NEP-2020-based syllabus for

M.Sc. Geoinformatics

[Course Duration: Two years, 4 semesters]

Effective from 2025 onwards

Department of Geoinformatics

University of Kashmir, Hazratbal Srinagar- 190006, J&K

School of Earth & Environmental Science
University of Kashmir

Department of Geoinformatics, University of Kashmir, Srinagar, J&K

Course Structure of M. Sc. Geoinformatics under NEP 2020 to be implemented from 2025

	Course Code	Course Title	Course Type	Credits L+P/T	Maximum Marks		Total
					Internal Assessment	Term End Examination	
1st Semester	**MGIFCCM125**	Computers and Geoinformation Management	C	3+1=4	28 (21= theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	MGIFCFR125	Fundamentals of Remote Sensing	C	3+1=4	28 (21= theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	MGIFCFG125	Fundamentals of Geographic Information System	C	3+1=4	28 (21= theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	MGIFCDV125	Digital Cartography and Geoinformation Visualization	C	3+1=4	28 (21= theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	Students shall have to opt for one DCE out of the following DCEs						
	MGIFDOG125	Open-Source GIS	DCE	0+2=2	14	36	50
	MGIFDCL125	Climatology	DCE	2+0=2	14	36	50
	MGIFSSH125	Seminar and Hands-on in Geospatial Technology	SE	0+2=2	14	36	50
		Total credits		**20**			

2nd Semester	**MGIFCAI225**	Advanced Remote Sensing and Image Processing	C	3+1=4	28 (21= theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	MGIFCAG225	Advanced Geoinformatics	C	3+1=4	28 (21= theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	MGIFCGS225	Geospatial Statistics	C	3+1=4	28 (21= theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	MGIFCDD225	DBMS and Geospatial Databases	C	2+0=2	14	36	50
	MGIFCGC225	Geospatial Cloud Computing	C	0+2=2	14	36	50
	Students shall have to opt for one DCE out of the following DCEs						
	MGIFDMR225	Fundamentals of Microwave Remote Sensing	DCE	2+0=2	14	36	50
	MGIFDGS225	Geomorphology from Space	DCE	2+0=2	14	36	50
	MGIFSMS225	Mapping from Space	SE	1+1=2	14	36	50
		Total credits		**20**			

Department of Geoinformatics, University of Kashmir, Srinagar, J&K

Course Structure of M. Sc. Geoinformatics under NEP 2020 to be implemented from 2025

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					Internal Assessment	Term End Examination	
3rd Semester	MGIFCAM325	Advanced GIS Data Analysis and Modelling	C	3+1=4	28 (21=theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	MGIFCAG325	Artificial Intelligence for Geoinformatics	C	3+1=4	28 (21=theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	MGIFCGL325	Glaciology	C	3+1=4	28 (21=theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	MGIFCRP325	Research Project	C	4+0=4	28	72	100
	Students shall have to opt for one DCE out of the following DCEs						
	MGIFDGS325	GNSS for Advanced Surveying	DCE	1+1=2	14	36	50
	MGIFDHI325	Hydroinformatics	DCE	2+0=2	14	36	50
	MGIFSFW325	Field Work	SE	2+0=2	14	36	50
		Total credits		**20**			

Students will follow the (CW+CW) option during the first three semesters. In the fourth semester, they may choose either to continue with the (CW+CW) option or to switch to the (CW+R) option.

4th Semester	MGIFCDH425	Disaster, Risk, and Hazard Assessment	C	3+1=4	28 (21=theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	MGIFCGP425	Geomatics for Urban and Regional Planning	C	3+1=4	28 (21=theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	MGIFCRN425	Remote Sensing of Natural Resources	C	3+1=4	28 (21=theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	MGIFCRC425	Research Synthesis and Scholarly Communication	C	3+1=4	28 (21=theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	Students shall have to opt for one DCE out of the following DCEs						
	MGIFDDP425	Recent Advancements in Digital Image Processing	DCE	2+0=2	14	36	50
	MGIFDCH425	Cryosphere-related Hazards	DCE	2+0=2	14	36	50
	MGIFSSG425	Health and Socioeconomic GIS	SE	2+0=2	14	36	50
		Total credits		**20**			

(CW +R) option in the 4th Semester

4th Semester	**MGIFCRC425**	Research Synthesis and Scholarly Communication	C	3+1=4	28 (21=theory; 7= P/T)	72 (54= theory; 18= P/T)	100
	MGIFCDI425	Dissertation	DI	16+0=16	112	288	400

C: Core Course; **DCE:** Discipline Centric Elective Course; **SEC:** Skill Enhancement Course; **DI:** Dissertation

Furthermore, the department of Geoinformatics will offer Skill Enhancement Courses itself.

Programme Educational Objectives (PEOs):

After completing the MSc in Geoinformatics, the students will be able to:

- Develop a strong foundation in geospatial science, gaining expertise in GIS, remote sensing, GNSS, and spatial data analytics to analyze and interpret various earth and environment-related processes.
- Acquire hands-on experience through field surveys and lab-based training, mastering skills in spatial data acquisition, satellite image processing, geospatial modeling, and map creation using industry-standard tools.
- Address real-world challenges such as natural resource management, disaster risk reduction, climate change assessment, and urban planning by applying integrated geospatial techniques.
- Demonstrate problem-solving abilities through dissertation work, applying geospatial analysis, modeling approaches to geospatial problems, and defending findings through specialized presentations and reports.
- Prepare for careers in academia, environmental consultancy, urban planning, and geospatial industries, with the ability to contribute to high-quality research and publish in peer-reviewed scientific journals.

Program Learning Outcomes (PLOs):

PLO Code	Title	Description
PLO 1	Advanced Geospatial Knowledge	Students will develop comprehensive expertise in geospatial principles, remote sensing, GIS, GNSS, and spatial data analytics. They will apply this knowledge to understand, model, and manage Earth and Environment-related applications.
PLO 2	Research Aptitude	Students will cultivate research skills by formulating geospatial research questions, designing workflows, acquiring spatial data, and using analytical tools to solve problems in environmental monitoring, cryosphere, urban planning, disaster risk, and resource management.
PLO 3	Communication	Students will effectively communicate geoinformatics concepts, spatial analysis results, and research findings through maps, visualizations, technical reports, academic publications, and oral presentations for both scientific and stakeholder audiences.
PLO 4	Problem Solving	Students will apply geospatial technologies and critical thinking to solve real-world problems in domains such as climate change, cryosphere, agriculture, hydrology, transportation, and natural hazard assessment.
PLO 5	Individual and Team Work	Students will demonstrate the ability to work independently and collaboratively in multidisciplinary teams, contributing to data acquisition, spatial modeling, and decision-support systems in geoinformatics projects.
PLO 6	Investigation and Field Skills	Students will plan and conduct field-based geospatial investigations, including GPS surveys, ground truthing, and mobile mapping, integrating field observations with remote sensing and GIS data.
PLO 7	Modern Tool Usage	Students will be proficient in using modern geoinformatics tools such as GIS software, remote sensing platforms (Google Earth Engine), GPS/GNSS devices, drones, spatial databases, and AI/ML frameworks.
PLO 8	Science and Society	Students will apply geospatial reasoning to address societal and environmental challenges, promoting sustainable development, disaster mitigation, urban resilience, and effective natural resource governance.
PLO 9	Lifelong Learning	Students will engage in continuous learning to keep pace with advances in geoinformatics, embracing evolving data sources, technologies, and interdisciplinary applications for personal and professional growth.

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs)

The Course Learning Outcomes (CLOs) are systematically aligned with the Program Learning Outcomes (PLOs) to ensure that each course contributes directly and meaningfully to the overarching objectives of the M.Sc. Geoinformatics program. This alignment establishes coherence between course-specific learning goals and the broader program-level competencies expected of graduates.

Each CLO is carefully examined against the relevant PLOs to assess the extent of its contribution toward achieving the program's academic and professional goals. Such structured mapping provides a transparent framework for evaluating how effectively individual courses support the program's mission. It also serves as a feedback mechanism for the continuous enhancement of curriculum design and program delivery based on outcome attainment.

Thus, the CLO-PLO mapping forms a cornerstone of academic planning, curriculum development, and quality assurance within the department. The levels of correlation used in this mapping are defined as follows:

The various correlation levels are:

Number	**Meaning**	**Description**
0	No Correlation	The Course Outcome is strongly contributing to the Program Outcome. There is a direct and significant relationship.
1	Low Correlation	The Course Outcome is moderately contributing to the Program Outcome. There is a partial but important relationship.
2	Moderate Correlation	The Course Outcome is minimally contributing to the Program Outcome. The connection is weak but present for multidisciplinary learning.
3	High Correlation	The Course Outcome does not contribute to the Program Outcome at all.

FIRST SEMESTER

MGIFCCM125: Computers and Geoinformation Management (3+1=4 credits)

Course Learning Outcomes (CLOs):

CLO1. Familiarize students with the fundamentals of programming for scientific computing and data management.

CLO2. Enable students to apply geomatic tools for sampling design and spatial modeling using practical case studies.

CLO3. Bridge the gap between theoretical geoinformatics and hands-on data management, preparing students for real-world geospatial analysis.

Unit I: Programming and Problem Solving in C

Introduction to number systems and conversions. Basic flowcharts with examples. 'C' character set, keywords, data types, constants, variables. Operators: arithmetic, logical, relational, assignment, and conditional operators. Expressions and statements in C, Symbolic constants. Basic programs in C. Control statements: *if* statements, *if-else*, and *switch* statements with examples. Loops in C: *while*, *do-while*, and *for* loop with examples. Introduction to arrays, structures, functions, and pointers.

Unit II: Geospatial Data Handling

Ideal computer configuration for satellite data analysis and geospatial modelling. Role of computers in GIS and remote sensing data analysis. Metadata: introduction, importance, and standards. Remote sensing data types: signed, unsigned, float, double, complex. Data compression techniques: advantages and disadvantages. Data conversion in remote sensing and GIS: necessity, advantages, and disadvantages. Metadata creation of GIS example data. Case studies on geospatial modelling.

