



SNDT Women's University
1, Nathibai Thackersey Road, Mumbai- 400020

Syllabus
As per NEP 2020

M.A./M.Sc. in Geoinformatics
Academic Year 2025-26 Onwards

Postgraduate Programme in Geoinformatics**Academic Year 2025 Onwards****Tentative Template****Programme Template:**

Programme Degree	M.A./M.Sc. in Geoinformatics
Parenthesis if any (Specialization)	BSC Geography, MA/MSc Geography / Post Graduation in Earth and Planetary Sciences/ BE / BTech/ BSc Agriculture/ BSc Life Sciences
Preamble (Brief Introduction to the Programme)	M.A./M.Sc. (Geoinformatics) is a Two Year PG/ Master's Programme with one Exit Option/ One Year PG Programme. At the end of programme students will be skilled in discipline specific concepts, theories, methodologies in Geography. They will equipped with the practical knowledge of surveying, mapping, spatial analysis and planning which can be applied in various fields and will help them to be competent for providing services related to the field, employability in various sectors etc.
Eligibility Criteria for Programme	BSC Geography, MA/MSc Geography / Post Graduation in Earth and Planetary Sciences/ BE / BTech/ BSc Agriculture/ BSc Life Sciences
Intake Capacity	25

**Structure with Course Titles
Masters Programme (M.A./M.Sc.) of Geoinformatics**

Duration : 2 years

Year I

SN	Courses	Type of Course	Credits	Marks	Int	Ext
	Semester I					
117011	Fundamentals of Remote Sensing	Major (Core)	4	100	50	50
117012	Introduction to GIS	Major (Core)	4	100	50	50
117023	Practicals of Remote Sensing and GIS	Major (Core)	4	100	50	50
117004	Principles of Satellite Navigation system	Major (Core)	2	50	50	0
127011	Digital Cartography	Major (Elective)	4	100	50	50
137011	Research Methodology	Minor Stream (RM)	4	100	50	50
			22	550	300	250
	Semester II					
217011	Digital Image Processing	Major (Core)	4	100	50	50
217012	Field Work and Surveying	Major (Core)	4	100	50	50
217023	Practicals in Image Processing	Major (Core)	4	100	50	50
217014	GPS Survey & Mapping	Major (Core)	2	50	0	50
227011	Geoinformatics in Water Resources	Major (Elective)	4	100	50	50
247041	On Job Training	OJT	4	100	50	50
			22	550	250	300

Year II

SN	Courses	Type of Course	Credits	Marks	Int	Ext
	Semester III					
317031	Internship	Major (Core)	4	100	50	50
317032	Internship	Major (Core)	4	100	50	50
317013	DBMS and Web GIS	Major (Core)	4	100	50	50
317024	Practicals in Advanced GIS	Major (Core)	2	50	0	50
327011	Introduction to Geo-statistics	Major (Elective)	4	100	50	50
357031	Research Project	RP	4	100	50	50
			22	550	250	300
	Semester IV					
417011	Programming in Python and HTML	Major (Core)	4	100	50	50
417012	Geoinformatics in Urban Planning	Major (Core)	4	100	50	50
417023	Advanced Practical in Geoinformatics	Major (Core)	4	100	50	50
417014	Geoinformatics in Land Resources	Major (Elective)	4	100	50	50
457031	Research Project	RP	6	150	100	50
			22	550	300	250

SEMESTER I**Major (Core)**

Course Title:	Fundamentals of Remote Sensing
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Explain electromagnetic radiation principles, spectral signatures, and interactions with atmospheric and surface features.
	2. Identify and compare various remote sensing platforms, sensors, orbital characteristics, and resolution concepts.
	3. Interpret aerial photographs and satellite imagery including 2D/stereo analysis, scale determination, and height measurement.
	4. Apply digital photogrammetry techniques and understand radiometric, geometric, and atmospheric error correction methods.
Module 1 (Credit 1): Remote Sensing Fundamentals and Physics	
Learning Outcomes:	After learning the module, learners will be able to understand basic concepts and principles of Remote Sensing, explain electromagnetic radiation and its interaction with matter, and understand spectral signatures.
Content Outline:	<ul style="list-style-type: none"> 1.1 Remote Sensing: Definition, concepts, scope, advantages and limitations 1.2 Electromagnetic Radiation: Laws of radiation, EM spectrum, wave properties 1.3 Interaction of EMR with atmosphere and matter: Reflection, absorption, transmission 1.4 Spectral signatures of natural features: Snow, soil, water, vegetation
Module 2 (Credit 1): Platforms, Sensors and Data Acquisition	
Learning Outcomes:	Understand types and characteristics of remote sensing platforms and sensors; explain orbital characteristics and resolution concepts; identify Indian space missions.
Content Outline:	<ul style="list-style-type: none"> 2.1 Platform types and sensor categories 2.2 Satellite orbits and orbital characteristics 2.3 Resolution concepts: Spatial, spectral, temporal, radiometric 2.4 Indian space missions and sensor characteristics
Module 3 (Credit 1): Aerial Photography and Photogrammetry	
Learning Outcomes:	Understand principles of aerial photography; apply photogrammetry principles; interpret aerial photographs and satellite imagery.
Content Outline:	<ul style="list-style-type: none"> 3.1 Aerial photography principles and geometry Scale determination methods 3.2 Parallax and height measurement 3.3 Aerial photo interpretation and satellite image interpretation
Module 4 (Credit 1): Data Products, Processing and Digital Photogrammetry	
Learning Outcomes:	Understand satellite data products and formats; apply radiometric, geometric and atmospheric corrections; apply digital photogrammetry.
Content Outline:	<ul style="list-style-type: none"> 4.1 Satellite data products and formats 4.2 Radiometric, geometric and atmospheric error corrections 4.3 Stereo photogrammetry concepts 4.4 Digital photogrammetry techniques

Continuous Comprehensive Evaluation (CCE):

1. Seminar/Group Discussion:	10 Marks
2. Home Assignments/Group Activities:	10 Marks
3. Field Visit and Observation:	10 Marks
4. Project Work and Presentation:	20 Marks

Internal Assessment Total:	50 Marks

References:

1. Campbell, J. (2002): Introduction to Remote Sensing, Taylor & Francis, London
2. Gupta, P.K. Remote Sensing Geology; Springer-Verlag
3. Jensen, J.R. Introductory Digital Image Processing; Pearson
4. Joseph, G. (2004): Fundamentals of Remote Sensing, Universities Press, Hyderabad, India
5. Lillesand, T.M.; Kiefer, R.W.; Chipman, J.W. Remote Sensing and Image Interpretation; Wiley
6. Mather, P.M. Computer Processing of Remotely Sensed Images; John Wiley & Sons
7. Sabins, F.F. Jr. Remote Sensing: Principles and Interpretation; W.H. Freeman

Major (Core)

Course Title:	Introduction to GIS
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Explain GIS concepts, components, functions and various GIS software packages.
	2. Understand and work with spatial data models (vector/raster), layers, topology and common spatial operations.
	3. Design and implement relational databases with proper normalization and spatial database concepts.
	4. Conduct spatial data input through digitization, identify and correct errors, and perform spatial analysis.
Module 1 (Credit 1): GIS Fundamentals and Software Overview	
Learning Outcomes:	Understand GIS concepts, components, functions, and major software platforms.
Content Outline:	1.1 GIS definitions, history, evolution and scope 1.2 Components of GIS: Hardware, software, data, people, methods 1.3 Functions and applications of GIS 1.4 Overview of GIS software packages
Module 2 (Credit 1): Spatial Data Models and Structures	
Learning Outcomes:	Work with vector and raster data models, topology, and common spatial operations.
Content Outline:	2.1 Spatial data models: Vector and raster 2.2 Topology and spatial operations 2.3 Computer representation methods 2.4 Digitizing errors and corrections
Module 3 (Credit 1): Database Management and SQL	
Learning Outcomes:	Design and implement relational databases with normalization and SQL queries.
Content Outline:	3.1 Database management systems 3.2 Relational data models and normalization 3.3 SQL commands and queries 3.4 Spatial database concepts
Module 4 (Credit 1): Spatial Data Input and Analysis	
Learning Outcomes:	Conduct spatial data input through digitization, error correction, and data quality assessment.
Content Outline:	4.1 Spatial data input methods 4.2 Error sources and correction procedures 4.3 Data quality assessment 4.4 Spatial analysis fundamentals

