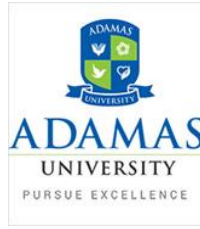


ADAMAS UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
Department of Geography
B.Sc. (Geoinformatics) Programme
(2025-26)



**ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY**

VISION OF THE UNIVERSITY

To be an internationally recognized university through excellence in inter-disciplinary education, research and innovation, preparing socially responsible well-grounded individuals contributing to nation building.

MISSION STATEMENTS OF THE UNIVERSITY

M.S 01: Improve employability through futuristic curriculum and progressive pedagogy with cutting-edge technology

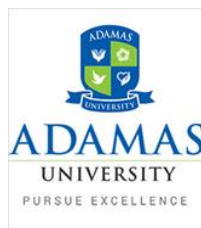
M.S 02: Foster outcomes-based education system for continuous improvement in education, research and all allied activities

M.S 03: Instill the notion of lifelong learning through culture of research and innovation

M.S 04: Collaborate with industries, research centers and professional bodies to stay relevant and up-to-date

M.S 05: Inculcate ethical principles and develop understanding of environmental and social realities

CHANCELLOR / VICE CHANCELLOR



**ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY**

VISION OF THE SCHOOL

To be recognized globally as a provider of education in Basic and Applied Sciences, fundamental and interdisciplinary research.

MISSION STATEMENTS OF THE SCHOOL

M.S 01: Develop solutions for the challenges in sciences through value-based science education.

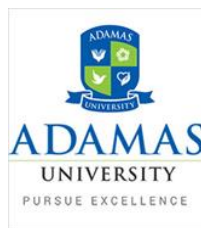
M.S 02: Conduct research leading to innovation in sciences.

M.S 03: Nurture students into scientifically competent professionals in the usage of modern tools.

M.S 04: Foster in students, a spirit of inquiry and collaboration to make them ready for careers in teaching, research and corporate world.

HOD, Geography

DEAN (SoBAS)



**ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY**

VISION OF THE DEPARTMENT

To achieve excellence for imparting quality higher education and skills in Geography that can serve to the society adopting the changing versatility of job and research opportunities

MISSION STATEMENTS OF THE DEPARTMENT

M.S 01: Create highly qualified and employable geographers by imparting quality education and research aptitude

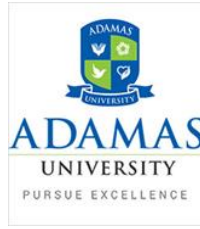
M.S 02: Enhance the skills of geoinformatics and data analysis along with encourage for entrepreneurship, innovativeness, self-learning in an interdisciplinary domain

M.S 03: To foster professional ethics and responsibilities for the organization, society and environment

M.S 04: To promote collaborations with industries, research institutes and experts for transmitting up-to-date knowledge, training, research skills and connection with the world

HOD, Geography

DEAN (SoBAS)



**ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY**

Name of the Programme: B.Sc.(Geoinformatics)

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 01: Develop robust analytical and problem-solving skills to address complex spatial and environmental challenges using geoinformatics principles and methods.

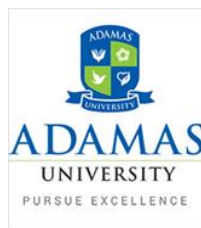
PEO 02: Enhance professional competence by leveraging advanced geospatial technologies—including GIS, remote sensing, and spatial data analytics—to innovate in diverse sectors.

PEO 03: Foster strong communication, teamwork, and leadership qualities, coupled with high ethical standards, enabling effective collaboration and responsible geospatial practice.

PEO 04: Embrace a culture of continuous learning and research, remaining open to emerging ideas, tools, and techniques that advance the geoinformatics field and contribute to lifelong personal and professional growth.

HOD, Geography

DEAN (SoBAS)



ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY

Name of the Programme: B.Sc. (Geoinformatics)

GRADUATE ATTRIBUTE / PROGRAMME OUTCOME (PO)

GA 01 / PO 01: Foundational Geospatial Knowledge: Develop a sound understanding of the fundamental concepts and principles in geoinformatics, including Remote Sensing, Geographic Information System (GIS), Surveying Techniques, Photogrammetry, Cartography, and Coding.