Unit III: Geospatial Data Management

Overview of data management in GIS. Common geospatial data types: geodatabase, feature class, raster, shapefile, and tables. Basic raster analysis in GIS: resampling, arithmetic operations, and clipping. Vector analysis: fishnet and its applications. Sampling and designing sampling intensity: systematic, random, stratified random. Spatial analysis operations: data extraction and zonal statistics. Creation of a geodatabase. Use of a fishnet for extracting information from raster files. Fishnet in multi-criteria analysis

C Programming and Geospatial Data Handling Lab **(Practical/Tutorial: 1 credit)**

- Hands-on MS Office (MS Word, MS Excel, MS PowerPoint).
- Basic programs in C
- Control statements: *if*, *if-else*, and *switch*.
- Loops: *for*, *while*, and *do-while*
- Data conversions: Basic import and export operations in GIS.
- Basic geospatial analysis: fishnet, sampling, zonal statistics.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	1	2	1	1	3	1	2	**1.8**
CLO 2	3	3	1	3	2	2	3	2	2	**2.3**
CLO 3	3	2	2	3	2	1	3	2	2	**2.2**
PLO Avg	**3**	**2.3**	**1.3**	**2.7**	**1.7**	**1.3**	**3**	**1.7**	**2**	

Suggested readings:

1. Balagurusamy, E. (2022). Programming in ANSI C (8th ed.). McGraw-Hill Education.
2. Bolstad, P. (2019). GIS fundamentals: A first text on geographic information systems (6th ed.). Eider Press.
3. Joseph, G. (2015). Fundamentals of remote sensing (3rd ed.). Universities Press.
4. Kanetkar, Y. (2023). Let us C (17th ed.). BPB Publications.
5. Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). Geographic information science and systems (4th ed.). Wiley.
6. Current review and comparisons of different hardware and software published frequently, particularly in magazines such as Byte and PC Magazine.

MGIFCFR125: Fundamentals of Remote Sensing **(3+1=4 credits)**

Course Learning Outcomes (CLOs):

CLO1. Developing an understanding of the current state of knowledge in remote sensing amongst students.

CLO2. To expose the students to the principles of electromagnetic radiation, satellite systems platforms, and sensors.

CLO3. Enable students to interpret satellite data and extract relevant geospatial information.

Unit I: Concepts and Overview of Remote Sensing

Remote sensing: Definition, history, and scope. Overview of remote sensing systems. Types of remote sensing: Active and passive, Air-borne and spaceborne, Geostationary and Sun-synchronous. Typical Remote Sensing system and its components. Sensor resolution (Spatial, spectral, temporal, and radiometric). Interactions of EMR with the atmosphere, interaction of EMR with earth's surface features: vegetation, water, soils, and settlements. Electromagnetic radiation (EMR) and Electromagnetic Spectrum (EMS): parts of electromagnetic radiation, theories of electromagnetic radiation, radiation laws, and atmospheric windows. Spectral signatures of common land-cover types and the criterion of choosing spectral signatures.

Unit II: Sensors and Data Interpretation

Types of Scanners: OM Line scanners, CCD Line and Area scanners. Photogrammetry: types and characteristics of aerial photographs (scale, resolution, projection, overlaps), measurement of scale and height, relief displacement. Stereoscopy, Stereo-imaging: principles, and sensors for stereo-imaging. Important satellite systems. Principles of visual image interpretation: elements of visual image interpretation, importance, and factors governing the interpretability. Use of ancillary information for satellite data interpretation. Ground Truth Collection: importance, methods, and equipment, Ground truth proforma.

Unit III: Digital Image Processing

Introduction to DIP. Digital data and data storage formats (BSQ, BIL, BIP), Pre-processing of satellite data like geometric and radiometric distortions. Image enhancement techniques: linear, non-linear, and histogram equalization. Color composites: band combination, false color composite, and true color composites. Image formats like Binary, IMG, GeoTIFF, and HDF, etc.

Fundamentals of Remote Sensing Lab **(Practical/Tutorial: 1 credit)**

- Tutorial on different modules of ERDAS Imagine image processing software.
- Visual interpretation of different earth features from the images.
- Preparation of satellite data for analysis, like rotate, subset, and layer stacking.
- Pre-processing of satellite data, like image registration and geo-correction.
- Introduction to different image and remote sensing data formats.
- Import and export utility of ERDAS Imagine.
- False color composite, True Color composite.
- Spectral response of different earth features from multi-spectral image data.
- Mini projects

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	1	2	1	1	2	2	2	**1.8**
CLO 2	3	2	1	2	1	1	3	2	2	**1.9**
CLO 3	3	2	1	3	1	1	3	2	2	**2**
PLO Avg	**3**	**2**	**1**	**2.3**	**1**	**1**	**2.7**	**2**	**2**	

Suggested readings:

1. Colwell, R. N. (1983). Manual of remote sensing. American Society of Photogrammetry.
2. Cracknell, A. P. & Hayes, L.W.B. (1993). Introduction to Remote Sensing, Taylor and Francis, London.
3. Jensen, J. R. (1996). Introductory digital image processing: a remote sensing perspective (No. Ed. 2). Prentice-Hall Inc.
4. Jensen, J. R. (2004). Introductory Digital Image Processing, Prentice Hall.
5. Lillesand, T., Kiefer, R. W., & Chipman, J. (2014). Remote sensing and image interpretation. John Wiley & Sons.

MGIFCFG125: Fundamentals of Geographic Information System **(3+1=4 credits)**

Course Learning Outcomes (CLOs):

CLO1. To introduce the fundamental concepts, components, and applications of GIS to students.

CLO2. Develop competence amongst students in the use of geospatial tools for the analysis of spatial data.

CLO3. Build the skills of students in geospatial data handling and analysis for solving spatial problems.

Unit I: Overview of GIS

Introduction, overview, history, and importance. Geographic data sources: Remote Sensing, GPS, Maps, and Field observations. Components of GIS. Types of GIS. Spatial and non-spatial data: introduction, importance, and integration. Concept of data/information and knowledge. Fundamental applications of GIS.

Unit II: GIS Data Models

Concept and types, Raster data model, Vector data model, issues related to data model conversion. Digitization, data errors, and data editing. Concept and applications of topology in GIS. Advantages and Disadvantages of Raster and Vector Data Models. Applications of data models. Data structure and their applications related to real-world features.

Unit III: Geospatial Data Analysis

Vector-based analysis: Buffer, overlay analysis, geoprocessing, network analysis, with examples of each type. Raster-based analysis: local operations, neighbourhood operations, extended neighbourhood operations, with examples of each type. Geospatial analysis: introduction to non-topological, regional operations with examples.

Geospatial Analysis Lab **(Practical/Tutorial: 1 credit)**

- Familiarization with GIS software and visualization of geographic datasets
- Exposure to basic features of a GIS software
- Working with common raster and vector data formats
- Digitisation of point, line, and polygon features.
- Queries and attribute data handling

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	1	2	1	1	3	2	2	**1.9**
CLO 2	3	2	1	3	1	1	3	2	2	**2.0**
CLO 3	3	3	1	3	2	1	3	2	2	**2.2**
PLO Avg	**3.0**	**2.3**	**1.0**	**2.7**	**1.3**	**1.0**	**3.0**	**2.0**	**2.0**	

Suggested readings:

1. Burrough, P. A. (1996). Principles of Geographic Information Systems for land resources assessment, Oxford: Clarendon Press.
2. Chang, K. (2004). Introduction to GIS, McGraw-Hill, Dubuque, Iowa.
3. Clarke, K. C. (2003). Getting Started with Geographical Information Systems, Prentice Hall, Upper Saddle River, New Jersey.
4. De Mers, M. N. (2002). Fundamentals of Geographic Information Systems. John Wiley and Sons, New York.

MGIFCDV125: Digital Cartography and Geoinformation Visualization (3+1=4 credits)

Course Learning Outcomes (CLOs):

CLO1. Expose students to the basic and advanced techniques of digital cartography for visual exploration and presentation of the geospatial data.

CLO2: Develop the skills of students in geospatial data updating, integration, and dissemination.

CLO3: Enable students to apply digital cartographic techniques to spatial and non-spatial geoinformation across various domains and scales.

Unit I: Introduction to Maps

Introduction, types of maps, uses of maps. Cartography: analogue and digital cartography, cartographic generalizations. Coordinate systems, Geoid and datums. Map projections: introduction, properties and aspects of map projections, classification of map projections. Map composition.

Unit II: Data Sources and Visualization

Data products w.r.t land surface processes, disasters, EIA, and geology. Visualization techniques: Visual exploration for different features/surfaces, virtual reality, and scenario mapping. Survey of India (SOI) map index. National geospatial data policy, Use and users of geo-spatial data. Geospatial data sources for various land surface processes.

Unit III: Geospatial data updating and dissemination

Quantitative representation of spatial and non-spatial data. Digital and cartographical, and landscape models. Geospatial data dissemination: maps, graphics, animations, multimedia, internet, and posters. Issues with the use of maps (accuracy, scale, updation).

Digital Cartography and Geoinformation Visualization Lab (Practical/Tutorial: 1 credit)

- Map-making
- Coordinate systems: assign spatial reference,
- Import coordinate systems from ancillary sources.
- Mini project on mapping

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	2	2	1	1	3	2	2	**2.0**
CLO 2	3	2	2	2	2	1	3	2	2	**2.1**
CLO 3	3	2	2	3	2	1	3	2	2	**2.2**
PLO Avg	**3.0**	**2.0**	**2.0**	**2.3**	**1.7**	**1.0**	**3.0**	**2.0**	**2.0**	

Suggested readings:

1. Ormeling, F., & Kraak, M. J. (2010). Cartography: Visualization of Geospatial Data. Prentice Hall.
2. Robinson, A. H., Morrison, J. L., Muehrcke, P. C., Kimerling, A. J., & Guptill, S. C. (1995). Elements of Cartography, John Wiley and Sons, New York.
3. Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2005). Geographic Information Systems and Science, John Wiley and Sons, New York.
4. De Mers, M. N. (2008). Fundamentals of geographic information systems, John Wiley & Sons.
5. Brail, R. K., & Klosterman, R. E. (2001). Planning Support Systems: Integrating Geographic Information Systems, Models, and Visualization Tools, ESRI Press.
6. Lo, C. P., & Yeung, A. K. (2007). Concepts and techniques of geographic information systems, Pearson Prentice Hall.

MGIFDOG125: Open-Source GIS **(2 credits)**

Course Learning Outcomes (CLOs):

CLO1. To introduce students to emerging trends and tools in open-source GIS, enhancing their adaptability to evolving geospatial technologies.

CLO2. To equip students with hands-on skills in using free and open-source GIS platforms for spatial data analysis and visualization.

CLO3. To develop the ability among students to perform essential geospatial operations, including data handling, analysis, visualization, and map composition using open-source tools.

Unit I: Foundations and Vector Analysis in QGIS

Overview of QGIS interface: Menu bar, toolbars, panels, and map canvas. Basic map navigation and coordinate referencing. Vector data handling: digitization, symbology and labelling, attribute table operations. Geoprocessing tools: Buffer, Union, Intersect, Clip, attribute querying, and spatial queries. Data import/export in QGIS.