Continuous Comprehensive Evaluation (CCE):

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|---------------------------------------|----------|
| 1. Seminar/Group Discussion: | 10 Marks |
| 2. Home Assignments/Group Activities: | 10 Marks |
| 3. Field Visit and Observation: | 10 Marks |
| 4. Project Work and Presentation: | 20 Marks |
| | ----- |

Internal Assessment Total: 50 Marks

References:

- Bailey, T. C., & Gatrell, A. C. (1995). Interactive spatial data analysis (Vol. 413, No. 8). Essex: Longman Scientific & Technical.
- Chang, K. T. (2008): Introduction to Geographic Information Systems, Avenue of the

Americas, McGraw-Hill, New York

3. Demers, M. N. (2000): Fundamentals of Geographic Information Systems, John Wiley and Sons, New Delhi
4. Environmental Systems Research Institute, Inc. (1998): Understanding GIS: The ARC/INFO Method, ESRI Press, Redland
5. Fotheringham, S., & Rogerson, P. (Eds.). (2013). Spatial analysis and GIS. Crc Press.
6. Korte, G. B. (2001): The GIS Book, Onward Press, Bangalore
7. Lo, C. P., Yeung, A. W. (2002): Concepts Techniques of Geographical Information Systems, Prentice-Hall of India, New Delhi
8. Longley, P. A., Goodchild, M. F., Maguire, D. J., Rhind, D. W. (2002): Geographical Information Systems and Science, John Wiley & Sons, Chichester
9. Longley, P. (2003). Advanced spatial analysis: the CASA book of GIS. ESRI, Inc.

Major (Core) Practical I

Course Title:	Practicals of Remote Sensing and GIS
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Interpret satellite imagery and aerial photographs.
	2. Process satellite data, digitize spatial features.
	3. Perform advanced spatial analysis.
Module 1 (Credit 1): Image Interpretation and Analysis	
Learning Outcomes:	Perform visual interpretation and classification of satellite images and aerial photographs.
Content Outline:	1.1 Visual interpretation of satellite images (basic concepts, elements, image acquisition) 1.2 Interpretation of aerial photographs (geometry, scale determination using various methods) 1.3 Identification of ground features 1.4 Stereo pair analysis and single image interpretation 1.5 Estimation of object height from aerial photographs 1.6 Derived land use/land cover (LULC) mapping from various sensors (FCC images)
Module 2 (Credit 1): Satellite Data Processing and Input	
Learning Outcomes:	Download and preprocess satellite data with geometric and radiometric corrections.
Content Outline:	2.1 Procurement and downloading of satellite data from open sources 2.2 Understanding satellite data products and formats; Demonstration of handling satellite data with image processing software 2.3 Geometric and radiometric corrections 2.4 Georeferencing and data preparation
Module 3 (Credit 1): Digital Data Creation and Attribute Management	
Learning Outcomes:	Create digital spatial data through digitization and manage attribute information.
Content Outline:	3.1 Introduction to digitizing in QGIS 3.2 Georeferencing for creating base maps 3.3 Creating shapefiles (point, line, polygon features) 3.4 Adding attribute data and creating classified/thematic maps 3.5 Generating layout with legends 3.6 Saving and editing shapefiles, Building topology
Module 4 (Credit 1): Spatial Analysis and Advanced Operations	
Learning Outcomes:	Execute spatial analysis including DEM generation, buffer analysis, and overlay operations.
Content Outline:	4.1 Digital Elevation Model (DEM) generation and analysis 4.2 Creating maps of slope, aspect, contour, relief, and hillshade 4.3 Buffer analysis and zone mapping 4.4 Overlay analysis and spatial intersection 4.5 Building topology and data query operations 4.6 Using QGIS tools (raster calculator, reproject, spatial analyst)

Continuous Comprehensive Evaluation (CCE):

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|---------------------------------------|----------|
| 1. Seminar/Group Discussion: | 10 Marks |
| 2. Home Assignments/Group Activities: | 10 Marks |
| 3. Field Visit and Observation: | 10 Marks |
| 4. Project Work and Presentation: | 20 Marks |

Internal Assessment Total: 50 Marks

References:

1. Burrough, P. A., & McDonnell, R. A. (1998). Principles of Geographical Information Systems. New York: Oxford University press Inc.
2. Campbell, J. B. (2002), Introduction to Remote Sensing. London: Taylor and Francis.
3. Chang, K. T. (2008). Introduction to Geographic Information Systems. Avenue of the Americas, McGraw-Hill.
4. Environmental Systems Research Institute, Inc. (1998). Understanding GIS: The ARC/INFO Method. Redlands: ESRI Press.
5. Goodchild, M. F. (2003). Geographic Information Science and System for Environmental Management. Annual Review of Environment and Resource 28: 493-519
6. Joseph, G. (2003). Fundamentals of Remote Sensing, Hyderabad: University Press.
7. Ollier Lillesand, T. M., & Ralph, K. W. (2008). Remote Sensing and Image Interpretation. Singapore: John Wiley and Sons.
8. Sabins, F. F. (1996). Remote Sensing: Principles and Interpretation, San Francisco: W. H. Freemanand Company.
9. Tempfi, K., Kerle, N., Huurneman, G., & Janssen, L. F. (Eds) (2009). Principles of Remote Sensing – An Introductory Text Book. Netherlands: The International Institute for Geoinformation Science.

Major (Core)

Course Title:	Principles of Satellite Navigation Systems
Course Credits:	2
Course Outcomes:	After going through the course, learners will be able to:
	1. Describe the fundamental principles of satellite navigation systems such as GPS, GLONASS, and regional systems.
	2. Explain the architecture, signal structure, and functioning of various satellite navigation systems.
	3. Analyze sources of error and the methods for improving positional accuracy in satellite navigation.
Module 1 (Credit 1): GNSS Fundamentals and Architecture	
Learning Outcomes:	Understand satellite navigation system architecture, constellations, and signal structure.
Content Outline:	1.1 Satellite navigation systems 1.2 GNSS architecture and satellite constellations 1.3 Orbital characteristics 1.4 Satellite signals and modulation
Module 2 (Credit 1): Positioning Principles and Error Sources	
Learning Outcomes:	Apply GPS positioning principles and differential/augmentation techniques for accuracy improvement.
Content Outline:	2.1 Positioning principles and trilateration 2.2 Error sources and their analysis 2.3 Differential GNSS techniques 2.4 Augmentation systems

Continuous Comprehensive Evaluation (CCE):

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|---------------------------------------|----------|
| 1. Seminar/Group Discussion: | 10 Marks |
| 2. Home Assignments/Group Activities: | 10 Marks |
| 3. Field Visit and Observation: | 10 Marks |
| 4. Project Work and Presentation: | 20 Marks |

Internal Assessment Total: 50 Marks

References:

- Betz, John W. (2015). Engineering Satellite-Based Navigation and Timing: Global Navigation Satellite Systems, Signals, and Receivers. Wiley-IEEE Press.
- Jeffrey, Charles (2010). An Introduction to GNSS: GPS, GLONASS, Galileo and Other Global Navigation Satellite Systems. NovAtel Inc.
- Prasad, Ramjee & Ruggieri, Marina. (2005). Applied Satellite Navigation Using GPS, GALILEO, and Augmentation Systems. Artech House Publishers.
- Teunissen, P.J.G., & Montenbruck, O. (Eds.) (2017). Springer Handbook of Global Navigation Satellite Systems. Springer.