GA 02 / PO 02: Data Acquisition and Management: Acquire the ability to collect, process, and organize spatial and non-spatial data from various sources (e.g., field surveys, imageries, existing databases) while ensuring data quality and integrity.

GA 03 / PO 03: Analytical & Problem-Solving Skills: Gain proficiency in using spatial analysis methods, geostatistics, and modelling techniques to address contemporary real-world problems in fields such as natural resource management, urban planning, and environmental monitoring.

GA 04 / PO 04: Visualization & Cartographic Techniques: Develop advanced skills in visualizing geographic information through cartographic design, thematic mapping, and interactive data visualization platforms, ensuring effective communication of spatial patterns and trends.

GA 05 / PO 05: Technological Competency: Demonstrate the ability to use, customize, and integrate modern geoinformatics tools (software, programming libraries, cloud-based services) for efficient data processing, analysis, and geospatial application development.

GA 06 / PO 06: Research Skills: Cultivate research aptitude by designing and executing geoinformatics-based projects, engaging in critical review of literature, adopting ethical research practices, and preparing high-quality technical reports.

GA 07 / PO 07: Societal Implication and Interdisciplinary Integration: Analysis and scrutinize the nature and socio-economic based reports in quantitative and qualitative way. Recognize and apply geoinformatics principles across diverse disciplines—such as environmental science, disaster management, public health, and resource planning—to foster multi-sector collaboration and solutions.

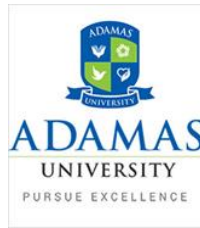
GA 08 / PO 08: Environment & Sustainability: Leverage geospatial insights to promote sustainable development and resource conservation, evaluating environmental impacts and advocating responsible stewardship of ecosystems.

GA 09 / PO 09: Communication & Leadership: Enhance oral, written, and visual communication skills to present geospatial findings effectively; demonstrate teamwork, leadership, and interpersonal skills in multidisciplinary project settings.

GA 10 / PO 10: Ethical & Professional Practices: Adhere to ethical guidelines and standards in geospatial data handling, respect privacy and data security concerns, and commit to lifelong learning to stay abreast of emerging geoinformatics technologies and professional responsibilities.

HOD, Geography

DEAN (SoBAS)



**ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY**

Name of the Programme: B.Sc.(Geoinformatics)

PROGRAMME SPECIFIC OUTCOME (PSO)

PSO 01: Demonstrate a strong foundational understanding of geospatial concepts, theories, and principles, emphasizing the critical role of location-based analysis in addressing environmental and societal challenges.

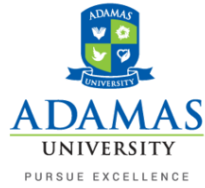
PSO 02: Acquire proficiency in leveraging Earth Observation Data (EOD), GIS, and remote sensing techniques to monitor, model, and manage spatial phenomena, ensuring effective resource and environmental stewardship.

PSO 03: Develop the ability to collect, interpret, and integrate various geospatial datasets (raster, vector, and attribute data) to create high-quality maps, reports, and visualizations that support analytical decision-making.

PSO 04: Exhibit competence in designing and implementing geoinformatics-based solutions, utilizing advanced spatial analytics and data science methods for problem-solving and informed decision support across diverse sectors.

HOD, Geography

DEAN (SoBAS)



ADAMAS UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY

Programme Name:

B.Sc. GEOINFORMATICS

Programme Code: GEO3410

Syllabus 2025-26

(Course Structure modified as per the Board of Studies meeting held on 19th March 2025)