Unit II: Advanced QGIS

Raster data visualization and analysis: Creating virtual rasters (VRT), Mosaicking, Terrain analysis: elevation, slope, aspect. Zonal statistics. Projection and transformation tools. Map composition and layout design in QGIS. Working with QGIS Plugins. Open Street Map integration in QGIS. On-the-fly projection and CRS management

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	1	2	1	1	3	2	3	**2.0**
CLO 2	3	2	1	3	1	1	3	2	3	**2.1**
CLO 3	3	2	2	3	2	1	3	2	3	**2.3**
PLO Avg	**3.0**	**2.0**	**1.3**	**2.7**	**1.3**	**1.0**	**3.0**	**2.0**	**3.0**	

Suggested readings:

1. Graser, A. (2022). Learning QGIS (5th ed.). Packt Publishing.
2. Menke, K. (2022). Discover QGIS: A Workbook for Classroom or Independent Study (4th ed.). Locate Press.
3. Sherman, G. (2017). The PyQGIS Programmer's Guide 3: Extending QGIS with Python (2nd ed.). Locate Press.

MGIFDCL125: CLIMATOLOGY (2 credits)

Course Learning Outcomes (CLOs):

CLO1. Explain the fundamental Earth System, including the processes governing global circulation and extreme weather events, to students.

CLO2. To enable students to understand the basic principles of climate modelling projections and the use of proxy data for reconstructing past climates.

CLO3. To demonstrate the impact of climate change on natural systems and human security to students.

Unit I: Atmospheric Science

Nature, composition, and layered structure of the atmosphere. Thermal distribution of temperature. Greenhouse effect. Factors controlling insolation. Earth's heat budget. Global atmospheric pressure belts and their oscillation. General wind circulation. Jet stream and index cycle. Monsoon and jet streams. Extreme weather events: Cloudbursts, erratic snowfall, heatwaves, and droughts.

Unit II: Climate Observations and Models

Synoptic weather forecasting, prediction of weather elements such as precipitation, temperature. Introduction to global climate models and regional climate models. Downscaling and upscaling of climate data. IPCC Climate Change scenarios. Climate change impact studies: biodiversity and food security. Palaeoclimatic inferences from ice-cores, tree rings, lake sediments, phytoliths and pollens.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	2	2	2	2	2	3	2	**2.2**
CLO 2	2	3	2	2	2	2	2	2	2	**2.1**
CLO 3	2	2	2	3	2	2	2	3	2	**2.2**
PLO Avg	**2.3**	**2.3**	**2.0**	**2.3**	**2.0**	**2.0**	**2.0**	**2.7**	**2.0**	**–**

Suggested readings:

1. Ahrens, C. D., & Henson, R. (2023). Meteorology today: An introduction to weather, climate, and the environment (13th ed.). Cengage Learning.
2. Barry, R. G., & Chorley, R. J. (2023). Atmosphere, weather and climate (12th ed.). Routledge.
3. IPCC. (2023). Climate change 2023: Synthesis report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. [Core Writing Team, H. Lee and J. Romero (Eds.)]. IPCC.
4. Ladurie, E. L. R., & Bray, B. (2023). Times of feast, times of famine: A history of climate since the year 1000. (New ed.). Princeton University Press.
5. Lal, D. S. (2003). Climatology. Sharda Pustak Bhawan, New Delhi.
6. Ruddiman, W. F. (2023). Earth's climate: Past and future (4th ed.). W. H. Freeman and Company.
7. Stull, R. (2023). Practical meteorology: An algebra-based survey of atmospheric science. University of British Columbia.

MGIFSSH125: Seminar and Hands-on in Geospatial Technology (2 credits)

Course Learning Outcomes (CLOs):

CLO1. To familiarize students with the practical applications of geospatial platforms, field instruments, and analytical tools used in geomatics.

CLO2. To strengthen the abilities of students in scientific communication, including effective reading, writing, and presentation of research papers.

CLO3. To promote critical thinking and group engagement amongst students through seminars, discussions, and collaborative learning on emerging topics in geoinformatics.

Unit I: Hands-on

Understanding the basic elements of a map and the workflow of map-making. Hands-on training using Google Earth Pro for spatial visualization and interpretation. Instrumentation used in cryospheric studies. Development of a geospatial database using ground data related to land use and land cover (LULC).

Unit II: Seminar

Student seminars and group discussions on contemporary topics in geomatics, such as disaster vulnerability mapping, smart city planning, and natural resource assessment. Reading, reviewing, and synthesizing scientific papers related to land system changes, Himalayan cryosphere, and Lake-wetland transformations.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	1	2	1	2	3	2	2	**2.0**
CLO 2	2	2	3	2	1	1	2	2	2	**1.9**
CLO 3	2	2	2	2	3	1	2	2	2	**2.0**
PLO Avg	**2.3**	**2.0**	**2.0**	**2.0**	**1.7**	**1.3**	**2.3**	**2.0**	**2.0**	

SECOND SEMESTER

MGIFCAI225: Advanced Remote Sensing and Image Processing (3+1=4 credits)

Course Learning Outcomes (CLOs):

CLO1. Develop the skills of the students in advanced remote sensing and digital image processing.

CLO2. Impart know-how among students about extracting information from satellite data.

CLO3. Demonstrate the usefulness of satellite data for real-world applications to students.

Unit I: Advances in Remote Sensing

Recent advancements in Remote Sensing. Thermal remote sensing: introduction, sensors and applications. Thermal infrared radiation properties and thermal properties of the terrain. Hyperspectral remote sensing. Integration of multi-sensor data: introduction, techniques, constraints, and applications. Planetary Remote Sensing, Geophysical Remote Sensing, LiDAR, and UAVs.

Unit II: Image Processing Techniques

Univariate and multivariate statistics in Digital Image Processing. Filtering: introduction, high-pass filters, low-pass filters, density slicing, edge enhancement, and detection filters. Band math, image indices (VI, NDVI, NDSI, NDGI, NDWI), and their applications. Principal component analysis (PCA): introduction, technique, and applications.

Unit III: Classification of Satellite Data

Parametric and non-parametric classifiers, Per-pixel and sub-pixel classification. Limitations of statistical classifiers. Classification algorithms: ISODATA, K-means, Maximum Likelihood, Minimum Distance, Parallelepiped, Mahalanobis. Image classification: Supervised and Unsupervised approaches, Feature selection and feature reduction. Classification Accuracy Assessment of classified images: error matrix, errors of commission and omission, kappa statistics.

Advanced Remote Sensing and Image Processing Lab (Practical/Tutorial: 1 credit)

- Advanced image processing techniques, viz., principal component analysis of remote sensing data.
- Digital Image Classification: unsupervised and supervised, change detection analysis.
- Model builder for different spectral indices.
- Development of image indices using optical remote sensing data.
- Mosaicking of satellite images (batch processing), Image fusion.
- Accuracy assessment of LULC maps.
- Mini Project/ Assignment

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	1	3	1	1	3	2	2	**2.0**
CLO 2	3	2	1	3	1	1	3	2	2	**2.0**
CLO 3	3	3	1	3	2	1	3	3	2	**2.3**
PLO Avg	**3.0**	**2.3**	**1.0**	**3.0**	**1.3**	**1.0**	**3.0**	**2.3**	**2.0**	

Suggested readings:

1. Campbell, J. B., (2011). Introduction to remote sensing, Taylor and Francis, London.
2. Jensen, J. R. (1996). Introductory Digital Image Processing, A Remote Sensing Perspective, Upper Sanddle River, Prentice Hall.
3. John, A. R. (1993). Remote Sensing Digital Image Analysis, Springer-Verlag.
4. Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). Remote sensing and image interpretation (7^{th} ed.). John Wiley & Sons.
5. Rencz, A. N. (1999). Manual of Remote Sensing for Earth Sciences. John Wiley & Sons.
6. Richards, J. A. & Jia, X. (2006). Remote Sensing Digital Image Analysis: An Introduction, Springer Verlag.
7. Sabins, F. F. & Freeman W. H. (1987). Remote sensing principles and interpretation, Taylor & Francis San Francisco.

MGIFCAG225: Advanced Geoinformatics **(3+1=4 credits)**

Course Learning Outcomes (CLOs):

CLO1. To introduce students to emerging trends and technologies in Geoinformatics.

CLO2. To build the technical skills of students in data integration in GIS, and its applications in socio-economic and environmental contexts.

CLO3. To enable students to critically evaluate data quality, standards, and scale issues in GIS for informed geospatial analysis and decision-making.

Unit I: **Emerging Trends in GI Science**

Technological advancements in geoinformatics. Integration of geoinformatics with the emerging technologies: AI, IT, IoT, mobile GIS, etc. Enterprise Geographic Information System (GIS): definition, trends, implementation, and its applications. Fundamentals of multi-criteria analysis: Overlay analysis, Analytical Hierarchy Process. Data use and importance in geospatial analysis, GIS-based decision support system: fundamentals and applications.

Unit II: GIS Data Standardization and Design

Data standardization: Data standards, data quality, Scale issues in remote sensing and GIS. GIS design methodology, implementation, technical, manpower, and institutional issues. Geospatial Data Standards: Open Geospatial Consortium, BIS, CityGML. Data integration in GIS: Socio-economic GIS, integration and application of socio-economic and environmental data.

Unit III: Sampling and Interpolation

Sampling theory: Geographic data sampling methods, Interpolation: importance, data sources for interpolation, types of interpolation, issues involved with interpolation of spatial data. Methods for interpolation: Thiessen polygons, inverse distance weighted, splines, and krigging. Digital Elevation Model (DEM): Definition, methods of development, and applications of DEM.

Advanced Geoinformatics Lab **(Practical/Tutorial: 1 credit)**

- Raster to vector data conversion.
- Interpolation: Thiessen polygons, inverse distance weighted, splines, and krigging.
- Model Builder for geospatial analysis.
- Spatial data analysis: Census and other socio-economic data analysis.

- Multi-criteria analysis through the AHP technique.
- Spatial modelling in a GIS environment.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	1	2	1	1	3	2	3	**2.0**
CLO 2	3	3	1	3	2	1	3	3	3	**2.4**
CLO 3	3	3	1	3	2	1	3	3	3	**2.4**
PLO Avg	**3.0**	**2.7**	**1.0**	**2.7**	**1.7**	**1.0**	**3.0**	**2.7**	**3.0**	

Suggested readings:

1. Burrough, P. A. (1996). Principles of Geographic Information Systems for land resources assessment: Oxford: Clarendon Press.
2. Chang, K. (2004). Introduction to GIS, 2nd Edition. McGraw-Hill, Dubuque, Iowa.
3. Lo, C. P. & Yeung, A. K. (2007). Concepts and techniques of geographic information systems, Pearson Prentice Hall.
4. DeMers, M. N. (2002). Fundamentals of Geographic Information Systems, 2nd Edition. John Wiley and Sons, New York.

MGIFCGS225: Geospatial Statistics **(3+1=4 credits)**

Course Learning Outcomes (CLOs):

CLO1. To help students design spatial sampling strategies and apply statistical hypothesis testing to geospatial data.

CLO2. To build the capacity of students to analyze multivariate and multitemporal geospatial data using descriptive statistics and transformation techniques.