Major (Elective)

Course Title:	Digital Cartography
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Explain and apply the foundational principles and conventions of cartography in a digital environment
	2. Develop proficiency in map design, data visualization, and geospatial representation using digital tools.
	3. Analyze and interpret various types of spatial data and map projections to create accurate and effective maps.
	4. Foster hands-on skills in digital mapping software for practical mapping, thematic map generation, and visual communication.
Module 1 (Credit 1): Digital Cartography Fundamentals and Projections	
Learning Outcomes:	Apply map projections and coordinate system transformations for cartographic representation.
Content Outline:	<ul style="list-style-type: none"> 1.1 Digital cartography concepts, history, and scope 1.2 Traditional vs digital mapping 1.3 Role of GIS, RS, GPS in map production 1.4 Map projections (types, properties, distortions) 1.5 Coordinate systems (UTM, Mercator, Polyconic, LCC) 1.6 Geodesy and geodetic principles; Projection selection criteria 1.7 Reprojection and coordinate transformations
Module 2 (Credit 1): Cartographic Design and Visualization	
Learning Outcomes:	Apply cartographic design principles including symbolization, color theory, and typography.
Content Outline:	<ul style="list-style-type: none"> 2.1 Cartographic communication principles (virtual, cognitive, temporal, permanent maps) 2.2 Graphic elements and design principles 2.3 Generalization and symbolization concepts 2.4 Visual variables (size, shape, color, orientation, texture) 2.5 Color theory and perception; Typography in maps 2.6 Map scale and representation 2.7 Data classification methods
Module 3 (Credit 1): Thematic Mapping Techniques and Composition	
Learning Outcomes:	Produce thematic maps using various mapping techniques and professional map layout design.
Content Outline:	<ul style="list-style-type: none"> 3.1 Types of maps (reference and thematic) 3.2 Thematic mapping techniques (dot maps, choropleth, isopleth/isometric, chorochromatic, choroschematic) 3.3 Map composition and layout design; Symbolization and color schemes 3.4 Legends, scale bars, and annotations; Title, orientation, and metadata 3.5 Cartographic software workflows in QGIS and ArcGIS 3.6 Map design standards and best practices
Module 4 (Credit 1): Data Sources and Applications	
Learning Outcomes:	Prepare cartographic data and apply techniques to real-world mapping applications.
Content Outline:	<ul style="list-style-type: none"> 4.1 Data structures (vector and raster) for cartographic purposes 4.2 Cartographic data sources; Digitization, scanning, and topology building 4.3 Error identification and removal; Editing for map production 4.4 Applications (weather maps, topographical maps, urban planning, disaster management)

	4.5 Case studies and project-based work
	4.6 Map presentation and quality assessment

Continuous Comprehensive Evaluation (CCE):

1. Seminar/Group Discussion:	10 Marks
2. Home Assignments/Group Activities:	10 Marks
3. Field Visit and Observation:	10 Marks
4. Project Work and Presentation:	20 Marks

Internal Assessment Total:	50 Marks

References:

1. Cuff, J. D. & Mattson, M. T. (1982). Thematic Maps: Their Design and Production. Methuen.
2. Kraak, Menno-Jan & Ormeling, Ferjan (2020). Cartography: Visualization of Geospatial Data. CRC Press.
3. Monkhouse, F. J., & Wilkinson, H. R. (1963). Maps and diagrams: their compilation and construction. Egmont Books Ltd
4. MacEachren, Alan M. (2004). How Maps Work: Representation, Visualization, and Design. The Guilford Press.
5. Robinson, Arthur H. et al. (1995). Elements of Cartography. John Wiley & Sons.
6. Scott, Dorris (2024). Digital Cartography. Washington University Libraries.
7. Singh, R. L. (1979): Elements of Practical Geography, Kalyani Publishers, New Delhi
8. Understanding Map Projection (2003-2004): GIS by ESRI, Redlands.

Minor Stream

Course Title:	Research Methodology
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. To make the students research oriented.
	2. To acquaint the students with the methods and techniques in Geographical research.
	3. To enable and encourage the students to undertake independent research work or dissertation
Module 1 (Credit 1) Introduction to Research	
Learning Outcomes:	After learning the module, learners will be able to Compare and classify the types of research and basic concepts of research.
Content Outline:	1.1 Research and its types 1.2 Theories in Research 1.3 Explanation in Geography 1.4 Approaches to Geographical Research: Interdisciplinary, trans-disciplinary and multi-disciplinary
Module 2 (Credit 1): Research Methods and Geographical Data	
Learning Outcomes:	Apply the various techniques in Geographical research.
Content Outline:	2.1 Research Methods in Geography 2.2 Collection of Data: Sources, Primary and secondary data, collection and classification 2.3 Sampling Methods: Techniques and types of sampling techniques 2.4 Hypothesis: Types, Characteristics, Formulation and testing
Module 3 (Credit 1): Research Design	
Learning Outcomes:	Achieve the research skill to select any research problem and design the framework of their future dissertation work.
Content Outline:	3.1 Meaning of Research Design 3.2 Formulation of research problem, analytical framework 3.3 Designing of a questionnaire 3.4 Review of literature survey, types and role in research 3.5 Computer based analysis e.g. techniques of analysis spatio-temporal changes etc.
Module 4 (Credit 1): Report Writing	
Learning Outcomes:	Present research report writing and academic writing.
Content Outline:	4.1 Organization of a research report/ thesis. 4.2 Preliminaries (Pre writing considerations) 4.3 Format of report writing, Abstract Writing, Synopsis Writing 4.4 Techniques of writing a scientific paper, steps in report/thesis writing 4.5 Language and presentation (form and style) 4.6 References and Bibliography

Continuous Comprehensive Evaluation (CCE):

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|---|----------|
| 1. Seminar/Group Discussion: | 10 Marks |
| 2. Home Assignments/Group Activities: | 10 Marks |
| 3. Research Proposal Writing and presentation | 30 Marks |

Internal Assessment Total:**50 Marks**

References:

1. Basil Gomez and John Paul Jones, (2010): "Research Methods in Geography: A Critical Introduction (Critical Introductions to Geography)", Wiley-Blackwell.
2. Davies Wayne K.D. (ed.), (1972): "The Conceptual Revolution in Geography", University of London Press Ltd., London.
3. Dydia DeLyser, Steve Herbert, Stuart Aitken and Mike A Crang, (2009) : "The SAGE Handbook of Qualitative Geography", Sage Publications Ltd. Geography", Oxford University Press, USA.
4. Har Prasad,(1992): "Research Methods and Techniques in Geography", Rawat Publications.
5. Harvey D., (1973): "Explanation in Geography", Edward Arnold, London.
6. Iain Hay, (2010): "Qualitative Research Methods in Human Geography", Oxford University Press, USA.
7. Keith Hoggart, Loretta Lees and Anna Davies, (2002): "Researching Human
8. Misra R. P., (1989): "Research Methodology: A Handbook", Concept Publishing Company, New Delhi.
9. Murthy, K.L.Narasimha (1999): ,Geographical Research , Concept Publishing company

SEMESTER II**Major (Core)**

Course Title:	Digital Image Processing
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Acquire satellite imagery from open sources and perform radiometric, atmospheric, and geometric corrections
	2. Apply image enhancement techniques including contrast stretching, spatial filtering, PCA, and spectral indices
	3. Conduct supervised and unsupervised classification with object-based image analysis and accuracy assessment
	4. Perform advanced image processing including change detection, image fusion, hyperspectral, thermal, and radar image analysis
Module 1 (Credit 1): Image Acquisition and Correction	
Learning Outcomes:	After learning the module, learners will be able to Download satellite data and apply radiometric, atmospheric, and geometric corrections.
Content Outline:	1.1 Open source data acquisition (USGS, Copernicus, Bhuvan, NASA) 1.2 Radiometric, atmospheric, and geometric corrections 1.3 Orthorectification, reprojection, mosaicking, resampling, cloud masking
Module 2 (Credit 1): Image Enhancement Techniques	
Learning Outcomes:	Apply image enhancement techniques including contrast stretching, filtering, and spectral indices.
Content Outline:	2.1 Contrast stretching, histogram equalization 2.2 Spatial filtering (high-pass, low-pass, edge detection) 2.3 Spectral enhancement (band ratios, vegetation/water/mineral indices), PCA 2.4 Tasselled Cap Transformation
Module 3 (Credit 1): Image Classification and Analysis	
Learning Outcomes:	Perform supervised and unsupervised image classification with accuracy assessment.
Content Outline:	3.1 Supervised and unsupervised classification methods 3.2 Object-based Image Analysis (OBIA) 3.3 Classification accuracy assessment 3.4 Change detection techniques
Module 4 (Credit 1): Advanced Image Processing Applications	
Learning Outcomes:	Conduct change detection, image fusion, hyperspectral, and thermal image analysis.
Content Outline:	4.1 Image fusion and pan-sharpening; Hyperspectral processing 4.2 Thermal remote sensing (LST, heat islands) 4.3 Radar processing (InSAR, flood mapping) 4.4 Drone image processing; Real-world applications

Continuous Comprehensive Evaluation (CCE):

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|---------------------------------------|----------|
| 1. Seminar/Group Discussion: | 10 Marks |
| 2. Home Assignments/Group Activities: | 10 Marks |
| 3. Field Visit and Observation: | 10 Marks |
| 4. Project Work and Presentation: | 20 Marks |

Internal Assessment Total: 50 Marks

References:

1. Cha, B., Dattaa, D., Majumdar (2001): Digital Image Processing Analysis, Prentice-Hall of India, New Delhi
2. Campbell, J. B., & Wynne, R. H. (2011). Introduction to Remote Sensing. Guilford Press.
3. Jensen, J. R. (2015). Introductory Digital Image Processing: A Remote Sensing Perspective. Pearson.
4. Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). Remote Sensing and Image Interpretation. Wiley.
5. Nag, P. Kudrat, M. (1998): Digital Remote Sensing, Concept Publishing Company, New Delhi
6. Richards, J. A., & Jia, X. (2006). Remote Sensing Digital Image Analysis. Springer.
7. Schowengerdt, R. A. (2007). Remote Sensing: Models and Methods for Image Processing. Elsevier.

