environmental monitoring, transportation, and smart cities
	UNIT-II
5.	**Satellite Navigation Architecture:** GNSS segments: space segment (constellation geometry), control segment (master tracking stations), and user segment (receiver configurations). Signal tracking: pseudo-range calculations, carrier-phase measurements, signal degradation vectors, dilution of precision (DOP), and reference station error corrections.
6.	**Operational GNSS Operations & Field Survey Systems:** Operational constellations: global architectures of NAVSTAR (USA), GLONASS (Russia), Galileo (EU), and NavIC (India). Operational modes: autonomous positioning, differential tracking (DGPS), Real-Time Kinematic (RTK) surveys, static networks, and kinematic navigation workflows
7.	**GNSS Foundations, Geodesy, and Error Modeling:** Geo positioning basic concepts, Pseudo Range Measurement, Phase Difference Measurement, Sources of GNSS errors, and DOP; Geoid, Datum/Ellipsoid (definition and basic concepts), Global Datum vs. Indian Geodetic Datum, Coordinate Systems, and Transformation of coordinates. Site characteristics of Reference Station, Reference Station Equipment.
8.	**Advanced Navigation, Augmentation, And AI Systems:** Basic concepts of Augmentation Systems (GAGAN, WAAS, LAAS, etc.; Differential Global Positioning System (DGPS) concept, Various Surveying Methods, Data Processing, Smart Station, and Applications. GNSS Remote Sensing. AI-based tracking systems and Navigation.

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To familiarize students with the fundamentals of digital cartography, including map projections, coordinate systems, geospatial data sources, and digital map production techniques. (ii) To provide comprehensive knowledge of Global Satellite Navigation Systems (GNSS), covering satellite architecture, signal processing, operational constellations, and error modeling.
Course Outcomes: (i) Students will be able to create, edit, and visualize digital maps using appropriate projections, symbolization, and thematic mapping techniques for various applications like urban planning and disaster management. (ii) Students will be able to operate GNSS systems and apply positioning techniques such as DGPS and RTK surveys, while understanding error sources and augmentation systems for accurate geospatial data collection.
Professional Skill Development: (i) The course builds practical skills in digital cartography, Web GIS, and mobile mapping technologies, preparing students for careers in geospatial data production and visualization. (ii) It develops technical expertise in satellite navigation, field survey systems, and AI-based tracking, enhancing employability in surveying, remote sensing, and location-based service industries.

Text & Reference Books:

1. Robinson, A.H. and Morrison, J.L. (1995). Elements of Cartography, John Wiley and Sons.
2. Gopi, Satish (2005). Global Positioning System: Principles and Applications, Tata Mac-Grow Hill.
3. Agrawal, N.K. (2004). Essentials of GPS, Spatial Network Pvt. Ltd.
4. Sathish Gopi (2000). GPS and Surveying using GPS.
5. Anson, R.W. and Ormeling, F.J. (2008). Basic Cartography, Vol. 1, 2nd ed., Elsevier Applied Science Publishers, London.
6. Gunter Seeber (2003). Satellite Geodesy Foundations-Methods and Applications
7. Hofmann W.B & Lichtenegger, H. Collins (2001). Global Positioning System – Theory and Practice, Springer-Verlag Wein, New York.
8. Paul, J. C. (2005). Geographical Information Systems and computer Cartography, Longman. 5. Keates, J.S. (2008). Cartographic Design and production, London, Longman.

Code & Level	Name of the Course
PG2GEOS1014	***Geo-statistics & Computer Programming***

Credits: 6
Maximum Marks: 75

PG2GEOS1014 (Practical) [75 Marks]

	UNIT-I
1.	**Introduction to R:** Overview of R Programming, Downloading and installing, Package Management **Data Input and output in R**: Data Types, Sub setting, writing data, reading from txt, CSV and image files, creating a vector and vector operation, Initializing data frame; **Data manipulation in R:** List Management, Data Transformation, Merging Data Frames, Outlier Detection, combining multiple vectors, Matrices and solving systems of linear equations, Multidimensional array manipulation
2.	**Functions and Programming in R:** Flow control: For loop, if condition, writing function; Data Visualization: Creating bar chart and scatter plot, creating histogram and box plot, Plotting with base graphics
3.	**Inferential Geostatistics & Probability Distributions:** Probability theory: random distributions, Normal distributions, and Bayes' theorem. Hypothesis testing: parametric models (Student's t-test, F-tests, Chi-square evaluations) and non-parametric algorithms (Kruskal-Wallis, Mann-Whitney U testing) applied to geospatial data matrices
4.	**Statistical Processing with R on spatial data:** Computing Basic Descriptive Statistics, Inferential Statistics: Confidence interval estimation and Hypothesis testing, Regression analysis; Basic simulation with R.
	UNIT-II
5.	**Introduction to Python:** Download, Install, Data types, variables, file handling, calculations, Built-in modules; Write elementary Python codes (Concept of Loops and Control structure); Python Functions
6.	**Python Data & Structure:** Structures (List, String, Tuple, Dictionary, Set); Drawing with Python: Module (Turtle), Multidimensional arrays, Matrices, Methods, Polynomials with NumPy (Numerical Python); Curve fitting; Statistics, interpolation with NumPy, SciPy (Scientific Python) Plotting Data (Plot in 2D, 3D, Contour plot, statistical plot) with Matplotlib; Structured Data, Reading Excel sheet with Pandas (Big Data, Data from remote sensing): Map plotting; Image Processing and Spatial data analysis by Python
7.	**Spatial Interpolation, Numerical Python (NumPy) & Pandas Data Architectures:** Inverse Distance Weighting (IDW), spline functions, and Kriging models. Python development environment setup: data types, script syntax, file input/output handling, control loops, conditional processing blocks, and functional programming routines. Array and dataset engineering: managing multidimensional matrices via NumPy, curve fitting routines, scientific computing with SciPy, and structural table handling via Panda's data frames.
8.	**Python Geospatial Libraries & Vector Handling Automation:** Automating geospatial operations: data rendering using Matplotlib. Integrating GIS engines: processing spatial tables via GeoPandas, geometric calculations with Shapely, and programmatic coordinate systems management.

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To introduce students to R and Python programming languages, covering data types, control structures, functions, and essential libraries for geospatial data handling. (ii) To develop competence in geostatistical methods, including probability distributions, hypothesis testing, spatial interpolation techniques, and statistical analysis of spatial data.
Course Outcomes: (i) Students will be able to write functional R and Python scripts to manage, manipulate, and visualize geospatial data using tools like NumPy, Pandas, Matplotlib, and GeoPandas. (ii) Students will be able to apply statistical and geostatistical techniques such as regression analysis, hypothesis testing, and interpolation methods (IDW, Kriging)—to analyze and interpret spatial datasets.
Professional Skill Development: (i) The course builds hands-on programming proficiency in R and Python, equipping students with automation and data processing skills essential for geospatial data science roles. (ii) It strengthens analytical capabilities in statistical modeling and spatial data interpolation, enhancing employability in research, remote sensing, GIS analytics, and data-driven geospatial industries.