CLO3. To enable students to apply the geospatial techniques to spatially varying phenomena.

Unit I: Fundamentals of Geospatial Statistics

Introduction: importance and application of statistics for earth and environmental sciences. Spatial sampling procedures, non-sampling and sampling errors, sampling design. Design of experiments. Confidence intervals. Hypothesis testing. Analysis of variance. Statistical methodology and models for time series data analysis with special reference to earth and environmental sciences. Models and methods for analysis of missing data.

Unit II: Statistical Analysis of Geospatial Data

Descriptive statistics and data analysis, organizing, summarizing, and analyzing spatial data, histogram analysis, probability distribution, scatter plots, and data redundancy analysis for multi-dimensional spatial data, correlation in multivariate data. Data transformations: logarithmic, indicator, normal-score, rank-order. Time series analysis and applications of time series analysis for feature extraction from the multitemporal satellite data with examples.

Unit III: Techniques and Applications of Geospatial Statistics

Overview of applications and techniques for univariate and multivariate statistics for multidimensional satellite data. Spatial continuity analysis: estimation and simulation. Overview of spatial statistics, estimation, and modelling with examples. Autocorrelation principles. Variogram analysis. Applications of variogram analysis for continuously varying phenomena like soil moisture, etc.

Geospatial Statistics Lab **(Practical/Tutorial: 1 credit)**

- Univariate and multivariate analysis in R-Studio
- Hypothesis tests: t-test, z-test.
- Estimation of spatially varying phenomena through semi-variogram analysis
- Time-series analysis of climate data

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	3	1	3	1	2	3	3	2	**2.3**
CLO 2	3	3	1	3	1	2	3	3	3	**2.4**
CLO 3	3	3	1	3	2	2	3	3	3	**2.6**
PLO Avg	**3.0**	**3.0**	**1.0**	**3.0**	**1.3**	**2.0**	**3.0**	**3.0**	**2.7**	

Suggested readings:

1. Cressie, N. (2015). Statistics for Spatial Data. John Wiley & Sons.
2. Gelfand, D. & Fuentes, G. (2010). The Handbook of Spatial Statistics. Chapman & Hall/CRC.
3. Gelfand, A. E., Diggle, P. J., Fuentes, M. & Guttorp, P., eds. (2010) Handbook of Spatial Statistics, CRC Press.
4. Burt, J. E., & Barber, G. M. (1996). Elementary Statistics for Geographers, 2nd ed., Guilford Press.
5. Fotheringham, S. & Rogerson, P. A. (2009). The SAGE Handbook of Spatial Analysis, SAGE Publications.

MGIFCDD225: DBMS and Geospatial Databases (2 credits)

Course Learning Outcomes (CLOs):

CLO1. To develop a foundational understanding of the working of database management systems, particularly in the context of geospatial data.

CLO2. To introduce key principles of database design and to explore their applications in geospatial and real-world information systems.

CLO3. To familiarize students with the structure, access, and applications of global and regional geodatabases.

Unit I: Fundamentals of Database Management Systems

Database concepts. Steps in database design: Prototype model and Waterfall model. Concept of keys in a database. DBMS and Relational DBMS, Codd's rules. Basics of SQL, data types, and constraints in SQL. Data definition language, data manipulation language, and data control language in SQL. GIS Data modelling using Entity Relationship Diagrams (ERD) with examples.

Unit II: Regional and Global Databases

Global topographic datasets: GOTOPO, SRTM, ASTER, Carto DEM, ALOS 3D, HMA DEM, TanDEM-X, Copernicus. Copernicus Sentinel-2 10 m global LULC. Vegetation type map of India (Roy et al. 2015). Gridded population of the world. World lake database and world's inland surface water database (Lehner et al. 2024). Robustness of existing glacier inventories (RGI and ICIMOD) over the Himalaya. Harmonized world soil database and its applications in modelling the regional hydrological and climate processes. Wetland Atlas of Jammu and Kashmir. Data portals for geospatial data download: Earth Explorer, Bhuvan, Vedas.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	1	3	1	1	3	2	2	**2.0**
CLO 2	3	3	1	3	2	1	3	2	2	**2.2**
CLO 3	3	2	1	3	1	1	3	2	2	**2.0**
PLO Avg	**3.0**	**2.3**	**1.0**	**3.0**	**1.3**	**1.0**	**3.0**	**2.0**	**2.0**	

Suggested readings:

1. Coronel, C., & Morris, S. (2022). Database systems: Design, implementation, & management (14th ed.). Cengage Learning.
2. Elmasri, R., & Navathe, S. B. (2017). Fundamentals of database systems (7th ed.). Pearson.
3. Ramakrishnan, R., & Gehrke, J. (2020). Database management systems (4th ed.). McGraw-Hill Education.
4. Rigaux, P., Scholl, M., & Voisard, A. (2020). Spatial databases: With application to GIS (revised ed.). Morgan Kaufmann.
5. Shekhar, S., Evans, M. R., Kang, J. M., & Mohan, P. (2020). Spatial databases: A tour (2nd ed.). Morgan & Claypool Publishers.

MGIFCGC225: Geospatial Cloud Computing (2 credits)

Course Learning Outcomes (CLOs):

CLO1. To introduce students to cloud-based geospatial data processing using the Google Earth Engine platform.

CLO2. Enable students to conduct big data analytics in the context of environmental monitoring and spatio-temporal analysis.

CLO3. To promote reproducible and scalable geospatial analysis through code-based workflows.

Unit I: Introduction to Geospatial Cloud Computing

Fundamentals, advantages, and applications in the geospatial domain. Overview of Google Earth Engine (GEE): Platform architecture, computational capabilities, and user access interface. Understanding Earth Engine data catalog: optical, radar, and climatic datasets. Basics of JavaScript for remote sensing workflows: Importing, filtering, cloud masking, and visualizing datasets.

Unit II: Cloud-Based Image Processing and Analysis

Image fusion: Temporal image fusion and multi-sensor integration, Image enhancement: IHS image transformation, Spectral indices, Image segmentation with machine learning algorithms. Raster and vector conversions, Automated feature detection, and mapping. Visualisation with time series charts, Data export to cloud storage.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	1	3	1	1	3	2	2	**2.0**
CLO 2	3	3	1	3	2	1	3	3	3	**2.4**
CLO 3	3	3	2	3	2	1	3	2	3	**2.4**
PLO Avg	**3.0**	**2.7**	**1.3**	**3.0**	**1.7**	**1.0**	**3.0**	**2.3**	**2.7**	

Suggested Readings:

1. Cardille, J. A., Crowley, M. A., Saah, D., and Clinton, N. E. (2023). Cloud-based remote sensing with Google Earth Engine: fundamentals and applications. Springer Nature.
2. Das, H., Barik, R. K., Dubey, H., and Roy, D. S. (2019). Cloud computing for geospatial big data analytics. Springer.
3. Mutanga, O., and Kumar, L. (2019). Google Earth Engine applications. MDPI.

MGIFDMR225: Fundamentals of Microwave Remote Sensing **(2 credits)**

Course Learning Outcomes (CLOs):

CLO1. Develop an understanding of the radar remote sensing principles among students

CLO2. Promote the complementary use of optical and microwave remote sensing products among students

CLO3. Expose the students to new applications in the field of microwave remote sensing.

Unit I: Fundamentals of Microwave Remote Sensing

Microwave region of the Electromagnetic spectrum. Historical perspective of microwave remote sensing. Advantages and disadvantages of radar remote sensing viz-à-viz optical remote sensing. Active and passive microwave remote sensing, Synthetic Aperture Radar (SAR). SAR viewing geometry: slant range, ground range, azimuth, look-angle, incidence angle, Local incidence angle.

Unit II: Sensor and Target Characteristics

Concept of wavelength and frequency in SAR. Radar penetration. SAR polarization. Dielectric constant, SAR dependence on dielectric constant w.r.t. angle and frequency. Speckle: Definition and causes of speckle in SAR images, speckle. Topographic influences on radar imaging: shadow, foreshortening and layover.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	1	3	1	1	3	2	2	**2.0**
CLO 2	3	3	1	3	2	1	3	3	3	**2.4**
CLO 3	3	3	1	3	2	1	3	3	3	**2.4**
PLO Avg	**3.0**	**2.7**	**1.0**	**3.0**	**1.7**	**1.0**	**3.0**	**2.7**	**2.7**	

Suggested readings:

1. Ulaby, F. T., Moore, R. K., Fung, A. K., (1982). Microwave Remote Sensing, vol. I, II and III. Massachusetts, Adison Wilsey.
2. Trevett, J. W. (2013). Imaging radar for resources surveys. Springer Science & Business Media Hall, London

MGIFDGS225: GEOMORPHOLOGY FROM SPACE (2 credits)

Course Learning Outcomes (CLOs):

CLO1. To help students identify and classify major geomorphic landforms and drainage patterns using remote sensing.

CLO2. Build the capacity of students to apply the principles of morphometric analysis to characterize drainage basins and infer the dominant processes shaping a landscape.

CLO3. To make students evaluate and utilize appropriate approaches for carrying out geomorphological mapping.

Unit I: Geomorphic Landforms

Overview of geomorphology: Geomorphological cycle. Morphometric and morphotectonic analysis of basins. Introduction to landforms: fluvial, glacial, and aeolian. Distribution of various landforms in the Himalaya. Drainage basins and drainage types.

Unit II: Geomorphological Mapping

Introduction to geomorphological mapping. Approaches: field sampling, medium and high-resolution satellite data, GPS usage, and 3D mapping using medium and high-resolution DEMs, UAVs, and laser scanning. Case studies focusing on glacial geomorphological mapping in the Himalaya.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	2	3	2	2	2	2	2	**2.2**
CLO 2	3	3	2	3	2	2	2	2	2	**2.3**
CLO 3	2	2	2	3	2	2	2	2	2	**2.1**
PLO Avg	**2.7**	**2.3**	**2.0**	**3.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**–**

Suggested readings:

1. Chorley, R. J., Schumm, S. A., & Sugden, D. E. (2023). Geomorphology (2nd ed.). Routledge.
2. Kale, V. S. (Ed.). (2023). Landscapes and landforms of India. Springer.

3. Smith, M. J., & Pain, C. F. (2023). Applications of remote sensing in geomorphology. Elsevier.
4. Short, N. M. (1986). Geomorphology from space: a global overview of regional landforms. Workshop on the Earth as a Planet.

MGIFSMS225: Mapping from Space **(2 credits)**

Course Learning Outcomes (CLOs):

CLO1. To provide hands-on experience to students in acquiring, processing, and interpreting satellite imagery for thematic mapping using GIS and remote sensing tools.

CLO2. To develop the ability of students to identify, extract, and classify spatial features (such as roads, rivers, buildings, forests, etc.) from satellite data using digital image interpretation techniques.