Major (Core)

Course Title:	Field Work and Surveying
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Plan and execute field surveys using traditional instruments (compass, level, theodolite) and understand coordinate systems.
	2. Operate modern surveying equipment including Total Station for topographic surveys and data collection.
	3. Conduct GNSS/GPS surveys using various methods (static, kinematic, RTK, DGPS) and process field data.
	4. Perform drone-based aerial surveys and integrate all field data with GIS for mapping and spatial analysis.
Module 1 (Credit 1): Introduction and Traditional Surveying	
Learning Outcomes:	After learning the module, learners will be able to Plan and execute field surveys using coordinate systems and traditional surveying instruments.
Content Outline:	1.1 Importance of fieldwork, scales, accuracy, precision, errors 1.2 Survey planning and field data recording 1.3 Coordinate systems and map projections 1.4 Compass surveying, levelling, theodolite surveys, profile mapping
Module 2 (Credit 1): Modern Surveying with Total Station	
Learning Outcomes:	Operate Total Station equipment for topographic surveys and spatial data collection.
Content Outline:	2.1 Total Station principles, operation, and data collection 2.2 Setting up and using Total Station 2.3 Topographic survey of area 2.4 Field data downloading, processing, and GIS integration
Module 3 (Credit 1): GNSS/GPS-based Surveying	
Learning Outcomes:	Conduct various GPS surveying methods (static, kinematic, RTK) with data processing and accuracy assessment.
Content Outline:	3.1 Principles of GNSS (GPS, GLONASS, Galileo, NavIC) 3.2 Point positioning with handheld GPS 3.3 Static, rapid-static, kinematic, and RTK surveys 3.4 Differential GPS and post-processing 3.5 GPS-GIS integration and accuracy assessment
Module 4 (Credit 1): Drone Surveying and Data Integration	
Learning Outcomes:	Perform UAV-based aerial surveys and generate DEM and orthomosaic for GIS integration.
Content Outline:	4.1 UAV/drone-based surveying and mapping 4.2 Drone-based aerial survey and image processing 4.3 DEM/orthomosaic generation 4.4 Field data integration with GIS 4.5 Thematic mapping and cartographic representation

Continuous Comprehensive Evaluation (CCE):

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|---------------------------------------|----------|
| 1. Seminar/Group Discussion: | 10 Marks |
| 2. Home Assignments/Group Activities: | 10 Marks |
| 3. Field Visit and Observation: | 10 Marks |
| 4. Project Work and Presentation: | 20 Marks |

Internal Assessment Total: 50 Marks

References:

1. Bannister, A., Raymond, S., & Baker, R. (1998). *Surveying* (7th ed.) Pearson.
2. Colomina, I., & Molina, P. (2014). "Unmanned aerial systems for photogrammetry and remote sensing: A review." *ISPRS Journal of Photogrammetry and Remote Sensing*, 92, 79–97.
3. Eisenbeiss, H. (2009). *UAV Photogrammetry*. ETH Zurich.
4. Gopi, S. (2008). *Basic Surveying*. Pearson.
5. Hofmann-Wellenhof, B., Lichtenegger, H., & Collins, J. (2001). *GPS: Theory and Practice* (5th ed.) Springer.
6. Kavanagh, B. F., & Slattery, T. E. (2008). *Surveying: Principles and Applications* (8th ed.) Pearson.
7. Lawrence, L. and Alex, L. (2008): *GPS Made Easy: Using Global Positioning Systems in the Outdoors*, Rocky Mountain Books, Calgary
8. 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
9. Punmia, B. C., Jain, A. K., & Jain, A. K. (2005). *Surveying Vol. I & II*. Laxmi Publications.
10. Satheesh, G., Sathikumar, R. and Madhu, N. (2007): *Advanced Surveying: Total Station, GIS and Remote Sensing*, Pearson Education, Delhi
11. Schofield, W., & Breach, M. (2007). *Engineering Surveying* (6th ed.). CRC Press.
12. Wolf, P. R., & Ghilani, C. D. (2012). *Elementary Surveying: An Introduction to Geomatics* (13th ed.) Pearson.

Major (Core) Practical: II

Course Title:	Practicals in Image Processing
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Import, display, and preprocess satellite images including radiometric, atmospheric, and geometric corrections
	2. Apply image enhancement and transformation techniques including PCA, filtering, and spectral indices
	3. Perform supervised, unsupervised, and object-based image classification with accuracy assessment
	4. Conduct advanced image analysis including change detection, image fusion, hyperspectral, thermal, and radar data processing for practical applications
Module 1 (Credit 1): Image Import and Pre-processing	
Learning Outcomes:	After learning the module, learners will be able to Import satellite images and apply preprocessing including mosaicking and coordinate transformations.
Content Outline:	1.1 Importing and displaying satellite images, extracting metadata, image subsetting, mosaicking, reprojection 1.2 Radiometric and atmospheric correction 1.3 Geometric correction and cloud masking
Module 2 (Credit 1): Image Enhancement and Transformation	
Learning Outcomes:	Apply image enhancement techniques and spectral transformations for feature enhancement.
Content Outline:	2.1 Contrast stretching, histogram equalization, band ratioing 2.2 Spatial filtering (edge detection, smoothing, sharpening) 2.3 PCA and Tasseled Cap Transformation
Module 3 (Credit 1): Image Classification Techniques	
Learning Outcomes:	Perform unsupervised, supervised, and object-based classification with accuracy evaluation.
Content Outline:	3.1 Unsupervised classification 3.2 Supervised classification 3.3 Object-based image classification 3.4 Accuracy assessment and validation
Module 4 (Credit 1): Advanced Image Analysis and Applications	
Learning Outcomes:	Conduct change detection, multi-temporal analysis, and apply techniques to real-world problems.
Content Outline:	4.1 Change detection and time series analysis 4.2 Image fusion and pan-sharpening 4.3 Hyperspectral, radar, and thermal data processing 4.4 Applications in water resources, agriculture, urban studies, forestry, disaster management

Continuous Comprehensive Evaluation (CCE):

- | | |
|---------------------------------------|----------|
| 1. Seminar/Group Discussion: | 10 Marks |
| 2. Home Assignments/Group Activities: | 10 Marks |
| 3. Field Visit and Observation: | 10 Marks |
| 4. Project Work and Presentation: | 20 Marks |

Internal Assessment Total: 50 Marks

References:

1. Cha, B., Dattaa, D., Majumdar (2001): Digital Image Processing Analysis, Prentice-Hall of India, New Delhi
2. Jensen, J. R. (2015). Introductory Digital Image Processing: A Remote Sensing Perspective

(4th ed.). Pearson.

3. Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). Remote Sensing and Image Interpretation (7th ed.). Wiley.
4. Nag, P. Kudrat, M. (1998): Digital Remote Sensing, Concept Publishing Company, New Delhi
5. Richards, J. A., & Jia, X. (2006). Remote Sensing Digital Image Analysis: An Introduction (4th ed.). Springer.
6. Schowengerdt, R. A. (2007). Remote Sensing: Models and Methods for Image Processing (3rd ed.). Academic Press.