Text & Reference Books:

1. Mark Lutz: Learning Python
2. Applied Geospatial Data Science with Python by David S.
3. Lalit Kumar, Onisimo Mutanga: Google Earth Engine Applications
4. Wes McKinney: Python for Data Analysis
5. Python for Geospatial Data Analysis: Theory, Tools, and Practice for Location Intelligence by Bonny P. McClain
6. Mather, P. M. & Koch, M. (2011). *Computer Processing of Remotely-Sensed Images: An Introduction*, 4th Edition, John Wiley & Sons.
7. Rogerson, P. A. (2010). *Statistical Methods for Geography*, 3rd Edition, SAGE Publications.
8. McKinney, W. (2017). *Python for Data Analysis*, 2nd Edition, O'Reilly Media.

Code & Level	Name of the Course
PG2GEOS1021	***Basics of Geoinformatics and Applications***

Credits: 4
Marks: 75

PG2GEOS1021 (Theory) [75 Marks]

	UNIT-I
1.	**Introduction to Geoinformatics**: Definition, scope, and evolution of Geoinformatics, Components of Geoinformatics, Geospatial technologies and their interdisciplinary nature, Applications and future prospects, National Geospatial Policy and geospatial ecosystem in India
2.	**Geospatial Data and Reference Systems:** Spatial and non-spatial data**,** Raster and vector data models, Coordinate systems and datums, Geodesy, Map projections, Scale, accuracy, precision, and metadata, Geospatial data standards
3.	**Remote Sensing Fundamentals:** Principles of remote sensing**,** Electromagnetic radiation and spectral signatures**,** Remote sensing platforms and sensors**,** Resolution concepts (spatial, spectral, temporal, radiometric)**,** Image interpretation and applications
4.	**Global Navigation Satellite Systems (GNSS):** Principles of GPS, GLONASS, Galileo, and NavIC, GNSS segments and positioning methods, Field data collection
	UNIT-II
5.	**Geographic Information Systems (GIS):** Fundamentals and components of GIS, GIS hardware and software, Spatial database concepts, Data input, editing, and management, Spatial queries and database operations.
6.	**Spatial Analysis and Cartography:** Buffer, overlay, proximity, and network analysis, Terrain analysis and Digital Elevation Models (DEM), Cartographic principles, Digital map preparation and visualization, Thematic mapping and map layout design
7.	**WebGIS and Emerging Geospatial Technologies:** WebGIS architecture, Open-source GIS, Artificial Intelligence (AI) and Machine Learning in Geoinformatics
8.	**Applications of Geoinformatics:** Agriculture and precision farming, Urban and regional planning, Disaster management, Forestry, Environmental monitoring, Water resources and watershed management

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To provide students with foundational knowledge of Geoinformatics, including its components, geospatial data systems, remote sensing principles, and GNSS technologies. (ii) To develop understanding of GIS fundamentals, spatial analysis techniques, cartographic principles, and emerging technologies like WebGIS and AI in geospatial applications.
Course Outcomes: (i) Students will be able to explain core geospatial concepts, interpret remote sensing data, and utilize GNSS systems for field data collection and positioning. (ii) Students will be able to perform spatial analysis operations (buffer, overlay, terrain analysis) and apply GIS tools for cartographic visualization and real-world problem-solving.
Professional Skill Development: (i) The course develops foundational competency in geospatial technologies and data management, preparing students for entry-level roles in GIS, remote sensing, and spatial analysis. (ii) It fosters practical skills in applying geoinformatics to real-world domains such as agriculture, urban planning, and disaster management, enhancing employability across diverse sectors relying on geospatial solutions.

Text & Reference Books:

1. Government of India. (2022). National Geospatial Policy 2022, Ministry of Science and Technology, New Delhi.
2. Rao, U. R. (2014). India's Rise as a Space Power, Cambridge University Press India.
3. Joseph, G. (2004). Fundamentals of Remote Sensing, Universities Press.

SEMESTER – II

Code & Level	Name of the Course
PG2GEOS2011	***Digital Image Processing***
Credits: 4 **Marks: 75**	
PG2GEOS2011 (Theory) [75 Marks]	
UNIT-I	
1.	**Introduction to DIP:** Definition of Digital Image, Sources of Data, Satellite Data Encoding and Decoding, Acquisition, Digital Data Formats (BSQ, BIL, BIP)
2.	**Pre-processing of Digital Images:** Cosmetic Operations, Noise Removal, Atmospheric Correction, Illumination and View Angle Effects, Sensor Calibration, Terrain Effects
3.	**Radiometric Correction:** Missing Scan Lines, De-stripping, Line Dropout, Gain Bios Error, Methods of Radiometric Correction: Nearest Neighbour, Bilinear Interpolation, Cubic Convolution
4.	**Image Rectification and Restoration:** Systematic, Random, collinearity, polynomial Rectification, Interpolation, Geo-computation Analysis and Application Sub-setting, Layer Stacking, Mosaicking
	UNIT-II
5.	**Image Enhancement Techniques:** Mathematics of Digital Image, Fourier series and Fourier Transformation (DFF& DFT); Spatial Filtering, Linear, Non-Linear, Contrast Manipulation, RGB Transformation, Density Slicing
6.	**Image Transform Operators & Vegetation Indices:** Multi-band operations, band math calculation, ratios, and differencing index algorithms. Spectral indices: NDVI, NDWI, NDBI, SAVI, and EVI formulations. Principal Component Analysis (PCA) and Tasselled Cap transformations
7.	**Statistical Classifiers & Machine Learning Workflows:** Unsupervised clustering: ISODATA and K-Means algorithms. Supervised learning systems: Minimum Distance to Mean, Parallelepiped boundaries, and Maximum Likelihood Classifiers (MLC)
8.	**Accuracy Assessment Verification Metrics:** Classification validation: confusion matrix calculations, producer accuracy, user accuracy, overall accuracy verification, and Cohen's Kappa coefficient statistics

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks. It shall be considered based on the % of attendance in the class (5 Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review etc. (10 Marks).

Course Objectives: (i) To familiarize students with the fundamentals of digital image processing, including data acquisition, pre-processing, and radiometric correction techniques for satellite imagery. (ii) To develop proficiency in image enhancement, transformation methods, statistical classification, and accuracy assessment for effective image analysis and interpretation.
Course Outcomes: (i) Students will be able to apply pre-processing and radiometric correction techniques to rectify and restore digital satellite images for accurate analysis. (ii) Students will be able to perform image enhancement, calculate vegetation indices, apply classification algorithms (supervised and unsupervised), and assess classification accuracy using statistical metrics.
Professional Skill Development: (i) The course builds technical expertise in satellite image processing and analysis, preparing students for careers in remote sensing, environmental monitoring, and geospatial data interpretation. (ii) It strengthens skills in machine learning-based classification and accuracy validation, enhancing employability in research, land-use mapping, and remote sensing industries.