CLO3. To foster teamwork, research communication, and spatial problem-solving through group-based assignments, presentations, and peer evaluation among students.

Unit I: Thematic Mapping using Satellite Data and GIS

Mapping of infrastructure (roads, buildings, urban extent), and natural resources (forests, water bodies, wetlands). Creation of attribute-linked vector layers from classified raster outputs. Planning and execution of ground-truth surveys using mobile GPS and field data sheets. Comparison of field data with map outputs for validation.

Unit II: Group assignment

Individual/group project on mapping: LULC, lake-wetland mapping, building footprint, glaciers using medium and high-resolution satellite data, including change detection analysis. Project planning: area selection, data sourcing, methodology design, and analysis. Preparation of maps, accuracy report, and brief project report (~10 pages). Group presentations.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	1	3	1	2	3	2	2	**2.1**
CLO 2	3	3	1	3	1	2	3	2	2	**2.2**
CLO 3	2	2	3	2	3	1	2	2	3	**2.2**
PLO Avg	**2.7**	**2.3**	**1.7**	**2.7**	**1.7**	**1.7**	**2.7**	**2.0**	**2.3**	

Suggested Readings:

1. Jensen, J. R. (2015). Introductory Digital Image Processing: A Remote Sensing Perspective (4th ed.). Pearson.
2. Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). Remote Sensing and Image Interpretation (7th ed.). Wiley.
3. Campbell, J. B., & Wynne, R. H. (2011). Introduction to Remote Sensing (5th ed.). Guilford Press.

Recommended Software:

QGIS, SNAP, Google Earth Pro, ArcGIS, Google Maps.

THIRD

SEMESTER

MGIFCAM325: Advanced GIS Data Analysis and Modelling (3+1=4 credits)

Course Learning Outcomes (CLOs):

CLO1. Utilize spatial models to make simulations and predictions of real-life phenomena.

CLO2. Evaluate and assess models in terms of accuracy, sensitivity, and uncertainty.

CLO3. Use a system-based approach for problem-solving.

Unit I: Modelling concepts

Modelling frameworks and approaches. Types and classification of models. Distributed and lumped models, empirical models, semi-empirical models, deduction and induction models. Hypothesis testing vs. exploratory data analysis, Raster-based modelling (Map algebra). Modelling in GIS: Agent-based modelling, Nexus approach.

Unit II: Model Evaluation

Framework for selecting the "best model" for any land surface process, Model conditions: initialization/boundary conditions. Model validation using various statistical approaches, calibration, and sensitivity analysis, Model uncertainty analysis, Data quality issues with observational data. Importance of observation networks to understand and predict land surface and climate processes.

Unit III: Modelling Approaches

Geospatial model input parameters for various land surface process models. Remotely sensed hydro-meteorological parameters and their uses in modelling. Downscaling and upscaling of geospatial data. Statistical approaches to representing natural variations.

Advanced GIS - Data Analysis and Modelling Lab (Practical/Tutorial: 1 credit)

- Upscaling and downscaling of geospatial data
- Floodplain and flood inundation mapping
- Landslide hazard zonation mapping in GIS
- Hands-on multi-criteria analysis
- Mini Project

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	3	2	3	2	3	3	3	3	**2.8**
CLO 2	3	3	2	3	2	3	3	2	3	**2.7**
CLO 3	3	2	2	3	2	3	3	3	3	**2.7**
PLO Avg	**3.0**	**2.7**	**2.0**	**3.0**	**2.0**	**3.0**	**3.0**	**2.7**	**3.0**	

Suggested readings:

1. Fotheringham, A. S., Brunsdon, C., & Charlton, M. (2000). Quantitative geography: perspectives on spatial data analysis. Sage.
2. Laurini, R., & Thompson, D. (1992). Fundamentals of spatial information systems. Academic Press.
3. Chou, Y. H. (1997). Exploring spatial analysis in geographic information systems. In Exploring Spatial Analysis in Geographic Information Systems. On WordPress.

MGIFCAG325: Artificial Intelligence for Geoinformatics **(3+1= 4 credits)**

Course Learning Outcomes (CLOs):

CLO1. To familiarize students with fundamental concepts and techniques of Artificial Intelligence in the context of geoinformatics.

CLO2. To provide students with exposure to key supervised machine learning algorithms suitable for geospatial applications.

CLO3. To equip students with practical experience of implementing Artificial Intelligence models on geospatial datasets

Unit I: Introduction to Machine learning

Overview of Artificial Intelligence, Machine learning, and Deep learning. Types of Machine Learning: Supervised, Unsupervised, and Reinforcement Learning. Role of machine learning in geospatial data analysis, classification, and prediction. Platforms: local and cloud-based. Basic Libraries.

Unit II: Data and Modelling Workflow

Geospatial data formats for machine learning: Raster and Vector as features and labels, Training and testing datasets; Data split ratios, Model hyperparameters, Manual model building and hyperparameter tuning, Model overfitting and underfitting. Evaluation metrics.

Unit III: Geospatial Machine Learning Algorithms

Regression-based models: univariate and multivariate regression models, Random Forest model (RF), Support Vector Machines (SVM). Ensemble Models: Gradient Boosting Machines, Extreme Gradient Boosting (XGboost), and Light Gradient Boosting Machine (LightGBM).

Practical-Geospatial Machine Learning **(Practical/Tutorial: 1 credit)**

- Hands-on experience with machine learning platforms
- Preprocessing and data preparation of geospatial data for machine learning applications
- Prediction of spatially varying phenomena using regression-based models, supervised and ensemble machine learning models
- Hands-on manual model building and hyperparameter tuning using grid search techniques to achieve optimal model performance.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	2	3	2	3	3	2	3	**2.6**
CLO 2	3	3	2	3	2	3	3	3	3	**2.8**
CLO 3	3	3	2	3	2	3	3	3	3	**2.8**
PLO Avg	**3.0**	**2.7**	**2.0**	**3.0**	**2.0**	**3.0**	**3.0**	**2.7**	**3.0**	

Suggested readings:

1. Kamusoko, C. (2024). Explainable machine learning for Geospatial data analysis: A data-centric approach. CRC Press.
2. Geron, A. (2022). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems. O'Reilly Media, Inc.
3. Wade, C., & Glynn, K. (2020). Hands-On Gradient Boosting with XGBoost and scikit-learn: Perform accessible machine learning and extreme gradient boosting with Python. Packt Publishing Ltd.
4. Shalev-Shwartz, S. & Ben-David, S. (2014). Understanding machine learning: From theory to algorithms. Cambridge University Press.

MGIFCGL325: Glaciology **(3+1=4 Credits)**

Course Learning Outcomes (CLOs):

CLO1. To introduce students to the fundamentals of glaciology and the glacial geomorphological processes.

CLO2. To develop an understanding of glacier dynamics through the use of field and remote sensing data.

CLO3. To explore the emerging scientific questions in glacier research in the Himalaya.

Unit I: Basics of Glaciology

Glaciers: formation, types, and facies. Glacier movement. Glacial erosional and depositional landforms. Glacial and interglacial periods, Last Glacial Maximum, Little Ice Age. Geochronology of glacial landforms. Dating techniques: radiocarbon dating, luminescence dating, lichenometry, dendrochronology.

Unit II: Remote Sensing of Cryosphere

Remote sensing of glaciers: frontal retreat, area changes, ELA, AAR, velocity, albedo. Snow: area, depth, density, water equivalent. Mass balance approaches: glaciological, hydrological, geodetic, AAR-based. Cryosphere-related hazards: GLOFs, Snow avalanches, etc.

Unit III: Himalayan Cryosphere

Snow and glacier resources of Jammu, Kashmir, and Ladakh. Climate change and glaciers. Light-absorbing impurities on glaciers: Black carbon, dust, microplastics. Cryoconite holes and their impact on glacier melt. Permafrost: definition, geomorphic signatures and hydrological significance.

Glaciology Lab **(Practical/Tutorial: 1 credit)**

- Safety measures for a glacier field expedition
- Delineation of glacial geomorphic features from satellite data
- Glacier inventory using medium and high-resolution satellite data
- AAR-based mass balance of Himalayan glaciers
- Geodetic mass balance using multi-source DEMs
- Mini Project

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	2	2	2	2	2	3	3	**2.3**
CLO 2	3	3	2	3	2	3	3	3	3	**2.8**
CLO 3	3	3	2	3	2	3	3	3	3	**2.8**
PLO Avg	**3.0**	**2.7**	**2.0**	**2.7**	**2.0**	**2.7**	**2.7**	**3.0**	**3.0**	

Suggested readings:

1. Benn, D. I. & Evans J. A. D. (1997). Glaciers and Glaciation. Woody's Books USA.
2. Bennett, M. R. & Glasser, N. F. (2000). Glacial Geology Ice Sheets and Landforms. Wiley Sharp,
3. Cuffey, K. M. & Paterson, W. S. B. (2010). The physics of glaciers. Academic Press.
4. Hubbard, B. & Glasser, N. F. (2005). Field Techniques in Glaciology and Glacial Geomorphology. Wiley.
5. Tedesco, M. (2015). Remote sensing and the cryosphere. Wiley.

MGIFCRP325: Research Project **(4 credits)**

Course Learning Outcomes (CLOs):

CLO1. To introduce students to the fundamentals of research methodology and the process of scholarly inquiry.

CLO2. To equip students with the skills to critically evaluate and synthesize existing scholarly literature through systematic review and meta-analysis.

CLO3. To develop the ability of students to conceptualize, plan, and execute an independent research project in geospatial science.

Students will be guided through the process of designing and initiating independent research under the supervision of a faculty member. Topics for dissertation research will be assigned in consultation with the supervisor, and each student will be required to submit and present a research synopsis within one month of topic allotment. The synopsis should clearly define the research problem, objectives, relevance, preliminary literature review, and methodology. This initial presentation will serve as a component of internal assessment and will help orient students toward the broader structure and expectations of academic research.

As part of the research process, students will also be required to conduct a meta-analysis or systematic review of the existing literature relevant to their research topic. This will enable them to critically evaluate trends, research gaps, and the broader context of their proposed work. A final review presentation, conducted at the end of the semester (as the Term-End Examination), will assess the progress of students, including their understanding of literature, methodology refinement, research progress/ field work, and clarity of research direction.

The synopsis, constituting the Internal Assessment, shall carry 28 marks and will be evaluated based on research idea, novelty, clarity in methodology, expected deliverables, presentation skills, viva-voce, and a one-page synopsis signed by the student and approved by the Supervisor. The Term-End Examination, assessed by a subject expert, shall carry 72 marks and will be evaluated on the significance of the proposed work, clarity of the methodological approach, extent of achievement of project objectives as outlined in the synopsis or results obtained, and viva-voce.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	3	2	3	2	2	2	2	3	**2.4**
CLO 2	3	3	3	3	2	2	2	2	3	**2.6**
CLO 3	3	3	3	3	3	3	3	2	3	**2.9**
PLO Avg	**3.0**	**3.0**	**2.7**	**3.0**	**2.3**	**2.3**	**2.3**	**2.0**	**3.0**	

MGIFDGS325: GNSS for Advanced Surveying **(1+1=2 credits)**

Course Learning Outcomes (CLOs):

CLO1. To make students understand the importance of field surveys and enable them to collect field data on various aspects of earth system using the survey instruments

CLO2. To acquire the skills of interpreting, synthesizing, and disseminating field data and other instrument data

CLO3. To make use of data from GPS and the field in a GIS environment.