Major (Core)

Course Title:	GPS Survey and Mapping
Course Credits:	2
Course Outcomes:	After going through the course, learners will be able to:
	1. Explain GPS principles including satellite constellation, trilateration, signal processing, and error sources
	2. Apply different GPS surveying methods including static, DGPS, RTK, and PPP for field data collection
	3. Integrate GPS data with GIS systems for mapping, spatial data management, and accuracy assessment
	4. Explain GPS principles including satellite constellation, trilateration, signal processing, and error sources
Module 1 (Credit 1): Fundamentals of GPS and Navigation	
Learning Outcomes:	After learning the module, learners will be able to Understand GPS constellation, signal structure, and positioning principles with error analysis.
Content Outline:	1.1 Introduction to geodesy and positioning; GPS constellation and segments 1.2 Principles of satellite navigation (trilateration, pseudo-ranges) 1.3 GPS signals, codes, carriers 1.4 Error sources (ionospheric, tropospheric, multipath, clock, ephemeris)
Module 2 (Credit 1): GPS Surveying Methods and Techniques	
Learning Outcomes:	Understand static, differential, and RTK GPS surveying with data processing and GIS integration.
Content Outline:	2.1 Static GPS surveying 2.2 Rapid static and fast-static methods 2.3 Differential GPS (DGPS) 2.4 Real-Time Kinematic (RTK) and Network RTK 2.5 Precise Point Positioning (PPP) 2.6 Post-processing techniques
Module 3 (Credit 1): GIS Integration and Applications	
Learning Outcomes:	Apply static, differential, and RTK GPS surveying with data processing and GIS integration.
Content Outline:	3.1 GPS data formats (RINEX, NMEA, shapefiles) 3.2 Field data collection (waypoints, tracks, routes) 3.3 GPS-GIS integration 3.4 Accuracy and precision assessment 3.5 Mobile mapping; Applications in land surveying, engineering, natural resources, disaster management, agriculture

Continuous Comprehensive Evaluation (CCE):

1. Seminar/Group Discussion:	10 Marks
2. Home Assignments/Group Activities:	10 Marks
3. Field Visit and Observation:	10 Marks
4. Project Work and Presentation:	20 Marks

External Assessment Total:	50 Marks

References:

- Hofmann-Wellenhof, B., Lichtenegger, H., & Collins, J. (2001). GPS: Theory and Practice. Springer.

2. Lawrence, L. and Alex, L. (2008): GPS Made Easy: Using Global Positioning Systems in the Outdoors, Rocky Mountain Books, Calgary
3. Leick, A., Rapoport, L., & Tatarnikov, D. (2015). GPS Satellite Surveying (4th ed.). Wiley.
4. Misra, P., & Enge, P. (2006). Global Positioning System: Signals, Measurements, and Performance. Ganga-Jamuna Press. Leick, A., Rapoport, L., & Tatarnikov, D. (2015). GPS Satellite Surveying (4th ed.). Wiley.
5. 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
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7. Trimble Navigation & Leica Geosystems manuals (for practical exercises).
8. Van Sickle, J. (2020). GPS for Land Surveyors (5th ed.). CRC Press.
9. Wolf, P. R., Ghilani, C. D. (2012). Elementary Surveying: An Introduction to Geomatics (13th ed.). Pearson.

Major (Elective)

Course Title:	Geoinformatics in Water Resources
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Apply GIS and remote sensing techniques for watershed delineation, groundwater mapping, and water quality assessment.
	2. Utilize hydrological models (SWAT, HEC-HMS, HEC-RAS) for rainfall-runoff modeling and flood prediction.
	3. Conduct surface water management studies including reservoir capacity assessment and river basin management.
	4. Evaluate water scarcity and climate change impacts on water resources using geoinformatics approaches.
Module 1 (Credit 1): Introduction to Water Resources and Watershed Management	
Learning Outcomes:	After learning the module, learners will be able to Understand hydrological concepts and watershed delineation for water resource management.
Content Outline:	1.1 Hydrological cycle, surface water, groundwater, water quality 1.2 Watershed concepts, delineation, development, and drainage networks
Module 2 (Credit 1): Groundwater and Remote Sensing Applications	
Learning Outcomes:	Apply remote sensing for rainfall estimation, snow mapping, flood detection, and drought monitoring.
Content Outline:	2.1 Aquifer mapping, recharge zone identification, groundwater quality assessment 2.2 RS sensors, land use/cover, water body mapping, vegetation indices (NDWI, NDSI, NDVI)
Module 3 (Credit 1): Hydrological Modeling and Surface Water Management	
Learning Outcomes:	Conduct watershed analysis and groundwater potential assessment using GIS techniques.
Content Outline:	3.1 Rainfall-runoff modeling, SWAT, HEC-HMS, HEC-RAS, flood modeling 3.2 Reservoir capacity assessment, river basin management, sedimentation analysis, water quality
Module 4 (Credit 1): Water Scarcity and Climate Change Impact Assessment	
Learning Outcomes:	Assess water quality and evaluate climate change impacts on water resources.
Content Outline:	4.1 Drought indices, drought prediction, crop-water requirement 4.2 Climate change impacts, downscaling climate models with GIS 4.3 Case studies

Continuous Comprehensive Evaluation (CCE):

- | | |
|---------------------------------------|----------|
| 1. Seminar/Group Discussion: | 10 Marks |
| 2. Home Assignments/Group Activities: | 10 Marks |
| 3. Field Visit and Observation: | 10 Marks |
| 4. Project Work and Presentation: | 20 Marks |

Internal Assessment Total: 50 Marks

References:

- Bhunja, G.S., Chatterjee, U., Panda, G.K., & Shit, P.K. (2019). Remote Sensing and GIS in Natural Resource Management. Springer.
- Chang, K.-T. (2020). Introduction to Geographic Information Systems (9th ed.). McGraw-Hill

3. Ebgman, E.T., and R.J. Gurney. (1991) Remote sensing in hydrology. London, Chapman and Hall
4. JVS Murty, 2004, "Watershed management" New Age International Pvt Ltd, New Delhi.
5. Lyon JG GIS for Water Resources and Watershed Management Chen Y, GIS and Remote Sensing in Hydrology, Water Resources and Environment, 2004
6. Ramasamy, S.M., & Govindarajan, S.T. (2017). Geomatics in Energy and Water Resources: A Coloured Handbook. NIPA.
7. Shamsi UM, GIS Applications for Water, Wastewater, and Stormwater Systems, Taylor and Francis, 2005
8. Shaw, E.M., Beven, K.J., Chappell, N.A., & Lamb, R. (2017). Hydrology in Practice (5th ed.). CRC Press.
9. Worboys, M.F., Duckham, M., & Sun, Q. (2019). GIS: A Computing Perspective (3rd ed.). CRC Press.
10. Xie, H., & Wang, X. (Eds.). (2021). Applications of Remote Sensing/GIS in Water Resources and Flooding Risk Managements. MDPI.

OJT

Course Title:	On Job Training
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Practical training through field placements and industry exposure.

Continuous Comprehensive Evaluation (CCE):

1. Field Work and Practical Training:	20 Marks
2. Report Preparation:	15 Marks
3. Presentation and Viva:	15 Marks

Internal Assessment Total:	50 Marks

SEMESTER III**Major (Core)**

Course Title:	Internship
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Practical training through field placements and industry exposure.

Continuous Comprehensive Evaluation (CCE):

- | | |
|---------------------------|----------|
| 1. Fieldwork Report: | 15 Marks |
| 2. Report Preparation: | 20 Marks |
| 3. Presentation and Viva: | 15 Marks |

Internal Assessment Total:	----- 50 Marks
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Major (Core)

Course Title:	Internship
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	2. Practical training through field placements and industry exposure.