Text & Reference Books:

1. Jensen, J. R. (2005). *Introductory Digital Image Processing: A Remote Sensing Perspective*, 3rd Edition, Prentice Hall.
2. Lillesand, T.M., Kiefer, R.W., & Chipman, J.W. – *Remote Sensing and Image Interpretation*, John Wiley & Sons.
3. Gonzalez, R. C. & Woods, R. E. (2018). *Digital Image Processing*, 4th Edition, Pearson.
4. Schowengerdt, R. A. (2007). *Remote Sensing: Models and Methods for Image Processing*, 3rd Edition, Academic Press.
5. Richards, J.A., & Jia, X. – *Remote Sensing Digital Image Analysis: An Introduction*, Springer.
6. Schowengerdt, R.A. – *Remote Sensing: Models and Methods for Image Processing*, Academic Press.
7. Gonzalez, R.C., & Woods, R.E. – *Digital Image Processing*, Pearson Education.
8. Mather, P.M., & Koch, M. – *Computer Processing of Remotely-Sensed Images: An Introduction*, Wiley-Blackwell.

Code	Name of the Course
PG2GEOS2012	***Research Methodology &Indian Knowledge System***
Credits: 4 **Marks: 75**	
PG2GEOS2012 (Theory) [75 Marks]	
UNIT-I	
1.	**Fundamentals of Research Methodology:** Meaning, objectives and types of research, Scientific method and research process Basic, applied and interdisciplinary research, Research in Remote Sensing and GIS, Identification of research gaps, Selection and formulation of research problems, Hypothesis: formulation and testing, Variables and research questions
2.	**Research Design and Data Collection:** Research design and sampling methods, Primary and secondary data, Qualitative and quantitative research, Experimental and observational research, Field survey techniques, GPS, GNSS and mobile data collection, Remote sensing data sources, Metadata and data quality
3.	**Statistical Methods and Geospatial Research:** Descriptive statistics, Probability distributions, Correlation and regression, Hypothesis testing, ANOVA and Chi-square, Spatial statistics, Accuracy assessment, Error and uncertainty analysis
4.	**Scientific Writing, Publication Ethics and Research Communication**: Structure of research proposal, Literature review, Review of research papers, Citation styles (APA, IEEE, Harvard), Reference management (Mendeley/Zotero), Research ethics, Plagiarism, Intellectual Property Rights (IPR), Patents and Copyright, Scientific presentation skills
	UNIT-II
5.	**Introduction to Indian Knowledge System (IKS):** Concept and evolution of Indian Knowledge System, Indian philosophy of science, Vedas, Upanishads and scientific traditions, Ancient Indian knowledge of Planetary System and Numerical Analysis, Contributions of Aryabhata, Varahamihira, Brahmagupta and Bhaskaracharya, Environmental ethics in Indian traditions, Sustainable development in Indian knowledge
6.	**Traditional Geographical and Environmental Knowledge:** Traditional ecological knowledge, Indigenous resource management, Ancient Indian cartography, Surveying and measurement traditions, Weather Prediction, Water harvesting systems, Sacred landscapes, Agricultural calendars, Biodiversity conservation practices, Disaster resilience in traditional societies
7.	**Applications of IKS in Remote Sensing & GIS:** GIS documentation of cultural heritage, Mapping archaeological sites, Geospatial technologies for heritage conservation, Digital India and geospatial initiatives, Indigenous climate knowledge and climate adaptation, Geospatial support for traditional agriculture, Village resource mapping, SDGs and Indian Knowledge System
8.	**Research Project Development and Emerging Trends:** Research proposal preparation, Project planning, Project budgeting, Research funding agencies, Scientific report writing, AI in Remote Sensing, Machine Learning in GIS

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To equip students with fundamental research methodology skills, including research design, data collection, statistical analysis, and scientific writing for geospatial research. (ii) To introduce students to the Indian Knowledge System (IKS) and its applications in remote sensing, GIS, and heritage conservation, integrating traditional wisdom with modern geospatial technologies.
Course Outcomes: (i) Students will be able to formulate research problems, apply statistical methods, and communicate findings ethically through proper scientific writing and citation practices. (ii) Students will be able to relate traditional Indian knowledge systems to contemporary geospatial applications, including cultural heritage mapping and indigenous climate adaptation strategies.
Professional Skill Development: (i) The course strengthens research competency, analytical thinking, and scientific communication skills, preparing students for academic research and interdisciplinary geospatial studies. (ii) It cultivates an appreciation for traditional knowledge integration with modern technology, enhancing employability in research institutions, heritage conservation projects, and policy-driven geospatial initiatives.

Text & Reference Books:

1. Kothari, C.R. – *Research Methodology: Methods and Techniques*, New Age International Publishers.
2. Kumar, R. – *Research Methodology: A Step-by-Step Guide for Beginners*, SAGE Publications.
3. Creswell, J.W. – *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, SAGE Publications.
4. Panneerselvam, R. – *Research Methodology*, PHI Learning Pvt. Ltd.
5. Kapoor, K. & Singh, A.K. (Eds.) – *Indian Knowledge Systems: Vol. 1 & 2*, D.K. Printworld.
6. Subbarayappa, B.V. – *Indian Science and Technology: Ancient and Medieval*, Concept Publishing.
7. Day, R.A. – *How to Write and Publish a Scientific Paper*, Cambridge University Press.
8. Government of India, Ministry of Education – *Introduction to Indian Knowledge System: Concepts and Applications* (IKS Division, AICTE).

Code & Level	Name of the Course
PG2GEOS2013	***Advanced Photogrammetry, UAV & Geo-AI Modelling***
Credits: 4 **Marks: 75**	
PG2GEOS2013 (Practical) [75 Marks]	
UNIT-I	
1.	**Foundation of Photogrammetry:** Photogrammetry concepts, principles, definitions, geometric parameters, flight constraints, and history. Scale variations: calculating heights, identifying radial displacement fields, and analysing
2.	**Flight Planning & Image Geometry:** Flight planning fundamentals, Scale, End Lap & Side Lap, Ground coverage, Flying height., Visual Interpretation: Elements of visual photo interpretation, Mapping terrain elements (land use/cover, drainage)., Geometric Characteristics: Projection types, Tilt, Swing, Scale variations, Image displacement due to relief and lens distortion., Photographs Types: Vertical vs. Tilted photographs
3.	**Photogrammetric Measurements & Triangulation:** Parallax & Relief: Parallax equations, Stereoscopic depth perception, Overlaps, Floating marks, Parallax bar measurements, Contouring from stereometric heights., Analytical Formulations: Coordinate systems, Air base components, Interior and Exterior orientation, Coordinate transformation; **Derivations & Triangulation:** Numerical derivations for height based on relief displacement, Epi-polar geometry, Aero triangulation (Semi-analytical, Analytical, and Bundle adjustment with GNSS) ; Close Range Photogrammetry
4.	**Non-Topographic Photogrammetry**: Definition, Potential of Close-Range Photogrammetry, Instrumentation for Photo Acquisition and Data Analysis, Under Water & X-Ray Photogrammetry
UNIT-II	
5.	**Unmanned Aerial Systems (UAS) Flight Engineering:** Drone engineering, multirotor configurations vs. fixed-wing units, payload specifications, inertial measurement units (IMU), and safety rules. Flight layout design: side lap settings, front lap parameters, ground sample distance (GSD) targets, and ground control point (GCP)
6.	**Structure-from-Motion (SfM) Workflows:** Point cloud processing, feature tracking algorithms, bundle block configurations, densified point cloud production, orthomosaic generation, and automated Digital Surface Model (DSM) construction.
7.	**Principles of Spatial Deep Learning Architectures:** Geo-AI modelling, integration of artificial intelligence with geospatial arrays. Machine learning architectures: Random Forest, Support Vector Machines (SVM), Convolutional Neural Networks (CNN), and spatial pattern classification networks.
8.	**Close-Range & Sub-Surface System Variations:** Industrial applications, close-range photogrammetry, terrestrial configurations, underwater tracking systems, and architectural modelling workflows.