Unit I: **Fundamentals of Surveying and GNSS**

Basic principles of surveying, types of surveys, techniques, procedure of field survey, data collection, error adjustments. Application of latest technology instruments, like laser scanners, echosounders, UAVs, time-lapse cameras, and spectroradiometer, for field data collection. GNSS: concept, types, and components. GNSS satellite constellations. Concept of DGPS, GPS accuracy, wave frequencies, and error corrections. GPS signal interferences, Applications of GPS in resources mapping, and crustal deformation.

Practical-Field Survey and GNSS **(Practical/Tutorial: 1 credit)**

- GPS handling and ground data collection.
- Measuring building heights through a laser range finder.
- DGPS survey of the University Campus.
- Spectral signatures of various land surface features using spectroradiometer
- Bathymetry data collection using echosounder and traditional methods.
- Mini Project

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	2	2	2	3	2	3	3	2	2	**2.3**
CLO 2	2	3	3	3	2	3	2	2	2	**2.4**
CLO 3	2	2	2	3	2	3	3	2	2	**2.3**
PLO Avg	**2.0**	**2.3**	**2.3**	**3.0**	**2.0**	**3.0**	**2.7**	**2.0**	**2.0**	

Suggested Readings:

1. Gebre-Egziabher, D., & Gleason, S. (2009). GNSS applications and methods. Artech House.
2. Leick, A., Rapoport, L., & Tatarnikov, D. (2015). GPS satellite surveying (4th ed.). John Wiley & Sons.
3. Lo, C. P., & Yeung, A. K. (2016). Concepts and Techniques of Geographic Information Systems. Pearson Education.
4. Ogaja, C. A. (2024). An Introduction to GNSS Geodesy and Applications. Springer Nature.

MGIFDHI325: Hydroinformatics **(2 credits)**

Course Learning Outcomes (CLOs):

CLO 1. Help students analyze the components of the hydrological cycle by applying geostatistical methods to solve water balance problems for gauged and ungauged watersheds.

CLO 2. Build the capacity of students to evaluate the potential of geoinformatics for assessing and mapping water resources.

CLO 3. To help students develop site-specific strategies or plans for water resource management using Geoinformatics.

Unit I: Geoinformatics for Surface and Ground Water

Hydrological cycle. Water balance and its components, Hydrology of ungauged watersheds. Hydrometeorology: stream flow, temperature, precipitation, and evapotranspiration measurements from instruments and remote sensing; Statistical methods for the analysis of stream flow, temperature, precipitation, and other time series data. Role of satellite remote sensing products for quantifying meteorological variables. Cal-Val of satellite meteorological products. Groundwater potential mapping using remote sensing and GIS.

Unit II: Geoinformatics for Watershed Management

Watershed concept and types. Watershed characterization and hydrological modelling. Concept of runoff and overland flow. Watershed characteristics affecting hydrological processes. DEM applications in hydrology. Geoinformatics for watershed management and prioritization

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	3	3	2	2	2	2	1	2	**2.2**
CLO 2	2	3	2	3	3	2	2	1	2	**2.2**
CLO 3	2	2	2	3	3	2	3	2	2	**2.3**
PLO Avg	**2.3**	**2.7**	**2.3**	**2.7**	**2.7**	**2.0**	**2.3**	**1.3**	**2.0**	**–**

Suggested readings:

1. Barnhart, T. B., Hutton, C. J., Tucker, G. E., & Idaszak, R. (2016). GIS and geocomputation for water resource science and engineering. John Wiley & Sons.

2. Black, P. E. (1996). Watershed hydrology (2nd ed.). CRC Press.
3. Cazenave, A., Champollion, N., Benveniste, J., & Chen, J. (Eds.). (2016). Remote sensing and water resources. Springer International Publishing.
4. Gehner, M. (2019). GIS applications in water resources management. CRC Press.
5. Haan, C. T. (2002). Statistical methods in hydrology (2nd ed.). Iowa State Press.
6. Karunanidhi, D., Aravinthasamy, P., Subramani, T., & Srinivasamoorthy, K. (2021). Groundwater assessment, modeling, and management. CRC Press.
7. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). Remote sensing and image interpretation (7th ed.). John Wiley & Sons.
8. Maidment, D. R. (Ed.). (2017). Handbook of applied hydrology (2nd ed.). McGraw-Hill Education.

MGIFSFW325: Fieldwork **(2 credits)**

Course Learning Outcomes (CLOs):

CLO1. To train students in generating and interpreting geospatial datasets using multi-source remote sensing in the lab.

CLO2. To expose students to diverse physical and cultural landscapes through fieldwork in Jammu & Kashmir or Ladakh, while developing skills in field data collection, ground validation, and real-world geoinformatics applications.

Unit I: Laboratory-Based Geospatial Data Generation

Generation of thematic maps pertaining to various application projects as per national mapping standards (NNRMS). Preparation of geospatial datasets, including maps for field validation/ accuracy assessment.

Unit II: Field Data Collection and Validation

Field visit to selected locations in Jammu & Kashmir or Ladakh. Understanding the physical geography, climate zones, vegetation, and cultural features. Hands-on training in the use of GPS, mobile mapping apps, and field data collection techniques. Validation of lab-generated maps through field observation and sample collection. Participatory/team involvement in fieldwork for contextual analysis. Post-field correction of datasets, report preparation, and presentation.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	3	2	3	2	3	3	2	2	**2.6**
CLO 2	3	3	3	3	3	3	3	3	3	**3.0**
PLO Avg	**3.0**	**3.0**	**2.5**	**3.0**	**2.5**	**3.0**	**3.0**	**2.5**	**2.5**	

FOURTH

SEMESTER

MGIFCDH425: DISASTER, RISK, AND HAZARD ASSESSMENT (3+1=4 credits)

Course Learning Outcomes (CLOs):

CLO1. To train students about the application of geoinformatics for disaster assessment.

CLO2. To help students evaluate the application of optical and microwave remote sensing for near-real-time disaster assessment and post-disaster damage analysis.

CLO3. To develop and devise logistic action plans for the post-disaster with the help of GIS analysis.

Unit I: Introduction to Disasters

IPCC concept of hazard, disaster, exposure, vulnerability, and risk. Disaster vulnerability of J&K State, Preparedness, and mitigation measures for various disasters. Disaster management with respect to earthquakes, floods, and landslides. Natural disasters (earthquakes, floods, landslides, GLOF & LLOF, avalanches, glacier detachments). Disaster vulnerability assessment and vulnerability in a GIS environment.

Unit II: Remote Sensing for Disaster Assessment

Satellite remote sensing for disaster assessment. Near-real-time disaster analysis and management. Identification of flood-prone areas using remote sensing and other ancillary data. Post-disaster analysis of inundated areas, earthquake-hit areas, and post-flood crop loss estimation, etc. Forest fire identification and zonation using remote sensing data. Potential of optical and microwave satellite remote sensing for near-real-time disaster assessment.

Unit III: Geoinformatics for Disaster Assessment

Geoinformatics for assessment of floods, cyclones, GLOFs/ LLOFs, avalanches. Land use planning and its importance for disaster resilience. A typical community-based early warning system for disasters in the Himalaya. GIS for risk assessment. Recent trends in geoinformatics for disaster management. Seismic microzonation using geological, geophysical, and socioeconomic data.

Disaster, Risk, and Hazard Assessment Lab (Practical/Tutorial: 1 credit)

- Infrastructure mapping and earthquake damage using before and after event images.
- Flood inundation mapping and impact assessment

- Landslide mapping along Srinagar-Jammu National highway
- GLOF risk assessment of a small catchment.
- Mini Project: Multi-hazard vulnerability mapping of a district

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	3	2	2	2	1	2	1	2	**2.0**
CLO 2	3	3	2	3	3	1	2	1	2	**2.2**
CLO 3	2	3	2	2	2	2	3	2	2	**2.2**
PLO Avg	**2.7**	**3.0**	**2.0**	**2.3**	**2.3**	**1.3**	**2.3**	**1.3**	**2.0**	

Suggested readings:

1. Intergovernmental Panel on Climate Change. (2012). Managing the risks of extreme events and disasters to advance climate change adaptation: Special report of the Intergovernmental Panel on Climate Change [Field, C.B., et al. (eds.)]. Cambridge University Press.
2. Keller, E. A., DeVecchio, D. E., & Clague, J. J. (2019). Natural hazards: Earth's processes as hazards, disasters, and catastrophes (5th ed.). Routledge.
3. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). Remote sensing and image interpretation (7th ed.). John Wiley & Sons.
4. Miles, S. B. (Ed.). (2019). GIS for emergency management. CRC Press.
5. United Nations Human Settlements Programme. (2021). Land use planning for disaster risk reduction and climate resilience: A guide for practitioners. UN-Habitat.
6. Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). At risk: Natural hazards, people's vulnerability and disasters (2nd ed.). Routledge.

MGIFCGP425: GEOMATICS FOR URBAN AND REGIONAL PLANNING (3+1=4 credits)

Course Learning Outcomes (CLOs):

CLO1. Build the capacity of students to evaluate the principles of urban planning and the impacts of urbanization through documented case studies.

CLO2. Train students to apply remote sensing techniques to map urban land use, sprawl, ecological zones, and the Urban Heat Island effect.

CLO3. Help students to synthesize geospatial data to create urban thematic maps for socio-economic evaluation and planning.

Unit I: Introduction to Urban Planning

Principles of urban area development and land use planning. Importance of urban and regional planning. Urbanization trends in India with special reference to Jammu and Srinagar cities. Impact of urbanization on different natural resources of Jammu and Kashmir with reference to some case studies. Master plans of Jammu and Srinagar cities. Concept of Smart Cities and the role of geoinformatics in mapping cities.

Unit II: Remote Sensing for Urban Planning

Urban area identification and interpretation using high and moderate resolution remote sensing data. NNRMS standards for urban LULC mapping. Mapping urban land use and urban sprawl with remotely sensed data. Ecozonation of ecologically fragile landscapes with special reference to tourist development authorities in J&K. Urban facility mapping. Urban land evaluation and suitability analysis. Concept of Urban Heat Island (UHI) and Surface Urban Heat Island (SUHI). Application of satellite LST products in UHI and SUHI assessments.