Continuous Comprehensive Evaluation (CCE):

1. Fieldwork Report:	15 Marks
2. Report Preparation:	20 Marks
3. Presentation and Viva:	15 Marks

Internal Assessment Total:	50 Marks

Major (Core)

Course Title:	DBMS and Web GIS
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Design relational databases using ER modeling, normalization, and implement database schemas
	2. Write complex SQL queries for data manipulation, joins, aggregation, and database management
	3. Work with spatial databases and integrate geospatial data with DBMS for GIS applications
	4. Develop web GIS applications using OGC standards, web mapping platforms, and programming interfaces
Module 1 (Credit 1): Database Fundamentals and Design	
Learning Outcomes:	After learning the module, learners will be able to Design and implement relational databases using ER models and normalization principles.
Content Outline:	1.1 Introduction to DBMS, data models, architecture 1.2 Entity-Relationship modeling (entities, attributes, relationships, ER diagrams) 1.3 Relational data model (relations, keys, integrity) 1.4 Normalization (1NF, 2NF, 3NF, BCNF)
Module 2 (Credit 1): SQL and Advanced DBMS	
Learning Outcomes:	Write complex SQL queries and manage spatial databases including Post GIS applications.
Content Outline:	2.1 Structured Query Language (DDL, DML, DCL) 2.2 Complex queries, joins, nested queries, aggregation functions 2.3 Triggers, stored procedures, indexing, security 2.4 NoSQL basics (MongoDB) 2.5 Spatial database analysis and geospatial data integration
Module 3 (Credit 1): Web GIS Fundamentals and Standards	
Learning Outcomes:	Understand Web GIS concepts, OGC standards (WMS, WFS, WCS), and web architecture.
Content Outline:	3.1 Concept, evolution, and components of Web GIS 3.2 Web mapping fundamentals (static vs dynamic maps) 3.3 Network and Internet basics, web GIS architectures 3.4 OGC specifications (WMS, WFS, WCS, WPS)
Module 4 (Credit 1): Web GIS Platforms and Application Development	
Learning Outcomes:	Develop interactive web maps using platforms like ArcGIS Online and open-source solutions.
Content Outline:	4.1 Web GIS tools (ArcGIS Online, QGIS, GeoServer, Google Maps APIs) 4.2 Programming for GIS (Python, JavaScript) 4.3 Building interactive web maps, publishing services 4.4 3D Web GIS, cloud GIS, big data, mobile GIS, geoportals

Continuous Comprehensive Evaluation (CCE):

- | | |
|---------------------------------------|----------|
| 1. Seminar/Group Discussion: | 10 Marks |
| 2. Home Assignments/Group Activities: | 10 Marks |
| 3. Field Visit and Observation: | 10 Marks |
| 4. Project Work and Presentation: | 20 Marks |

Internal Assessment Total: 50 Marks

References:

1. Connolly, T. M., & Begg, C. E. (2005). Database systems: a practical approach to design,

implementation, and management. Pearson Education.

2. Date, C. J. (2004). An introduction to database systems (8th ed.). Addison-Wesley.
3. Deshpande, P. S. (2008): SQL & PL/SQL for Oracle 10g, Blackbook, Dreamtech Press, New Delhi
4. Elmasri, R., & Navathe, S. B. (2016). Fundamentals of database systems (7th ed.). Pearson.
5. Panneerselvam, R. (2012). Database management systems. PHI Learning.
6. Ramakrishnan, R., & Gehrke, J. (2003). Database management systems (3rd ed.). McGraw-Hill.
7. Silberschatz, A., Korth, H. F., & Sudarshan, S. (2011). Database system concepts.
8. Ullman, J. D. (1983). Principles of database systems. Galgotia publications.

Major (Core)

Course Title:	Practicals in Advanced GIS
Course Credits:	2
Course Outcomes:	After going through the course, learners will be able to:
	1. Create and manage spatial databases with advanced overlay, density mapping, network, and geostatistical analysis
	2. Perform 3D GIS analysis, temporal visualizations, and develop web-based GIS applications
	3. Conduct multi-criteria decision analysis for site suitability, risk mapping, and execute independent GIS projects
Module 1 (Credit 1): Advanced Spatial Analysis	
Learning Outcomes:	After learning the module, learners will be able to Perform network analysis, geostatistical methods, and advanced overlay operations.
Content Outline:	1.1 Spatial database creation and geodatabase design 1.2 Advanced overlay analysis (weighted, fuzzy) 1.3 Density mapping and hotspot analysis (KDE, Getis-Ord Gi*) 1.4 Network analysis (shortest path, service area, route optimization) 1.5 Geostatistical analysis (Kriging, IDW, semi-variogram)
Module 2 (Credit 1): 3D, Temporal, and Web GIS	
Learning Outcomes:	Create 3D visualizations, conduct spatio-temporal analysis, and publish web-based GIS applications.
Content Outline:	2.1 3D surface modeling (DEM, DSM, TIN) 2.2 3D visualization, fly-through animation 2.3 Time-enabled GIS and spatio-temporal analysis 2.4 Change detection using temporal layers 2.5 Publishing maps online (ArcGIS Online, QGIS Cloud) 2.6 Web map services (WMS, WFS, WMTS) 2.7 Custom web maps (Leaflet, Mapbox)
Module 3 (Credit 1): Decision Support and Project Work	
Learning Outcomes:	Perform 3D visualization and analysis.
Content Outline:	3.1 Multi-Criteria Decision Analysis (MCDA) in GIS 3.2 Site suitability analysis (groundwater potential, landfill, urban planning) 3.3 Risk and vulnerability mapping (flood, landslide, drought) 3.4 Integration of RS data for thematic modeling 3.5 Independent GIS project design and execution 3.6 Report preparation and presentation

Continuous Comprehensive Evaluation (CCE):

1. Seminar/Group Discussion:	10 Marks
2. Home Assignments/Group Activities:	10 Marks
3. Field Visit and Observation:	10 Marks
4. Project Work and Presentation:	20 Marks

Internal Assessment Total:	50 Marks

References:

1. Bolstad, P. (2019). GIS Fundamentals: A First Text on Geographic Information Systems. Eider Press.

2. Burrough, P.A., McDonnell, R.A., & Lloyd, C.D. (2015). Principles of Geographical Information Systems. Oxford University Press.
3. Chang, K.T. (2020). Introduction to Geographic Information Systems. McGraw-Hill.
4. De Smith, M.J., Goodchild, M.F., & Longley, P.A. (2022). Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools. Troubador.
5. Foote, K.E. & Lynch, M. (2020). The Geographer's Craft: Advanced GIS Applications. University of Texas.
6. Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. (2005) Geographic Information Systems and Science. Chichester: Wiley. 2nd edition.
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8. Muralikrishna V Geographical Information Systems and Remote Sensing Applications Allied Publishers Private Limited
9. Tomlin, C.D. (2013). GIS and Cartographic Modelling. Esri Press

Major (Elective)

Course Title:	Introduction to Geostatistics
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Describe and apply foundational probability, statistics, and spatial data concepts in geostatistics.
	2. Quantitatively analyze spatial data using correlation, regression, and descriptive statistics.
	3. Model and interpret spatial continuity and perform spatial predictions using variogram and kriging techniques.
	4. Use multivariate approaches to handle and extract meaningful information from large spatial data sets.
Module 1 (Credit 1): Foundations of Geostatistics and Descriptive Statistics	
Learning Outcomes:	After learning the module, learners will be able to Understand the foundations of geostatistics, data types, descriptive statistics, and probability concepts relevant to spatial data.
Content Outline:	1.1 Definition and scope of geostatistics, applications, history of spatial statistics 1.2 Types and sources of geographic data, discrete/continuous series, scales of measurement 1.3 Probability theory, sampling, hypothesis testing 1.4 Descriptive statistics (mean, median, mode), 1.5 Graphical data representation (histograms, ogive, etc.).
Module 2 (Credit 1): Spatial Data Analysis and Correlation	
Learning Outcomes:	Analyze spatial data variability, relationships, and trends using quantitative statistical measures, correlation, and regression.
Content Outline:	2.1 Measures of central tendency and dispersion 2.2 Absolute and relative measures, bivariate correlation 2.3 Linear and exponential regression 2.4 Basics of matrix algebra for spatial analysis
Module 3 (Credit 1): Variogram Analysis and Spatial Interpolation	
Learning Outcomes:	Apply and interpret variogram analysis and geostatistical interpolation methods (kriging) for spatial prediction and mapping.
Content Outline:	3.1 Concepts and computation of variograms/semivariograms 3.2 Spatial continuity parameters (nugget, sill, range, anisotropy) 3.3 Classical interpolation (IDW, trend), and kriging (simple, ordinary, universal, block, co-kriging).
Module 4 (Credit 1): Multivariate and Advanced Geostatistical Techniques	
Learning Outcomes:	Employ multivariate and advanced geostatistical methods to interpret and model spatial patterns in complex datasets.
Content Outline:	4.1 Multivariate analysis (e.g., principal component analysis) 4.2 Introduction to advanced modeling 4.3 Synthesis/application in large and complex data sets.