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To provide students with foundational knowledge of photogrammetry principles, flight planning, image geometry, and photogrammetric measurement techniques. (ii) To develop skills in UAV/drone flight engineering, Structure-from-Motion workflows, and Geo-AI modeling using machine learning architectures for spatial analysis.
Course Outcomes: (i) Students will be able to apply photogrammetric principles for stereoscopic measurements, aerial triangulation, and terrain mapping from aerial photographs. (ii) Students will be able to plan UAV flights, process point cloud data through SfM workflows, and implement Geo-AI models (CNN, SVM, Random Forest) for spatial pattern classification.
Professional Skill Development: (i) The course builds practical expertise in UAV operations, photogrammetric data acquisition, and drone-based mapping technologies, preparing students for careers in surveying and geospatial data collection. (ii) It strengthens proficiency in Geo-AI and machine learning applications for spatial analysis, enhancing employability in emerging fields like precision agriculture, infrastructure monitoring, and automated geospatial modeling.

Text & Reference Books:

1. Wolf, P.R., Dewitt, B.A., & Wilkinson, B.E. – *Elements of Photogrammetry with Applications in GIS*, McGraw-Hill Education.
2. Kasser, M., & Egels, Y. – *Digital Photogrammetry*, CRC Press.
3. Linder, W. – *Digital Photogrammetry: A Practical Course*, Springer.
4. Mikhail, E.M., Bethel, J.S., & McGlone, J.C. – *Introduction to Modern Photogrammetry*, John Wiley & Sons.
5. Colomina, I., & Molina, P. – *Unmanned Aerial Systems for Photogrammetry and Remote Sensing: A Review*, ISPRS Journal of Photogrammetry and Remote Sensing.
6. Westoby, M.J., Brasington, J., Glasser, N.F., Hambrey, M.J., & Reynolds, J.M. – *Structure-from-Motion Photogrammetry: A Low-Cost, Effective Tool for Geoscience Applications*, Geomorphology.
7. Yao, H., Qin, R., & Chen, X. – *Unmanned Aerial Vehicle for Remote Sensing Applications: A Review*, Remote Sensing (MDPI).
8. Ghamisi, P., et al. – *Multisource and Multitemporal Data Fusion in Remote Sensing: A Comprehensive Review* (relevant for Geo-AI modelling), IEEE Geoscience and Remote Sensing Magazine.

Code & Level	Name of the Course
PG2GEOS2014	***GIS Data Analysis & DBMS***
Credits: 4 **Marks: 75**	
PG2GEOS2014 (Practical) [75 Marks]	
	UNIT-I
1.	**DBMS:** Introduction, Purpose of Database, Database System Architecture – Levels, Mappings, Database, Users and DBA **Entity Relationship Model:** Basic Concepts, Design Process, Constraints, Keys, Design Issues, E-R Diagram, Weak Entity Sets, Extended E-R Features Generalization, Specialization, Aggregation, Reduction to E-R Database Schema
2.	**Relational Database System Architecture:** DBMS design parameters: database architecture tiers, access privilege settings, multi-user concurrency controls, structural integrity constraints, and data administrator (DBA) tools.
3.	**Relational Model:** Structure of Relational Databases, Domains, Relations, Relational Algebra – Fundamental Operations and Syntax, Relational Algebra Queries, Tuple Relational Calculus SQL Concepts: Basics of SQL, DDL, DML, DCL, Structure – Creation Alteration, Defining Constraints – Primary Key, Foreign Key, Unique, Not Null, Check, and IN Operator
4.	**Functions, Agreeable Functions, Built-in Functions:** Numeric, Date, String, Set Operations, Queries, Sub-Queries, Correlated Sub-Queries, use of group by, having, order by, join and its types, Exist, Any, All, view and its types. Transaction control commands – Commit, Rollback, save points **Relational Database Design:** Functional Dependency – definition, trivial and non-trivial FD, closure of FD set, closure of attributes
UNIT-II	
5.	**Spatial Analytical Operators & Proximity Matrices:** Vector query pipelines, attribute selectors, spatial location joints, logical expressions, and proximity analyses (multi-ring buffering variations, Thiessen polygon zones).
6.	**Spatial Data Routing & Network Analysis Architecture:** Graph computations: node connections, impedance factors, turn tables, address matching, and dynamic segmentation workflows.
7.	**Layer extraction:** comparison of vector and raster-based data analysis, Geocoding, Dynamic Segmentation and its Application, Path analysis, Network Analysis
8.	**Advanced Vector Topologies & Overlay Computations:** Overlay logic model, Boolean intersections, vector boundary processing (union, identity, symmetrical difference operators), spatial join anomalies, and automated line cleaning methods; Hydrological Analysis: Drainage Basin Extraction, Stream Ordering, Slope, Aspect, Curvature, TIN, DEM, DTM, Hillshade and Viewshade Multivariate Analysis for Geospatial Mapping

Method of Evaluation for Internal Assessment:

Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To introduce students to database management system concepts, including relational models, SQL, and database design principles for managing spatial and non-spatial data. (ii) To develop proficiency in spatial data analysis techniques, including proximity analysis, network analysis, overlay operations, and hydrological modeling using GIS tools.
Course Outcomes: (i) Students will be able to design databases using ER modeling, write SQL queries, and apply relational database concepts for effective data management. (ii) Students will be able to perform spatial analysis operations such as buffering, network routing, overlay computations, and terrain/hydrological analysis (DEM, TIN, drainage basin extraction) for geospatial applications.
Professional Skill Development: (i) The course builds technical proficiency in database management and SQL programming, preparing students for roles involving geospatial data administration and system design. (ii) It strengthens practical skills in spatial analysis and hydrological modeling, enhancing employability in GIS analytics, urban planning, water resource management, and environmental research sectors.

Text & Reference Books:

1. Elmasri, R., & Navathe, S.B. – *Fundamentals of Database Systems*, Pearson Education.
2. Silberschatz, A., Korth, H.F., & Sudarshan, S. – *Database System Concepts*, McGraw-Hill Education.
3. Date, C.J. – *An Introduction to Database Systems*, Pearson Education.
4. Ramakrishnan, R., & Gehrke, J. – *Database Management Systems*, McGraw-Hill Education.
5. Longley, P.A., Goodchild, M.F., Maguire, D.J., & Rhind, D.W. – *Geographic Information Systems and Science*, John Wiley & Sons.
6. Burrough, P.A., McDonnell, R.A., & Lloyd, C.D. – *Principles of Geographical Information Systems*, Oxford University Press.
7. Chang, K. – *Introduction to Geographic Information Systems*, McGraw-Hill Education.
8. Zeiler, M. – *Modeling Our World: The ESRI Guide to Geodatabase Design*, ESRI Press.