Unit III: Socio-economic GIS

Census operation in India, census data and field observations, demographic and social patterns, socio-economic and residential area evaluation. Remote sensing for population studies and slum delineation. Traffic and parking survey with high spatial resolution satellite data. Role of Geoinformatics in Transportation Planning. Geoinformatics for land information systems.

Geomatics for Urban and Regional Planning Lab (Practical/Tutorial: 1 credit)

- Urban LULC mapping using high-resolution satellite data.

- Mapping the building typologies of any ward in Srinagar city.
- Mapping the green cover of any ward in Srinagar city.
- LST assessment of Srinagar city using various satellite data.
- Socioeconomic data visualization in a GIS environment.
- Comparing the building footprint as delineated manually with Google/ Microsoft building data.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	2	3	3	2	2	1	2	**2.2**
CLO 2	3	3	2	3	3	1	2	1	2	**2.2**
CLO 3	2	3	2	2	3	2	3	2	2	**2.3**
PLO Avg	**2.7**	**2.7**	**2.0**	**2.7**	**3.0**	**1.7**	**2.3**	**1.3**	**2.0**	**–**

Suggested readings:

1. American Planning Association. (2006). Planning and urban design standards. John Wiley & Sons.
2. Bhatta, B. (2010). Analysis of urban growth and sprawl from remote sensing data. Springer.
3. Jensen, J. R. (2015). Remote sensing of the environment: An earth resource perspective (2nd ed.). Pearson.
4. O'Sullivan, D., & Unwin, D. J. (2010). Geographic information analysis (2nd ed.). John Wiley & Sons.
5. Weng, Q. (2012). Remote sensing of impervious surfaces. CRC Press.

MGIFCRN425: REMOTE SENSING OF NATURAL RESOURCES (3+1=4 credits)

Course Learning Outcomes (CLOs):

CLO1. To acquaint the students with the applications and use of Geoinformatics for Natural Resource Conservation and Management

CLO2. To impart knowledge about the GIS analytical capabilities to solve environmental problems.

CLO3. To equip the students with the know-how about integrated environmental analysis using Geoinformatics

Unit I: Natural Resource Management

Natural resources: Introduction and classification. Major natural resources of the Himalaya with special reference to J&K. Wetlands: Concepts, Ramsar Convention, socio-economic and environmental importance, mapping, inventorying, and management of wetlands at global and regional scales. United Nations Sustainable Development Goals and their relevance to Himalaya.

Unit II: Remote Sensing of Natural Resources

Remote sensing-based inventory and monitoring of major natural resources of Jammu and Kashmir forests and cryosphere. Forest resources inventory and management using high- and moderate-resolution satellite data. Vegetation mapping. Above-ground forest biomass estimation using conventional field surveys, proximal remote sensing, and satellite data. Snow depletion curves, SWE, glacier area and frontal changes, glacier mass balance, and permafrost distribution using satellite remote sensing.

Unit III: GIS for Natural Resource Assessment

GIS for modelling land surface processes, particularly erosion and hydrological processes. Potential and limitations of topographic data in modelling earth surface processes in a GIS environment. Role of geoinformatics for management of wildlife reserves, wildlife habitat suitability analysis of hangul, black bear, and leopard in Jammu and Kashmir.

Remote Sensing of Natural Resources Lab (Practical/Tutorial: 1 credit)

- Forest cover, crown, and density mapping using high-resolution satellite data.
- Input datasets and modelling criteria for wildlife suitability assessment.

- Snow-depletion curves using MODIS satellite data
- Mini project: Decadal land system changes within any Ramsar-designated wetland

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	3	2	3	2	2	2	2	**2.3**
CLO 2	2	3	2	3	3	2	2	2	2	**2.3**
CLO 3	2	2	2	3	3	3	2	2	2	**2.3**
PLO Avg	**2.3**	**2.3**	**2.3**	**2.7**	**3.0**	**2.3**	**2.0**	**2.0**	**2.0**	**–**

Suggested readings:

1. Chaturvedi, A. (2021). Natural resource management in the Himalayas: A geoinformatic approach. Routledge.
2. Maltby, E., & Barker, T. (Eds.). (2009). The wetlands handbook (2 vols.). Wiley-Blackwell.
3. United Nations. (2015). Transforming our world: The 2030 Agenda for Sustainable Development. United Nations Department of Economic and Social Affairs.
4. Rees, W. G. (2020). Physical principles of remote sensing (3rd ed.). Cambridge University Press.
5. Thenkabail, P. S. (Ed.). (2015). Remote sensing handbook (Vol. 1-3). CRC Press.
6. Bonham-Carter, G. F. (2014). Geographic information systems for geoscientists: Modelling with GIS (Vol. 13). Elsevier.
7. DeMers, M. N. (2009). Fundamentals of geographic information systems (4th ed.). Wiley.

MGIFCRC425: Research Synthesis and Scholarly Communication (3+1=4 credits)

Course Learning Outcomes (CLOs):

CLO1. Train students to formulate and execute systematic, reproducible search strategies across major scholarly databases to map the research landscape and synthesize literature.

CLO2. Build the capacity of students to use bibliometric tools and understand the principles of meta-analysis to visualize research trends, identify knowledge gaps, and analyze literature.

CLO3. Help students evaluate publishing scenarios based on a robust understanding of academic ethics, copyright licensing, and best practices in open science and data sharing.

Unit I: The Architecture of Literature Review

From Question to Query: Framing research questions using PICO/PICO(S) frameworks. Principles of search strategy development. Theoretical understanding of indexing and unique features of major databases (Google Scholar, WoS, Scopus). Key metrics (h-index, Impact Factor, Altmetrics). Principles of the PRISMA statement and the rationale for meta-analysis.

Unit II: Ethics and Dissemination in the Digital Age

Core Tenets of Research Integrity: COPE (Committee on Publication Ethics) guidelines. Theoretical exploration of authorship, plagiarism, data manipulation, and conflict of interest through case studies. Models of publishing (Subscription, Open Access, Hybrid). Intellectual Property and Licensing: Understanding the legal permissions and restrictions of different CC licenses (BY, SA, NC, ND). Open Science Theory: The FAIR Guiding Principles (Findable, Accessible, Interoperable, Reusable) as a theoretical framework for research data management.

Unit III: Applied Bibliometrics and Synthesis

Data Handling and Preprocessing Theory: Understanding the common issues in bibliographic metadata and the principles of cleaning and standardizing data for analysis. Science Mapping Theory: Deeper theoretical understanding of the algorithms behind network creation and visualization in tools like VOSviewer. Meta-Analysis Methodology: Theoretical foundation of effect sizes, confidence intervals, heterogeneity tests (I^2 statistic), & model selection (fixed vs random).

Applied Tools and Project Execution Lab **(Practical/Tutorial: 1 credit)**

- Using Zotero for reference management.
- Using Mendeley for reference management.
- Exporting records from WoS/Scopus and cleaning data using OpenRefine.
- Hands-on creation of bibliometric networks using VOSviewer.
- Research Portfolio. Students will integrate their learning into a final project based on their research interest. This includes developing a systematic review protocol with a replicable search strategy, executing the search and producing a VOSviewer map with interpretation, and creating a Data Management Plan (DMP) that applies FAIR principles and CCL.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	2	3	2	2	2	2	2	2	3	**2.2**
CLO 2	2	3	2	2	2	2	2	2	3	**2.2**
CLO 3	2	2	3	2	2	2	2	2	3	**2.2**
PLO Avg	**2.0**	**2.7**	**2.3**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**3.0**	**–**

Suggested readings:

1. Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of Informetrics, 11, 959-975.
2. Booth, A., Sutton, A., & Papaioannou, D. (2016). Systematic approaches to a successful literature review (2nd ed.). SAGE Publications.
3. Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2021). Introduction to meta-analysis (2nd ed.). John Wiley & Sons.
4. Committee on Publication Ethics (COPE). (n.d.). Core practices. Retrieved from https://publicationethics.org/core-practices
5. Creative Commons. (n.d.). About CC licenses. Retrieved from https://creativecommons.org/licenses/
6. The Cochrane Collaboration. (2022). Review Manager (RevMan) [Computer software]. Available from https://training.cochrane.org/online-learning/core-software/revman
7. van Eck, N. J., & Waltman, L. (2017). Citation-based clustering of publications using CitNetExplorer and VOSviewer. Scientometrics, 111, 1053–1070.
8. VOSviewer [Computer software]. (n.d.). Available from https://www.vosviewer.com/

MGIFDDP425: RECENT ADVANCEMENTS IN DIGITAL IMAGE PROCESSING (2 credits)

Course Learning Outcomes (CLOs):

CLO1. Enable students to evaluate the theoretical principles of advanced digital image processing techniques, including image fusion and deep learning architectures.

CLO2. Help students to implement advanced image processing workflows for specific tasks like super-resolution, land cover classification, and object detection.

CLO3. Build the capacity of students to design sensing solutions for complex real-world problems in urban planning, disaster management, and environmental monitoring.

Unit I: Digital Image Processing

Image fusion and resolution merge. Basic pattern recognition concepts, boundary detection and representation, textural and contextual analysis. Deep Learning for Pixel-Level Classification: Using Convolutional Neural Networks (CNNs) like U-Net, ResNet, and PSPNet for land cover/land use classification. Image Segmentation: graph-based methods and contour detection models. Generative Adversarial Networks (GANs) for creating high-resolution imagery from lower-resolution data.

Unit III: Remote sensing Applications

3D City Modeling and Digital Twins: Automatically generating textured 3D models of cities from aerial imagery and LiDAR for urban planning and simulation. Disaster Response: Near-real-time automated damage assessment from pre- and post-event satellite imagery using change detection and CNN models. Automated Individual Tree Crown (ITC) Delineation: instance segmentation models (e.g., Mask R-CNN) to very high-resolution satellite (WorldView) and drone-based imagery.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	3	2	2	2	2	3	2	2	**2.3**
CLO 2	3	3	2	3	2	2	3	2	2	**2.4**
CLO 3	3	3	2	3	2	2	3	3	2	**2.6**
PLO Avg	**3.0**	**3.0**	**2.0**	**2.7**	**2.0**	**2.0**	**3.0**	**2.3**	**2.0**	**–**

Suggested readings:

1. Richards, J. A. (2022). Remote sensing digital image analysis: An introduction (6th ed.). Springer.
2. Szeliski, R. (2022). Computer vision: Algorithms and applications (2nd ed.). Springer.
3. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT Press. http://www.deeplearningbook.org
4. Zhang, C., & Atkinson, P. M. (2021). Image processing and GIS for remote sensing: Techniques and applications (2nd ed.). Wiley-Blackwell.
5. Vosselman, G., & Maas, H. (2023). Airborne and terrestrial laser scanning (2nd ed.). Whittles Publishing.
6. Maltamo, M., Næsset, E., & Vauhkonen, J. (2023). Forestry applications of airborne laser scanning: Concepts and case studies. Springer.