Continuous Comprehensive Evaluation (CCE):

- | | |
|---------------------------------------|----------|
| 1. Seminar/Group Discussion: | 10 Marks |
| 2. Home Assignments/Group Activities: | 10 Marks |
| 3. Field Visit and Observation: | 10 Marks |
| 4. Project Work and Presentation: | 20 Marks |
| | ----- |

Internal Assessment Total: 50 Marks

References:

- Chiles, J.P. & Delfiner, P. (2012). Geostatistics: Modeling Spatial Uncertainty. John Wiley

- & Sons.
2. Deutsch, C.V. (2002). *Geostatistical Reservoir Modeling*. Oxford University Press.
 3. Diggle, P.J. & Ribeiro, P.J. Jr. (2007). *Model-Based Geostatistics*. Springer.
 4. Ebdon, D. (1977): *Statistics in Geography*, Basil Blackwell, Oxford
 5. Frank, H. and Althoen, S.C. (1994): *Statistics: Concepts Applications*, Cambridge University Press, Cambridge.
 6. Goovaerts, P. (1997). *Geostatistics for Natural Resources Evaluation*. Oxford University Press.
 7. Gregory, S. (1978): *Statistical Methods for Geographers*, Longman, London
 8. Hammond, R. and McCullagh, P. (1991): *Quantitative Techniques in Geography*, Clarendon Press, Oxford
 9. Isaaks, E.H. & Srivastava, R.M. (1989). *An Introduction to Applied Geostatistics*. Oxford University Press.
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 11. Schabenberger, O. & Gotway, C.A. (2005). *Statistical Methods for Spatial Data Analysis*. Chapman & Hall/CRC.
 12. Walford, N. (2011). *Practical Statistics for Geographers and Earth Scientists*. John Wiley & Sons

RP

Course Title:	Research Project
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	4. Practical training through field placements and industry exposure.

Continuous Comprehensive Evaluation (CCE):

1. Preparation of Research Proposal:	15 Marks
2. Report Preparation:	20 Marks
3. Presentation and Viva:	15 Marks

Internal Assessment Total:	50 Marks

SEMESTER IV**Major (Core)**

Course Title:	Programming in Python and HTML
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Write Python scripts for data manipulation, spatial analysis, and automation in GIS workflows using standard libraries
	2. Apply Python geospatial libraries (GeoPandas, Rasterio, Shapely, Folium) for vector/raster data handling and interactive mapping
	3. Create and structure HTML documents with tags, elements, forms, tables, and media for web presentation of GIS data
	4. Develop geospatial web applications by integrating Python backend (Flask/Django basics) with HTML front-end for interactive mapping and spatial data visualization
Module 1 (Credit 1): Python Programming Fundamentals	
Learning Outcomes:	After learning the module, learners will be able to Write Python code for programming with variables, data types, control structures, and functions.
Content Outline:	<ul style="list-style-type: none"> 1.1 Introduction to programming concepts 1.2 Python basics (syntax, variables, data types—strings, numbers, lists, dictionaries, tuples) 1.3 Operators (arithmetic, logical, comparison) 1.4 Control structures (loops, conditional statements) 1.5 Functions and error handling; Working with files; Libraries and modules 1.6 Jupyter notebook environment for interactive coding
Module 2 (Credit 1): Advanced Python for GIS and Geospatial Data	
Learning Outcomes:	Use GeoPandas, Rasterio, and Shapely for spatial data processing and GIS automation.
Content Outline:	<ul style="list-style-type: none"> 2.1 Geospatial libraries: GeoPandas (vector data handling), Rasterio (raster data processing), Shapely (geometric objects) 2.2 Spatial data input/output 2.3 Working with shapefiles, GeoTIFFs, and other geospatial formats 2.4 Data manipulation and filtering 2.5 Coordinate transformations and reprojections 2.6 Spatial queries and analysis 2.7 Automation of GIS workflows; Batch processing and scripting for repetitive tasks
Module 3 (Credit 1): Data Visualization and Web Technologies	
Learning Outcomes:	Create visualizations using Matplotlib and Folium, and understand HTML, CSS, and web architecture.
Content Outline:	<ul style="list-style-type: none"> 3.1 Visualization libraries: Matplotlib (static plots), Folium (interactive maps) 3.2 Raster and vector data visualization 3.3 Creating thematic visualizations 3.4 Interactive map features (popups, tooltips, layer control) 3.5 Web fundamentals (HTTP, client-server architecture) 3.6 HTML basics (tags, elements, attributes) 3.7 HTML forms, tables, and media integration 3.8 CSS for styling (basic concepts) 3.9 Introduction to Flask/Django frameworks 3.10 REST API concepts
Module 4 (Credit 1): GIS Web Applications and Project Development	
Learning Outcomes:	Develop web-based GIS applications and interactive dashboards with Python and web technologies.

Content Outline:	<ol style="list-style-type: none"> 5. Building web-based GIS applications 6. Embedding Python visualizations in web pages 7. Creating interactive dashboards 8. Data-driven web maps 9. Real-world geospatial applications 10. Web map services integration 11. Small project development (site suitability, flood risk mapping) 12. Code documentation and version control 13. Performance optimization 14. Testing and deployment 15. Final project work and presentations
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Continuous Comprehensive Evaluation (CCE):

1. Seminar/Group Discussion:	10 Marks
2. Home Assignments/Group Activities:	10 Marks
3. Field Visit and Observation:	10 Marks
4. Project Work and Presentation:	20 Marks

Internal Assessment Total:	50 Marks

References:

1. Duckett, Jon (2011). HTML and CSS: Design and Build Websites. Wiley
2. Holzner, S. (2008):HTML Black Book, Dreamtech Press, India Paraglyph Press, USA
3. Kanetkar, Y. (2019). Let Us Python. BPB Publications
4. McKinney, Wes (2017). Python for Data Analysis: Data Wrangling with Pandas, NumPy, and I Python. O'Reilly Media
5. Richardson, Leonard & Amundsen, Mike (2013). RESTful Web APIs. O'Reilly Media
6. Sweigart, Al (2019). Automate the Boring Stuff with Python: Practical Programming for Total Beginners.
7. Zandbergen, Paul A. (2009). Python Scripting for ArcGIS. Esri Press.

Major (Core)

Course Title:	Geoinformatics in Urban Planning
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. To understand the integration of Remote Sensing and GIS in urban studies
	2. To learn to analyze urban growth, land use/land cover changes, and infrastructure planning in urban areas by using RS and GIS techniques
	3. Apply remote sensing and GIS techniques to assess urban growth, monitor land use changes, and evaluate impacts on urban environments, settlements, and utilities
Module 1 (Credit 1): Basics of Urban Geoinformatics	
Learning Outcomes:	After learning the module, learners will be able to Understand urban systems, planning principles, and the use of high-resolution remote sensing data for urban governance
Content Outline:	1.1 Urban systems and planning principles. 1.2 Importance of geospatial data for urban governance. 1.3 Urban Remote Sensing: High-resolution imagery, LiDAR, OSM
Module 2 (Credit 1): Urban Land Use and Land Cover Analysis	
Learning Outcomes:	Apply techniques for mapping urban land use and detecting changes related to urban sprawl.
Content Outline:	2.1 Techniques for urban LULC mapping 2.2 Change detection techniques 2.3 Urban sprawl analysis
Module 3 (Credit 1): Urban Infrastructure and Utilities	
Learning Outcomes:	Analyze and map urban infrastructure including transportation networks and utility services with GIS for smart city planning
Content Outline:	3.1 Integrated Development Planning 3.2 GIS for transportation networks 3.3 Urban utilities mapping (water supply, sewage, solid waste) 3.4 Smart Cities and Urban GIS
Module 4 (Credit 1): Urban Risk and Sustainability	
Learning Outcomes:	Assess urban hazards, conduct environmental impact assessments, and develop sustainable urban development indicators.
Content Outline:	4.1 Urban hazard mapping: flood risk, heat islands 4.2 Environmental impact assessment using GIS 4.3 Sustainable urban development indicators 4.4 Environmental Impact Assessment (EIA)

Continuous Comprehensive Evaluation (CCE):

- | | |
|---------------------------------------|----------|
| 1. Seminar/Group Discussion: | 10 Marks |
| 2. Home Assignments/Group Activities: | 10 Marks |
| 3. Field Visit and Observation: | 10 Marks |
| 4. Project Work and Presentation: | 20 Marks |
| | ----- |

Internal Assessment Total: 50 Marks

References:

1. Ayse Pamuk (2008) Mapping Global Cities, GIS Methods In Urban Analysis. ESRI Press. New York
2. Deekshatulu, B. L. (1990): Description and use of Land use/Landcover, NRSA,

Hyderabad.