Code & Level	Name of the Course
PG2GEOS2021	**GIS, GNSS, Surveying & Projection**
Credits: 4 **Marks: 75**	
PG2GEOS2021 **(Theory) [75 Marks]**	
UNIT-I	
1.	**GIS Data Capture and processing:** Source of data, topology, methods of collection, transformation, correction and accuracy, Types database in GIS, RDBMS, Geodatabases
2.	**Data manipulation and Analysis:** Raster and Vector based point, line and area; Proximity analysis: buffer, near and Thiessen polygon
3.	**Cartography:** Definition, Scope and Content, Recent Trends in Cartography; Basic Concepts: Parallels, Meridians, Great Circles, Scale Factor (Radial and Tangential), Orthodrome, Loxodrome
4.	**GNSS Foundations:** Geo positioning basic concepts, Pseudo Range Measurement, Phase Difference Measurement, Sources of GNSS errors, and DOP; Geoid, Datum/Ellipsoid (definition and basic concepts), Global Datum vs. Indian Geodetic Datum, Coordinate Systems.
5.	**Map Projection:** Definition, Characteristics, Selected Groups of Projections: Polar Case (Polar Zenithal Gnomonic), Cylindrical (Mercator's), Conical (Bonne's), Universal Transverse Mercator, **Coordinate, Distance,** Bearing, Azimuth and Scale Variations in different projections

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To provide students with knowledge of GIS data capture, processing, and analysis techniques, along with cartographic principles and concepts. (ii) To develop understanding of GNSS positioning fundamentals and map projection systems, including their characteristics and applications in spatial referencing.
Course Outcomes: (i) Students will be able to capture, process, and analyze spatial data using GIS techniques, including proximity analysis and raster/vector data manipulation. (ii) Students will be able to apply GNSS positioning concepts and select appropriate map projections for accurate cartographic representation and geospatial referencing.
Professional Skill Development: (i) The course strengthens technical competency in GIS data processing and cartographic design, preparing students for roles in spatial data management and map production. (ii) It builds proficiency in GNSS surveying and projection systems, enhancing employability in surveying, geodesy, and geospatial infrastructure development sectors.

Text & Reference Books:

1. Chang, K. – *Introduction to Geographic Information Systems*, McGraw-Hill Education.
2. Hofmann-Wellenhof, B., Lichtenegger, H., & Wasle, E. – *GNSS – Global Navigation Satellite Systems: GPS, GLONASS, Galileo & more*, Springer.
3. Burrough, P.A., McDonnell, R.A., & Lloyd, C.D. – *Principles of Geographical Information Systems*, Oxford University Press.
4. Longley, P.A., Goodchild, M.F., Maguire, D.J., & Rhind, D.W. – *Geographic Information Systems and Science*, John Wiley & Sons.
5. Robinson, A.H., Morrison, J.L., Muehrcke, P.C., Kimerling, A.J., & Guptill, S.C. – *Elements of Cartography*, John Wiley & Sons.
6. Snyder, J.P. – *Map Projections: A Working Manual*, U.S. Geological Survey Professional Paper.
7. Kennedy, M. – *Understanding Map Projections*, ESRI Press.
8. Leick, A., Rapoport, L., & Tatarnikov, D. – *GPS Satellite Surveying*, John Wiley & Sons.

SEMESTER – III

Code & Level	Name of the Course
PG2GEOS3011	***Thermal, Microwave, Hyperspectral & LIDAR Remote Sensing***
Credits: 4 **Marks: 50**	
PG2GEOS2011 (Theory) [50 Marks]	
1.	**Active & Passive Non-Optical Sensing Principles**: structural comparison of active microwave, continuous thermal line scanners, and hyperspectral data arrays.
2.	**Blackbody Radiative Laws & Atmospheric Attenuation**: Thermodynamic radiation concepts: ideal blackbody engines, Kirchhoff's law of thermal radiation, Stefan-Boltzmann law, and Wien's displacement theorem; Atmospheric windows: gas absorption states, transmission attributes, and their design impacts on satellite sensors
3.	**Thermal Infrared (TIR) Radiometry & Kinetics**: Thermal remote sensing physics, radiant vs. kinetic temperature states, emissivity variations, thermal inertia properties, and airborne/spaceborne TIR sensor architectures. Algorithmic workflows for deriving Land Surface Temperature (LST) and evaluating urban heat islands. **Thermal Remote Sensing:** Thermal Imaging Techniques, Thermal Properties of Terrain, Thermal Inertia of Earth Surface Features, IR-Radiometers, Airborne and Satellite TTR Scanner Systems, Thermal Scanners, Radiometric Calibrations, Interpretation of Thermal Images
4.	**RADAR:** Working Principle of RADAR, Physics of RADAR Remote Sensing, Measurement and Discrimination, System Parameters: Wavelength, Polarization, Resolution, Look Angle, Target Parameters: Back Scattering, Point Target, Volume Scattering, Penetration, Reflection, Physics of RADAR Remote Sensing, Factors affecting Microwave Measurement RADAR Interferometry: Principles of Interferometry, need for Interferometry Measurement, Radiometers and RADAR Geometry: Fundamentals and Data Processing Techniques
UNIT-II	
5.	**Synthetic Aperture Radar (SAR) Systems & Interferometry**: Principles and Application of SAR, Platforms and Sensors, Airborne Data Products and Selection Procedures, Different Passive Microwave Radiometers, Propagation of Microwave, Polarimetry: Importance of Polarimetry Property, Passive and Active Microwave Imaging, Factors affecting Microwave Measurement Doppler shift processing, synthetic aperture lengths, azimuth/range resolution limits, and satellite systems (Sentinel-1, NISAR). Radar interferometry (InSAR): phase correlation matrices, coherence maps, differential InSAR (DInSAR), and automated Digital Elevation Model (DEM) extraction
6.	**Hyperspectral Remote Sensing Techniques and Analysis:** Multispectral and Hyperspectral Data Comparison, Hyperspectral Sensors and Satellite Systems, Spectral Reflectance Libraries, Absorption Processes, Theoretical Basis and Relevance
7.	**Imaging Spectroscopy & Narrow-Band Libraries:** Hyperspectral engineering, continuous narrow-band imaging arrays vs. broad multispectral bands. Data architectures: handling hyperspectral data cubes, utilizing spectral libraries (USGS, JPL), mapping absorption positions, and analysing chemical/mineral composition properties
8.	**Hyperspectral Processing & Transformation Workflows:** Preprocessing hyperspectral cubes: empirical line corrections, FLAASH atmospheric models, Minimum Noise Fraction (MNF) transforms, Pixel Purity Index (PPI) tracking, and spectral unmixing models

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To provide students with in-depth knowledge of thermal and microwave remote sensing principles, including blackbody radiation laws, RADAR fundamentals, and SAR interferometry techniques. (ii) To develop expertise in hyperspectral remote sensing, covering spectral libraries, data cube processing, and advanced transformation workflows for mineral and chemical composition analysis.
Course Outcomes: (i) Students will be able to apply thermal remote sensing principles to derive Land Surface Temperature, analyze RADAR data, and process SAR/InSAR imagery for DEM extraction and deformation studies. (ii) Students will be able to process hyperspectral data cubes using techniques like MNF transforms and spectral unmixing to identify surface materials and analyze absorption features.
Professional Skill Development: (i) The course builds specialized technical skills in thermal and microwave sensor data processing, preparing students for advanced roles in satellite-based environmental and disaster monitoring. (ii) It strengthens expertise in hyperspectral image analysis and radar interferometry, enhancing employability in mineral exploration, precision agriculture, and cutting-edge remote sensing research fields.

