Description of “Advanced Geospatial Analysis in GIS”

Information				
Administering Department		**Remote Sensing**	**College**	**Remote Sensing & Geophysics College**
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Module Leader’s Acad. Title		**Professor**		
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Module Aims, Learning Outcomes and Indicative Contents	
Module Aims أ	1. Mastery of Geospatial Data Management - Objective: Students will demonstrate proficiency in managing and manipulating various types of geospatial data, including vector and raster formats. - Key Skills: - Understanding data structures and formats. - Applying methods for data acquisition, cleaning, and preparation for analysis. 2. Application of Advanced Analytical Techniques - Objective: Students will apply advanced spatial analysis techniques to solve complex geospatial problems. - Key Skills: - Utilizing geoprocessing tools and techniques (e.g., overlay analysis, network analysis). - Implementing statistical methods and machine learning algorithms to analyze spatial data. 3. Integration of Multidisciplinary Approaches - Objective: Students will integrate knowledge from various disciplines to address multifaceted spatial issues. - Key Skills:

	- Collaborating on projects that require interdisciplinary approaches, such as environmental science, urban planning, and public health. - Conducting assessments that consider social, economic, and ecological factors. 4. Development of Critical Thinking and Problem-Solving Skills - Objective: Students will develop critical thinking skills necessary for evaluating spatial data and methodologies. - Key Skills: - Analyzing the validity and reliability of data sources. - Formulating research questions and hypotheses based on spatial patterns and trends. 5. Proficiency in Visualization and Communication - Objective: Students will effectively communicate their findings through appropriate visualizations and presentations. - Key Skills: - Creating maps, graphs, and other visual aids to represent spatial data. - Presenting results using appropriate terminology and engaging storytelling techniques. 6. Ethical Considerations in Geospatial Analysis - Objective: Students will understand the ethical implications of geospatial data usage. - Key Skills: - Discussing issues related to privacy, data ownership, and the societal impacts of geospatial technologies. - Evaluating the ethical dimensions of their analyses and recommendations.
Module Learning Outcomes	Learning Outcomes for Advanced Geospatial Analysis 1. Knowledge and Understanding Outcome: Students will demonstrate a comprehensive understanding of advanced geospatial concepts and methodologies. Key Areas: Theoretical principles of Geographic Information Systems (GIS) and remote sensing. Understanding of spatial data structures, types, and sources. Familiarity with current trends and technologies in geospatial analysis, including LiDAR data processing.

	2. Technical Proficiency Outcome: Students will acquire proficiency in using industry-standard geospatial tools and software. Key Skills: Effective use of GIS software (e.g., ArcGIS, QGIS) for data manipulation and analysis. Application of geoprocessing tools to perform complex spatial analyses. Ability to integrate machine learning techniques into GIS workflows for enhanced data analysis. 3. Analytical Skills Outcome: Students will develop advanced analytical skills to solve complex geospatial problems. Key Skills: Conducting spatial regression analyses and interpreting results. Performing change detection and trend analysis using time-series data. Utilizing statistical methods to evaluate hypotheses related to spatial phenomena. 4. Project Development and Management Outcome: Students will demonstrate the ability to formulate, execute, and manage geospatial projects effectively. Key Skills: Designing research questions and methodologies tailored to specific geospatial issues. Collaborating in teams to develop comprehensive project proposals that include objectives, methodologies, and expected outcomes. Managing project timelines and deliverables while adhering to ethical standards in research. 5. Communication and Presentation Outcome: Students will effectively communicate their findings through various formats. Key Skills: Presenting complex geospatial analyses clearly through visualizations such as maps, graphs, and reports. Writing technical reports that articulate methodologies, results, and implications of analyses. Engaging in discussions about their work and the work of peers critically and

	constructively. 6. Ethical Considerations Outcome: Students will understand the ethical implications of geospatial data usage. Key Skills: Identifying potential ethical issues related to privacy, data ownership, and the societal impacts of geospatial technologies. Formulating personal research ethics positions based on case studies and discussions. 7. Lifelong Learning Outcome: Students will cultivate a mindset geared towards continuous learning in the field of geospatial analysis. Key Areas: Staying updated with emerging technologies and methodologies in geospatial science. Developing skills for troubleshooting and seeking solutions independently within geospatial software environments.

Advanced Geospatial Analysis in GIS Syllabus	
Week 1	**Advanced Data Management** • Data types and structures (vector vs. raster) • Data acquisition and preprocessing techniques
Week 2	**Spatial Analysis Techniques** • Introduction to spatial statistics • Advanced attribute queries and spatial joins
Week 3	**Geoprocessing Tools** • Using geoprocessing tools for data analysis • Implementing models with multiple geoprocessing steps
Week 4	**Design-Based Sampling**: This traditional approach assumes that the population values are fixed but unknown. It includes methods like simple random sampling, stratified sampling, and cluster sampling.

	Model-Based Sampling: In contrast, this method treats the observed values as realizations of a stochastic process. It often employs statistical models to estimate parameters and optimize sample locations based on covariance structures
Week 5	**Interpolation Methods** • **Linear Interpolation**: Estimating values between two known points using linear polynomials. • **Polynomial Interpolation**: Constructing a polynomial that passes through a set of points. • **Lagrange Interpolation**: A method that uses Lagrange polynomials for interpolation. • **Newton's Divided Differences**: Building polynomials incrementally using divided differences.
Week 6	**Advanced Interpolation Techniques** • **Spline Interpolation**: Using piecewise polynomials (cubic splines) for smooth curve fitting. • **Hermite Interpolation**: A method that also considers the derivatives at the data points. • **Bilinear and Biquadratic Interpolation**: Techniques for two-dimensional data. • **Shape-Preservation Methods**: Ensuring the interpolated curve maintains the shape of the data.
Week 7	**Geostatistical Methods** • **Kriging**: A method based on statistical models that takes spatial correlation into account. • **Inverse Distance Weighting (IDW)**: A technique that weights nearby points more heavily than distant ones.
Week 8	**Geomorphometry** • Definition and significance of geomorphometry in understanding landforms. • Historical development and key concepts in geomorphometry. • Remote sensing techniques for terrain analysis. • Digital Elevation Models (DEMs): creation, sources, and applications. • GIS tools for spatial analysis and visualization.

Week 9	**Quantitative Analysis of Landforms** • Measurement of landform attributes: slope, aspect, curvature, and elevation. • Statistical methods for analyzing terrain features. • Use of fractals and other mathematical models in geomorphometry.
Week 10	**Terrain Analysis Techniques** • Terrain classification systems and their applications. • Hydrological modeling: watershed delineation and flow accumulation. • Geomorphometric indices for characterizing landforms (e.g., relief ratio, hypsometric curve).
Week 11	**Geospatial Technology and Intelligence Tradecraft**: • The course explores how geographic information science and technology integrate with intelligence analysis to support decision-making in various sectors, including national security and emergency management.
Week 12	**Applications of GEOINT**: • Discussion on how geospatial intelligence contributes to solving real-world problems, particularly in areas like law enforcement, disaster response, and international relief efforts.
Week 13	**Project Proposal Development** • Guidelines for developing a final project proposal • Workshop on project proposal writing
Week 14	**Project Presentations**
Week 15	**Pre-final exam**

Learning and Teaching Resources

	Text	Available in the Library?
Required Texts	Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools (7th Edition) by Michael J. de Smith, Michael F. Goodchild, and Paul A. Longley (2024)	No
Recommended Texts	Spatial Data Science by John P. Wilson (2024)	No
Websites	https://www.youtube.com/channel/UCOOUW1LA5B93j5V0oNVYN6Q	