3. Escalante, R. B. (2012): Remote Sensing- Advances techniques and Platforms, Intech, Rijeka Croatia.
4. Jensen, J.R. Introductory Digital Image Processing.
5. Longley, P.A. et al. Geographical Information Systems and Science.
6. Ministry of Housing & Urban Affairs reports.
7. SPRS Technical Commission VII (2002): Symposium on Resource Environmental Monitoring, ISRS Annual Convention, IIRS, Dehradun
8. Yeh, A.G.O. Urban Remote Sensing.
9. Yang, X., Urban Remote Sensing Monitoring, Synthesis and Modeling in the urban Environment, Wiley Blackwell, 2011.

Major (Core)

Course Title:	Advanced Practicals in Geoinformatics
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. Perform advanced spatial data management, terrain morphometric analysis, and complex network analysis
	2. Apply advanced geostatistical modeling techniques and machine learning-based image classification methods
	3. Develop spatial models for environmental analysis, create web GIS applications, and automate geospatial workflows using Python
Module 1 (Credit 1): Advanced Data Management and Terrain Analysis	
Learning Outcomes:	After learning the module, learners will be able to Create geodatabases and perform complex spatial analysis.
Content Outline:	1.1 Spatial database creation (PostGIS, Geopackage) 1.2 Georeferencing and coordinate transformations 1.3 Data quality control and metadata 1.4 DEM-based morphometric analysis (curvature, roughness, TWI, SPI) 1.5 Watershed delineation and drainage network extraction 1.6 LS factor calculation for erosion modeling
Module 2 (Credit 1): Network and Geostatistical Analysis	
Learning Outcomes:	Utilize advanced spatio-temporal geostatistical methods for dynamic spatial pattern analysis.
Content Outline:	2.1 Location-allocation analysis 2.2 Network accessibility index 2.3 Multi-modal and flow analysis 2.4 Utility network modeling 2.5 Trend analysis and drift models 2.6 Cross-variograms and co-regionalization 2.7 Spatio-temporal kriging 2.8 Co-Kriging with secondary variables 2.9 Space-time modeling
Module 3 (Credit 2): Advanced Modeling and Automation	
Learning Outcomes:	Apply machine learning for classification and perform change detection and temporal analysis.
Content Outline:	3.1 OBIA and machine learning classification 3.2 Change detection and time-series analysis 3.3 Hydrological and environmental modeling 3.4 Urban growth modeling (CA/Markov) 3.5 Site suitability analysis 3.6 Web GIS (ArcGIS Online, QGIS Cloud, Leaflet, Mapbox, Google Earth Engine) 3.7 Python scripting (ArcPy, PyQGIS) 3.8 Batch processing and data visualization

Continuous Comprehensive Evaluation (CCE):

1. Seminar/Group Discussion:	10 Marks
2. Home Assignments/Group Activities:	10 Marks
3. Field Visit and Observation:	10 Marks
4. Project Work and Presentation:	20 Marks

Internal Assessment Total:	50 Marks

References:

1. Bolstad, P. (2005) GIS Fundamentals: A first text on Geographic Information Systems,

Second Edition. White Bear Lake, MN: Eider Press, 543 pp.

2. Bhatta, B. (2021). Remote Sensing and GIS. Oxford University Press.
3. Burrough, P. A., McDonnell, R. A., & Lloyd, C. D. (2015). Principles of Geographical Information Systems. Oxford University Press.
4. Campbell, J. B., & Wynne, R. H. (2011) Introduction to Remote Sensing. Guilford Press.
5. Chorley, R. J., & Haggett, P. (2019) Models in Geography. Routledge.
6. De Smith, M. J., Goodchild, M. F., & Longley, P. A. (2022) Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools. Troubador.
7. Elangovan, K (2006) GIS: Fundamentals, Applications and Implementations. New India Publishing Agency, New Delhi"208 pp.
8. Goodchild, M. F. (2020) Spatial Analysis and Modelling in a GIS Environment. Esri Press.
9. Heywood, I., Cornelius, S., and Carver, S. (2006) An Introduction to Geographical Information Systems. Prentice Hall. 3rd edition.
10. Jensen, J. R. (2016) Introductory Digital Image Processing: A Remote Sensing Perspective. Pearson.

Major (Elective)

Course Title:	Geoinformatics in Land Resources
Course Credits:	4
Course Outcomes:	After going through the course, learners will be able to:
	1. To learn to assess, monitor, and manage land resources using geospatial technology.
	2. To understand land degradation, land use planning, and resource conservation.
	3. To gain practical experience with satellite data for land resource inventory.
	4. To understand the RS and GIS based sustainable land resource management techniques
Module 1 (Credit 1): Introduction to Land Resources	
Learning Outcomes:	After learning the module, learners will be able to Understand types of land resources and major issues related to land degradation and desertification, and their appraisal using geoinformatics.
Content Outline:	1.1 Definition and types of land resources. 1.2 Problems of land degradation and desertification. 1.3 Geoinformatics in land resource appraisal.
Module 2 (Credit 1): Remote Sensing for Land Resource Inventory	
Learning Outcomes:	Apply remote sensing techniques for land capability classification, mapping degraded lands, and interpreting national resource maps with practical case studies.
Content Outline:	2.1 Land capability classification. 2.2 Mapping degraded lands, soil erosion, wastelands. 2.3 Interpretation of national land resource maps. 2.4 Case Study: Example of National Wasteland Atlas of India
Module 3 (Credit 1): GIS in Land Use Planning	
Learning Outcomes:	Conduct land capability and suitability analysis using GIS, including agricultural, industrial, and settlement site evaluations with decision support systems.
Content Outline:	3.1 Land Capability and Suitability Analysis: Principles of land evaluation (FAO framework); criteria for agriculture, horticulture, forestry, settlement. 3.2 Land suitability analysis for agriculture. 3.3 Site suitability for industries, settlements. 3.4 Land resource decision support systems.
Module 4 (Credit 1): Sustainable Land Management	
Learning Outcomes:	Monitor land degradation and implement soil conservation, reclamation, and community-based resource management practices supported by government programs.
Content Outline:	4.1 Monitoring land degradation: Urban encroachment, deforestation, mining impacts. 4.2 Land Reclamation Practices: Soil conservation, afforestation, wasteland reclamation, desertification control. 4.3 Community-Based Resource Management 4.4 Government Programs: IWMP, NMSA etc.

Continuous Comprehensive Evaluation (CCE):

- | | |
|---------------------------------------|----------|
| 1. Seminar/Group Discussion: | 10 Marks |
| 2. Home Assignments/Group Activities: | 10 Marks |
| 3. Field Visit and Observation: | 10 Marks |
| 4. Project Work and Presentation: | 20 Marks |

Internal Assessment Total: 50 Marks

References:

1. Burrough, P.A. & McDonnell, R.A. (2015). Principles of Geographical Information Systems. Oxford University Press.
2. Diwedi, R.S. (2017). Remote Sensing of Soils. Springer
3. Gergel, Sarah E., and Monica G. Turner, eds. Learning landscape ecology: a practical guide to concepts and techniques. Springer, 2017.
4. Turner, M. G., Gardner, R. H., O'Neill, R. V., Gardner, R. H., & O'Neill, R. V. (2001). Landscape ecology in theory and practice (Vol. 401). New York: Springer.
5. Jensen, J.R. (2006). Remote Sensing of the Environment: An Earth Resource Perspective. Pearson.
6. Lillesand, T.M., Kiefer, R.W., & Chipman, J.W. (2015). Remote Sensing and Image Interpretation. Wiley India.
7. Sabins, F.F. Jr. (1997). Remote Sensing: Principles and Interpretation. Waveland Press.
8. Steven, M. D., & Clark, J. A. (Eds.). (2013). Applications of remote sensing in agriculture. Elsevier.
9. Wulder, M. A., & Franklin, S. E. (Eds.). (2012). Remote sensing of forest environments: concepts and case studies. Springer Science & Business Media.

RP

Course Title:	Research Project
Course Credits:	6
Course Outcomes:	After going through the course, learners will be able to:
	4. Practical training through field placements and industry exposure.

Continuous Comprehensive Evaluation (CCE):

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|--------------------------------------|----------|
| 1. Preparation of Research Proposal: | 30 Marks |
| 2. Report Preparation: | 50 Marks |
| 3. Presentation and Viva: | 20 Marks |

Internal Assessment Total:

100 Marks