Text & Reference Books:

1. Lillesand, T.M., Kiefer, R.W., & Chipman, J.W. – *Remote Sensing and Image Interpretation*, John Wiley & Sons.
2. Henderson, F.M., & Lewis, A.J. – *Principles and Applications of Imaging Radar (Manual of Remote Sensing, Vol. 2)*, John Wiley & Sons.
3. Elachi, C., & van Zyl, J.J. – *Introduction to the Physics and Techniques of Remote Sensing*, John Wiley & Sons.
4. Woodhouse, I.H. – *Introduction to Microwave Remote Sensing*, CRC Press.
5. Richards, J.A. – *Remote Sensing with Imaging Radar*, Springer.
6. Sabins, F.F. – *Remote Sensing: Principles and Interpretation*, Waveland Press.
7. van der Meer, F.D., & de Jong, S.M. (Eds.) – *Imaging Spectrometry: Basic Principles and Prospective Applications*, Springer.
8. Hanssen, R.F. – *Radar Interferometry: Data Interpretation and Error Analysis*, Springer/Kluwer Academic Publishers.
9. Shaw, G.A., & Burke, H.K. – *Spectral Imaging for Remote Sensing*, Lincoln Laboratory Journal.

Code & Level	Name of the Course
PG2GEOS3012	***Regional Planning & Disaster Management***
Credits: 4 **Marks: 50**	
PG2GEOS3012 (Theory) [50 Marks]	
UNIT-I	
1.	**Spatial Development Frameworks & Regional Networks:** Planning theories, core methodologies, operational frameworks, data requirements, and historical trends. Implementing advanced geospatial tracking inside complex urban development frameworks
2.	**Morphological Urban Spatial Growth Models:** Urban spatial patterns: concentric zone layouts, sector profiles, multiple nuclei dynamics, cellular automata models, urban sprawl indicators, and land consumption metric calculations
3.	**High-Resolution Cadastral & Asset Management:** Advanced parcel tracking. Integrating drone-derived high-resolution terrain (DSM & DTM) models into local government Municipality for better natural resource management and flood network planning, utility maintenance, and property boundary dispute resolution frameworks.
4.	**Rural-Urban Interface Dynamics:** Spatial analysis of peri-urban expansion. Modeling the environmental stress of urbanization on rural watersheds, agricultural lands, and local ecosystems using Cellular Automata (CA) and Markov Chain models.
UNIT-II	
5.	**Soil Degradation Processes & Universal Loss Modelling**: Soil vulnerability analysis: mapping soil profiles, tracking salinity extensions, and using the Revised Universal Soil Loss Equation (RUSLE) to predict spatial erosion distributions
6.	**Cryosphere Dynamics & Remote Sensing:** Advanced monitoring of high-altitude and polar environments. Tracking glacier mass balance, snow-cover fraction modeling, and ice kinematics using multi-temporal SAR and optical sensors
7.	**Cascading Geo-Hazards & Complex Systems:** Earthquake-induced landslides damming rivers, resulting in flash floods). Quantitative risk assessment formulas incorporating spatial probability, temporal exposure, and structural vulnerability
8.	**UAV Applications in Disaster Damage Assessment:** Rapid deployment of drone technology for post-disaster mapping. Near real-time volumetric analysis of landslide debris, infrastructure damage quantification, and safe-route mapping for first responders

Method of Evaluation for Internal Assessment:

Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To familiarize students with regional planning frameworks, urban spatial growth models, and cadastral asset management using advanced geospatial technologies. (ii) To develop understanding of geo-hazard processes, including soil erosion modeling, cryosphere dynamics, cascading disasters, and UAV-based disaster damage assessment.
Course Outcomes: (i) Students will be able to analyze urban spatial patterns, model rural-urban interface dynamics, and apply Cellular Automata/Markov Chain models for regional planning applications. (ii) Students will be able to assess geo-hazard risks through soil loss modeling (RUSLE), glacier/cryosphere monitoring, and UAV-based rapid damage assessment for disaster management.
Professional Skill Development: (i) The course builds practical expertise in regional planning, cadastral mapping, and urban growth modeling, preparing students for careers in urban planning and land management sectors. (ii) It strengthens technical skills in geo-hazard risk assessment and UAV-based disaster response mapping, enhancing employability in disaster management, environmental monitoring, and geo-hazard mitigation agencies.

Text & Reference Books:

1. Kaiser, E.J., Godschalk, D.R., & Chapin, F.S. – *Urban Land Use Planning*, University of Illinois Press.
2. Alcántara-Ayala, I., & Goudie, A.S. (Eds.) – *Geomorphological Hazards and Disaster Prevention*, Cambridge University Press.
3. Klosterman, R.E. – *Community Analysis and Planning Techniques*, Rowman & Littlefield.
4. Batty, M. – *Cities and Complexity: Understanding Cities with Cellular Automata, Agent-Based Models, and Fractals*, MIT Press.
5. Morgan, R.P.C. – *Soil Erosion and Conservation*, Wiley-Blackwell.
6. Renard, K.G., et al. – *Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE)*, USDA Agriculture Handbook.
7. Singh, V.P., Singh, P., & Haritashya, U.K. (Eds.) – *Encyclopedia of Snow, Ice and Glaciers*, Springer.
8. Alcántara-Ayala, I. – *Geomorphology, Natural Hazards, Vulnerability and Prevention of Natural Disasters in Developing Countries*, Geomorphology Journal.
9. Westen, C.J. van – *Remote Sensing and GIS for Natural Hazards Assessment and Disaster Risk Management*, ITC/Elsevier.

Code & Level	Name of the Course	
PG2GEOS3013	***AI based Geospatial Modelling***	
Credits: 4 **Marks: 50**		
PG2GEOS3011 (Theory) [50 Marks]		
UNIT-I		
1.	**Introduction to DSS:** Objectives and Types, Decision Support Systems (DSS): Concept and Characteristics, Spatial Decision Support Systems (SDSS) and GIS	
2.	**Spatial Multi-Criteria Foundations**: SMCDA structure, identifying criteria options, bounding analysis regions, mapping alternatives, and processing step-by-step evaluation matrices.	
3.	**Attribute Multi-Collinearity Diagnostic Verification**: Redundancy testing protocols: calculating cross-correlation values, computing Variance Inflation Factors (VIF), evaluating multi-collinearity errors, and using attribute reduction methods	
4.	**Standardization Techniques & Normalization:** Transforming criteria fields: sorting beneficial vs. non-beneficial factors. Mathematical normalizations: Linear Max-Min transformations, Vector normalizations, Enhanced Accuracy scales, and Logarithmic normalization scaling	
UNIT-II		
5.	**Criteria Optimization Weighting Algorithms**: Weight assignment models: direct ranking lists, rating scales, pairwise comparison structures, Weighted Sum Models (WSM), Weighted Product Models (WPM), and TOPSIS pipelines.	
6.	**Analytical Hierarchy Process (AHP) & Fuzzy Implementations**: AHP mathematical modelling: constructing reciprocal pairwise comparison matrices, computing Principal Eigenvectors, identifying maximum Eigenvalues, checking Consistency Ratios (CR), and implementing Fuzzy AHP weights	
7.	**Machine Learning for Hazard & Resource Modelling**: Applied programming implementations using machine learning scripts (Random Forest, SVM, XGBoost) to predict spatial parameters, including groundwater potential mapping, land suitability analysis and flooding etc.	
8.	Application of AI in the field of Remote Sensing	