MGIFDCH425: CRYOSPHERE-RELATED HAZARDS **(2 credits)**

Course Learning Outcomes (CLOs):

CLO1. Help students differentiate between the geomorphic, climatic, and seismic triggering mechanisms of cryospheric hazards.

CLO2. Build the capacity of students to evaluate the structural and non-structural mitigation strategies and early warning systems used for cryospheric hazard risk reduction.

CLO3. Make students analyze the cascading sequence of events that lead from a primary cryospheric instability to secondary hazards.

Unit I: Glacier-Related Hazards

Glacial lake outburst floods (GLOFs) and landslide-dammed lake outburst floods (LLOFs). Triggering mechanisms: geomorphic, climatic, and seismic. Structural and non-structural mitigation measures as per NDMA / GAPHAZ guidelines. Components of effective early warning systems for risk reduction. Uncertainties associated with hydrodynamic model simulations.

Unit II: Snow and Permafrost-Related Hazards

Permafrost degradation-induced slope failures, including catastrophic rock-ice avalanches and large-scale glacier detachments. Secondary hazards: debris flows and mudflows. Case studies: Chamoli rock-ice avalanche, Birch Glacier collapse, and Blatten landslide in the Swiss Alps.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	3	2	2	2	2	2	2	2	**2.2**
CLO 2	2	3	2	3	3	2	2	3	3	**2.6**
CLO 3	3	3	2	3	3	2	2	2	3	**2.6**
PLO Avg	**2.7**	**3.0**	**2.0**	**2.7**	**2.7**	**2.0**	**2.0**	**2.3**	**2.7**	**–**

Suggested readings:

1. Haeberli, W., & Whiteman, C. (Eds.). (2021). Snow and ice-related hazards, risks, and disasters (2nd ed.). Elsevier.
2. Huggel, C., Carey, M., Clague, J. J., & Kääb, A. (Eds.). (2022). The high-mountain cryosphere: Environmental changes and human risks. Cambridge University Press.
3. National Disaster Management Authority (NDMA). (2020). Guidelines for management of glacial lake outburst floods (GLOFs). Government of India.
4. Shroder, J. F., Haeberli, W., & Whiteman, C. (Eds.). (2023). Past glacial environments (2nd ed.). Elsevier.

MGIFSSG425: HEALTH AND SOCIOECONOMIC GIS **(2 credits)**

Course Learning Outcomes (CLOs):

CLO1. Differentiate between the geographic methods and spatial data models used to analyze public health patterns and socioeconomic characteristics.

CLO2. Apply GIS techniques to map and analyze health outcomes, healthcare accessibility, and socioeconomic disparities.

CLO3. Evaluate the limitations and ethical considerations of using spatial data for analyzing health and socioeconomic phenomena.

UNIT I: Health GIS and Geography

Geographic Foundations of Public Health. Spatial Data Models and Management for Health Data. Mapping Health Outcomes: Rates, Risks, and Spatial Smoothing. Spatial Patterns of Infectious Disease Diffusion. Analyzing Accessibility to Healthcare Services. Limitations and Biases in Spatial Health Data

UNIT II: Geoinformatics and Socioeconomics

Foundations of Socioeconomic Data and Census Attributes. Spatial Sampling Methods for Socioeconomic Data Collection. Remote Sensing for Detection of Informal Settlements and Poverty. Spatial Analysis of Socioeconomic Disparities and Inequality. Geodemographic Segmentation and Classification. Modelling Social Vulnerability and Access to Resources

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	2	2	2	2	2	2	2	2	**2.1**
CLO 2	3	3	2	3	3	2	2	3	3	**2.7**
CLO 3	2	3	2	2	2	3	3	2	3	**2.4**
PLO Avg	**2.7**	**2.7**	**2.0**	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**2.7**	**–**

Suggested readings:

1. Cromley, E. K., & McLafferty, S. L. (2011). GIS and public health (2nd ed.). Guilford Press.
2. Lo, C. P., & Yeung, A. K. W. (2006). Concepts and techniques of geographic information systems (3rd ed.). Pearson Prentice Hall.

3. Lawson, A. B. (2018). Bayesian disease mapping: Hierarchical modeling in spatial epidemiology (3rd ed.). CRC Press.
4. Waller, L. A., & Gotway, C. A. (2004). Applied spatial statistics for public health data. John Wiley & Sons.
5. Lloyd, C. D. (2010). Spatial data analysis: An introduction for GIS users. Oxford University Press.
6. World Bank Living Standards Measurement Study (LSMS) Guides. Available from: https://www.worldbank.org/en/programs/lsms

MGIFCRC425: Research Synthesis and Scholarly Communication (3+1=4 credits)

Course Learning Outcomes (CLOs):

CLO1. Train students to formulate and execute systematic, reproducible search strategies across major scholarly databases to map the research landscape and synthesize literature.

CLO2. Build the capacity of students to use bibliometric tools and understand the principles of meta-analysis to visualize research trends, identify knowledge gaps, and analyze literature.

CLO3. Help students evaluate publishing scenarios based on a robust understanding of academic ethics, copyright licensing, and best practices in open science and data sharing.

Unit I: The Architecture of Literature Review

From Question to Query: Framing research questions using PICO/PICO(S) frameworks. Principles of search strategy development. Theoretical understanding of indexing and unique features of major databases (Google Scholar, WoS, Scopus). Key metrics (h-index, Impact Factor, Altmetrics). Principles of the PRISMA statement and the rationale for meta-analysis.

Unit II: Ethics and Dissemination in the Digital Age

Core Tenets of Research Integrity: COPE (Committee on Publication Ethics) guidelines. Theoretical exploration of authorship, plagiarism, data manipulation, and conflict of interest through case studies. Models of publishing (Subscription, Open Access, Hybrid). Intellectual Property and Licensing: Understanding the legal permissions and restrictions of different CC licenses (BY, SA, NC, ND). Open Science Theory: The FAIR Guiding Principles (Findable, Accessible, Interoperable, Reusable) as a theoretical framework for research data management.

Unit III: Applied Bibliometrics and Synthesis

Data Handling and Preprocessing Theory: Understanding the common issues in bibliographic metadata and the principles of cleaning and standardizing data for analysis. Science Mapping Theory: Deeper theoretical understanding of the algorithms behind network creation and visualization in tools like VOSviewer. Meta-Analysis Methodology: Theoretical foundation of effect sizes, confidence intervals, heterogeneity tests (I^2 statistic), & model selection (fixed vs random).

Applied Tools and Project Execution Lab (Practical/Tutorial: 1 credit)

- Using Zotero for reference management.
- Using Mendeley for reference management.
- Exporting records from WoS/Scopus and cleaning data using OpenRefine.
- Hands-on creation of bibliometric networks using VOSviewer.
- Research Portfolio. Students will integrate their learning into a final project based on their research interest. This includes developing a systematic review protocol with a replicable search strategy, executing the search and producing a VOSviewer map with interpretation, and creating a Data Management Plan (DMP) that applies FAIR principles and CCL.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	2	3	2	2	2	2	2	2	3	**2.2**
CLO 2	2	3	2	2	2	2	2	2	3	**2.2**
CLO 3	2	2	3	2	2	2	2	2	3	**2.2**
PLO Avg	**2.0**	**2.7**	**2.3**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**3.0**	**–**

Suggested readings:

9. Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of Informetrics, 11, 959-975.
10. Booth, A., Sutton, A., & Papaioannou, D. (2016). Systematic approaches to a successful literature review (2nd ed.). SAGE Publications.
11. Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2021). Introduction to meta-analysis (2nd ed.). John Wiley & Sons.
12. Committee on Publication Ethics (COPE). (n.d.). Core practices. Retrieved from https://publicationethics.org/core-practices
13. Creative Commons. (n.d.). About CC licenses. Retrieved from https://creativecommons.org/licenses/
14. The Cochrane Collaboration. (2022). Review Manager (RevMan) [Computer software]. Available from https://training.cochrane.org/online-learning/core-software/revman
15. van Eck, N. J., & Waltman, L. (2017). Citation-based clustering of publications using CitNetExplorer and VOSviewer. Scientometrics, 111, 1053–1070.

VOSviewer [Computer software]. (n.d.). Available from https://www.vosviewer.com/

MGIFCDI425: Dissertation (16 Credits)

Course Learning Outcomes (CLOs):

CLO1. To enable students to independently apply geospatial techniques to solve real-world problems across a range of thematic areas.

CLO2. To consolidate theoretical knowledge and practical skills acquired during coursework through focused research.

CLO3. To develop scientific research skills, including literature review, data collection, analysis, interpretation, and presentation.

CLO4. To foster academic writing, critical thinking, and the ability to communicate research findings effectively.

As part of the final semester curriculum, students are required to undertake an independent dissertation project under the guidance of a faculty supervisor. The dissertation must involve the application of geospatial techniques to address real-world challenges. Students may choose research themes related to land use/land cover mapping, cartography, geomorphology, hydrology, agriculture, urban and regional planning, and geospatial database development. The primary objective is to provide students with an opportunity to apply the theoretical knowledge and practical skills they have acquired during the course in a focused and independent research setting.

The dissertation process includes formulation of a research problem, review of relevant literature, selection of appropriate datasets, methodology design, data analysis, validation, and presentation of results. This hands-on experience is designed to build competencies in scientific research, critical thinking, spatial data analysis, and technical writing. Students are also expected to present their findings in a well-structured report and defend their work during a viva voce.

Assessment for the course is divided into two components. The internal assessment, conducted by the assigned supervisor, will be based on the punctuality of the student, progress, quality of work, and overall engagement during the project period. The term-end assessment will be carried out by a subject expert and will include evaluation of the final dissertation report and a formal presentation/viva. This course acts as a capstone to the academic program and is intended to prepare students for higher research, industry roles, or professional positions requiring advanced geospatial expertise.

The dissertation paper shall carry an Internal Assessment of 112 marks, comprising 30 marks for attendance and 82 marks for a mid-semester progress presentation before the Internal Evaluation Committee, duly constituted by the Head of the Department. In comparison, the External Assessment by a subject expert shall carry 288 marks, including 100 marks for data analysis based on the proposed synopsis, 75 marks for presentation skills, 75 marks for viva-voce, and 38 marks for the dissertation write-up.

CLO-PLO mapping matrix (Strength version)

PLOs / CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	CLO Avg
CLO 1	3	3	2	3	2	3	3	3	3	**2.8**
CLO 2	3	3	2	3	2	3	3	3	3	**2.8**
CLO 3	3	3	3	3	2	3	3	3	3	**2.9**
CLO 4	3	3	3	3	3	2	2	3	3	**2.8**
PLO Avg	**3.0**	**3.0**	**2.5**	**3.0**	**2.3**	**2.8**	**2.8**	**3.0**	**3.0**	