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To introduce students to spatial decision support systems (SDSS), multi-criteria decision analysis frameworks, and standardization techniques for geospatial evaluation. (ii) To develop proficiency in AI-based geospatial modeling, including AHP weighting algorithms, machine learning techniques, and their applications in hazard and resource prediction.
Course Outcomes: (i) Students will be able to apply spatial multi-criteria decision analysis, perform multi-collinearity diagnostics, and normalize criteria for effective decision-making models. (ii) Students will be able to implement AHP/Fuzzy AHP weighting techniques and apply machine learning algorithms (Random Forest, SVM, XGBoost) for groundwater potential mapping, land suitability analysis, and flood prediction.
Professional Skill Development: (i) The course builds analytical competency in spatial decision-making frameworks and multi-criteria evaluation, preparing students for roles in planning and resource management. (ii) It strengthens technical expertise in AI and machine learning applications for geospatial modeling, enhancing employability in hazard prediction, natural resource management, and AI-driven remote sensing research sectors.

Text & Reference Books:

1. Malczewski, J., & Rinner, C. – *Multicriteria Decision Analysis in Geographic Information Science*, Springer.
2. Saaty, T.L. – *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*, RWS Publications.
3. Malczewski, J. – *GIS and Multicriteria Decision Analysis*, John Wiley & Sons.
4. Hwang, C.L., & Yoon, K. – *Multiple Attribute Decision Making: Methods and Applications (TOPSIS)*, Springer.
5. Zimmermann, H.J. – *Fuzzy Set Theory and Its Applications*, Springer.
6. James, G., Witten, D., Hastie, T., & Tibshirani, R. – *An Introduction to Statistical Learning with Applications in R*, Springer.
7. Lary, D.J., Alavi, A.H., Gandomi, A.H., & Walker, A.L. – *Machine Learning in Geosciences and Remote Sensing*, Geoscience Frontiers.
8. Sameen, M.I., Pradhan, B., & Lee, S. – *Application of Convolutional Neural Networks for Geohazard Susceptibility Mapping*, Catena Journal.
9. Chen, W., et al. – *Applying Random Forest and GIS for Groundwater Potential Mapping*, Journal of Hydrology.

Code & Level	Name of the Course
PG2GEOS3014	***WebGIS Technology and Applications***
Credits: 4 **Marks: 50**	
PG2GEOS3014 (Practical) [50 Marks]	
1.	**Cloud-Native Geospatial Architectures:** Introduction to cloud computing for spatial data. Understanding Cloud Optimized GeoTIFFs (COG), Spatio-Temporal Asset Catalogs (STAC), and serverless spatial queries
2.	**Planetary-Scale Processing Engines:** Hands-on coding within cloud ecosystems using the Google Earth Engine (GEE) API and Microsoft Planetary Computer. Writing JavaScript and Python scripts for parallel processing of petabyte-scale satellite archives and Big Data Analysis.
3.	**Interactive Risk & Resource Dashboards:** Building dynamic web interfaces. Using React.js, Leaflet, and Mapbox GL JS to create user-facing dashboards that visualize complex AI/ML outputs and hydrodynamic flood models.
4.	**Spatial APIs and Real-Time Data Streaming:** Developing custom RESTful APIs to serve geospatial data, Management of live telemetry feeds (e.g., river gauge sensors, weather stations) directly into web maps via WebSocket
UNIT-II	
5.	**Web-Based Geoprocessing Services (WPS):** Moving analysis to the web. Allowing users to execute spatial operations (buffering, clipping, index calculation) via browser-based interfaces without local software.
6.	**Geospatial App Deployment & Security:** Geospatial applications using Docker, implementing role-based access control, securing spatial endpoints, and deploying applications to AWS or Google Cloud Platform.
7.	**Emerging Trends in WebGIS:** Realtime GIS, Mobile and Location based GIS,WebGIS and Artificial Intelligence
8.	**Geospatial Applications:** Smart Cities, Urban Planning, Utility and Infrastructure Mapping, E-Governance Applications

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To introduce students to cloud-native geospatial architectures, planetary-scale processing engines, and interactive dashboard development using modern web technologies. (ii) To develop proficiency in building spatial APIs, real-time data streaming, web-based geoprocessing services, and deploying secure geospatial applications on cloud platforms.
Course Outcomes: (i) Students will be able to process large-scale satellite data using Google Earth Engine and build interactive web dashboards using React.js, Leaflet, and Mapbox GL JS. (ii) Students will be able to develop RESTful spatial APIs, implement web-based geoprocessing services, and deploy secure geospatial applications using Docker and cloud platforms (AWS/GCP).
Professional Skill Development: (i) The course builds practical expertise in cloud computing and web development for geospatial applications, preparing students for careers in WebGIS development and cloud-based spatial analytics. (ii) It strengthens skills in real-time data integration, application deployment, and security practices, enhancing employability in smart city projects, e-governance, and infrastructure mapping industries.

Text & Reference Books:

1. Peterson, M.P. (Ed.) – *Online Maps with APIs and WebServices*, Springer.
2. Fu, P. – *Getting to Know Web GIS*, ESRI Press.
3. Kraak, M.J., & Ormeling, F. – *Cartography: Visualization of Spatial Data*, CRC Press.
4. Gorelick, N., et al. – *Google Earth Engine: Planetary-Scale Geospatial Analysis for Everyone*, Remote Sensing of Environment.
5. Neumann, A. – *Web Mapping and Web Cartography* (in *Encyclopedia of GIS*), Springer.
6. Miller, C. – *A Beast in the Field: The Google Maps Mashup as GIS/2*, Cartographica.
7. Freeman, A. – *Pro ASP.NET/React Web Application Development* (relevant for dashboard frameworks), Apress.
8. Erl, T., Puttini, R., & Mahmood, Z. – *Cloud Computing: Concepts, Technology & Architecture*, Prentice Hall.
9. Nolan, C., & Lang, D.T. – *XML and Web Technologies for Data Sciences with R* (relevant for spatial APIs), Springer.

Code & Level		Name of the Course
PG2GEOS3015		*Fieldwork & Community Engagement*
PG2GEOS3015 (Practical) [50 Marks]		
UNIT-I		
1.	**Field Instrument Setup & Spatial Collection Protocols:** Field data collection management: calibrating mobile geodatabase configurations, setting up DGPS baseline receivers, planning field traverse sectors, tracking landform features, and running field validation checks	
2.	**Questionnaire Design & Socioeconomic Data Matching:** Social survey management, drafting household questionnaire lists, running random sampling sweeps, conducting focus group reviews, tracking spatial vulnerabilities, and building digital tables of field attributes.	
3.	**Public Geospatial Asset Creation & Community Engagement:** Community field activities: presenting map visualizations to local government bodies, holding spatial awareness sessions, identifying community hazards, and co-creating local planning assets.	
4.	**Participatory GIS (PGIS) & Open Data Collection:** Deploying open-source mobile data collection frameworks (e.g., ODK, KoBoToolbox, QField). Designing complex logic-branched surveys to capture indigenous knowledge, local hazard histories, and socio-economic vulnerabilities.	
UNIT-II		
5.	**Ground-Truthing:** Strategies for collecting validation data in challenging environments (e.g., cryosphere margins, dense forests, steep topography), Protocols for physical water/soil sampling to calibrate satellite-derived hydrodynamic and erosion models.	
6.	**Field Report Compilation Framework: Report compilation rules: processing field observations, running multi-criteria analysis tests, creating layout graphics, and writing structured research chapters**	
7.	**Drafting Local Environmental Action Plans:** developing local flood response paths, identifying sites for micro water harvesting structures, or mapping solid waste zones to present to municipal administrative departments.	
8.	**Open Data Publishing:** Presenting field findings to academic and community boards. Cleaning and publishing the collected spatial datasets to open repositories (like OpenStreetMap) to ensure long-term community benefit.	

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks. It shall be assessed based on the % of attendance in the class (5 Marks) and Test 10 (Marks); There shall be the test (s) of knowledge and understanding through Written Test/ Presentation /Paper review/ Book review / Individual assignment/ Quiz, etc. (10 Marks).

Course Objectives: (i) To equip students with practical field data collection skills, including DGPS setup, questionnaire design, and participatory GIS techniques for community-based spatial research. (ii) To develop competency in ground-truthing methods, field report compilation, and community engagement strategies for translating geospatial findings into actionable local plans.
Course Outcomes: (i) Students will be able to conduct field surveys using mobile data collection tools (ODK, KoBoToolbox, QField) and design socioeconomic questionnaires integrated with spatial data. (ii) Students will be able to perform ground-truthing validation, compile structured field reports, and publish open geospatial datasets while engaging communities in local environmental action planning.
Professional Skill Development: (i) The course builds hands-on fieldwork competency and technical proficiency in participatory GIS tools, preparing students for careers involving community-based spatial data collection and validation. (ii) It strengthens communication and stakeholder engagement skills through public presentations and collaborative planning, enhancing employability in community development, disaster response, and open-data geospatial initiatives.

Text & Reference Books:

1. Kindon, S., Pain, R., & Kesby, M. (Eds.) – *Participatory Action Research Approaches and Methods: Connecting People, Participation and Place*, Routledge.
2. Chambers, R. – *Whose Reality Counts? Putting the First Last (Participatory Rural Appraisal)*, Practical Action Publishing.
3. Corbett, J. – *Good Practices in Participatory Mapping*, IFAD (International Fund for Agricultural Development).
4. McCall, M.K. – *Participatory Mapping and Participatory GIS (PGIS) for CRVA, Local Knowledge and Adaptation*, GIS Development.
5. Elwood, S., & Cope, M. – *Qualitative GIS: A Mixed Methods Approach*, SAGE Publications.
6. Kumar, R. – *Research Methodology: A Step-by-Step Guide for Beginners*, SAGE Publications.
7. Rambaldi, G. – *Participatory Mapping to Enrich Local Spatial Knowledge*, CTA Publications.
8. Fisher, W.F. – *Toward Sustainable Development: Struggling over India's Narmada River*, Routledge (relevant for community-based environmental planning).
9. OpenStreetMap Foundation – *OpenStreetMap Wiki and Documentation on Humanitarian Mapping*, OSM/HOT Guidelines.

SEMESTER – IV

Code & Level	Name of the Course
PG2GEOS4031	***Research Thesis/ Project/ Dissertation/Patent***
PG2GEOS4031(Practical) [250 Marks]	
Credits: 20 **Marks: 250**	
1.	Identify, Collect, Compare, evaluate and summarise relevant existing literature related to the problem in hand.
2.	Identify Research Gaps, Develop appropriate research questions and Objectives in relation to their domain of research.
3.	Design Research Strategy and Methodology and Create coherent geospatial database and other relevant data for each objective.
4.	Apply Geospatial, Geostatistical, Statistical tools and techniques, and evaluate the appropriateness of results in relation to objectives and research questions.
5.	Integrate, interpret and synthesis all results and write a scientifically sound academic report with appropriate references (APA/MLA style), and communicate research findings to stakeholders and in peer reviewed journal/conferences. **

** Two copies of hard binding report not more than 25,000 words (Front Size 12) must be typed in Times New Roman with 1.5 spacing

Method of Evaluation for Internal Assessment:
Continuous/ Internal Assessment: 15 Marks out of 75 and 30 out of 150. It shall be assessed based on the % of attendance in the class (5 out of 15/10 out of 30 Marks) and Test 10 out of 15/20 out of 30 (Marks); There shall be the test (s) of knowledge and understanding preparation and presentation of literature review and or finding research gap/hypothesis/research questions/ reason for the selection of study area.

Course Objectives: (i) To guide students in identifying research gaps, developing research questions, and designing an appropriate methodology for their thesis/project work in geospatial science. (ii) To enable students to apply geospatial and geostatistical tools for data analysis and synthesize findings into a scientifically sound academic report or patent.
Course Outcomes: (i) Students will be able to conduct a comprehensive literature review, formulate research objectives, and design a coherent research methodology and database for their chosen problem. (ii) Students will be able to apply appropriate analytical tools, interpret results critically, and communicate findings through a well-referenced thesis, publication, or patent submission.
Professional Skill Development: (i) The course cultivates independent research capability and critical thinking, preparing students for advanced academic research, doctoral studies, and R&D roles in the geospatial industry. (ii) It strengthens scientific writing, data analysis, and professional communication skills, enhancing employability in research institutions, industry R&D, and academic/scientific publishing environments.

Text & Reference Books:

1. Kothari, C.R. – *Research Methodology: Methods and Techniques*, New Age International Publishers.
2. Day, R.A., & Gastel, B. – *How to Write and Publish a Scientific Paper*, Cambridge University

Press.

3. Creswell, J.W. – *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, SAGE Publications.
4. Kumar, R. – *Research Methodology: A Step-by-Step Guide for Beginners*, SAGE Publications.
5. Booth, W.C., Colomb, G.G., & Williams, J.M. – *The Craft of Research*, University of Chicago Press.
6. Glasman-Deal, H. – *Science Research Writing for Non-Native Speakers of English*, Imperial College Press.
7. Ganguli, P. – *Intellectual Property Rights: Unleashing the Knowledge Economy*, McGraw-Hill Education.
8. World Intellectual Property Organization (WIPO) – *WIPO Guide to the Patent Cooperation Treaty (PCT)*, WIPO Publications.
9. American Psychological Association – *Publication Manual of the American Psychological Association (APA Style)*, APA.