SCHOOL OF BASIC AND APPLIED SCIENCES								
UNDERGRADUATE COURSE STRUCTURE								
B.Sc. (GEOINFORMATICS): BATCH 2025-2029								
SEMESTER I								
Sl. No.	Type of Course	Code	Title of the Course	Credit				Remarks
				L	T	P	C	
1	CC	GEO151	Basic Remote Sensing	3	0	1	4	CC-1
2	CC	GEO152	Basic Geographic Information System	3	0	1	4	CC-2
3	MDC	GEO105	Physical Geography	2	0	1	3	
4	AEC		Choose one from a pool of AEC courses				3	
5	Minor		Choose one from a pool of Minor courses				4	
6	VAC		Choose one from a pool of VAC courses				2	
							Semester Credits: 20	
SEMESTER II								
7	CC	GEO153	Advanced Remote Sensing	2	0	2	4	CC-3
8	CC	GEO154	Cartographic Techniques and Thematic Mapping	1	0	3	4	CC-4
9	MDC	GEO106	Human Geography	2	0	1	3	
10	AEC		Choose one from a pool of AEC courses				3	
11	SEC		Choose one from a pool of SEC courses				2	
12	Minor		Choose one from a pool of Minor courses				4	
13	VAC		Choose one from a pool of VAC courses				2	
							Semester Credits	22
SEMESTER III								
14	CC	GEO251	Advanced Geographic Information System	2	0	2	4	CC-5
15	CC	GEO252	Surveying Techniques in Geoinformatics	1	0	3	4	CC-6
16	MDC	GEO107	Disaster Management	2	0	1	3	
17	AEC		Choose one from a pool of AEC courses				2	
18	SEC		Choose one from a pool of SEC courses				2	
19	Minor		Choose one from a pool of Minor courses				4	
20	VAC		Choose one from a pool of VAC courses				2	
							Semester Credits	21
SEMESTER IV								
21	CC	GEO253	Digital Image Processing	2	0	2	4	CC-7
22	CC	GEO254	Basics of Programming	1	0	3	4	CC-8
23	CC	GEO255	Basic Mathematics and Statistics in Geoinformatics	3	0	1	4	CC-9
24	SEC		Choose one from a pool of SEC courses				2	
25	Minor		Choose one from a pool of Minor courses				4	
26	VAC		Choose one from a pool of VAC courses				2	
							Semester Credits	20
SEMESTER V								
27	CC	GEO351	Photogrammetry	2	0	2	4	CC-10
28	CC	GEO352	Python for Geospatial Analysis	1	0	3	4	CC-11
29	CC	GEO353	Geo-statistics	1	0	3	4	CC-12
30	SEC		Choose one from a pool of SEC courses				2	
31	Minor		Choose one from a pool of Minor courses				4	
32	INT	GEO354	Internship				4	
							Semester Credits	22
SEMESTER VI								
33	CC	GEO355	Web GIS and Google Earth Engine	1	0	3	4	CC-13
34	CC	GEO356	Open-Source GIS	1	0	3	4	CC-14
35	CC	GEO357	Database Management Systems	1	0	3	4	CC-15
36	SEC		Choose one from a pool of SEC courses				2	
37	Minor		Choose one from a pool of Minor courses				4	
38	Project	GEO358	Field Project	0	0	4	4	
							Semester Credits	22
Total Credits of the Program after 3rd Year				127				
SEMESTER VII								
39	CC	GEO451	Spatial Data Science with R	1	0	3	4	CC-16

40	CC	GEO452	Introduction to Artificial Intelligence and Machine Learning in Geoinformatics	1	0	3	4	CC-17
41	CC	GEO453	Research Methodology	2	0	2	4	CC-18
42	CC (with research)	GEO454	Term paper leading to Dissertation	0	0	4	4	CC-19 (With Research)
43	CC (without research)	GEO405	Startup Skill Development	3	0	1	4	CC-19 (Without Research)
44	Minor		Choose one from a pool of Minor courses				4	
Semester Credit								20
Semester VIII								
45	CC	GEO456	Business Communication	4	0	0	4	CC-20
46	CC (without research)	GEO457	Spatial Data Science with MATLAB	1	0	3	4	CC-21 (Without Research)
47	CC (without Research)	GEO458	Spatial Data Science with AUTOCAD	1	0	3	4	CC-22 (Without Research)
48	Minor		Choose one from a pool of Minor courses				4	
49	Minor (without research)		Choose one from a pool of Minor courses				4	
50	Dissertation (with research)	GEO459	Dissertation and Comprehensive viva	0	0	12	12	
Semester Credit								20
Total Credits of the Program after 4th Year				167				

SEMESTER I

Title of the Course: Basic Remote Sensing

Code: GEO151

L-T-P-C: 3-0-1-4

Course Objectives

1. To understand the fundamental principles of remote sensing and electromagnetic radiation, including active and passive energy sources, atmospheric windows, and spectral signatures.
2. To learn about various remote sensing platforms and sensors (terrestrial, airborne, and spaceborne), their orbital characteristics, and the implications of different swath and FOV parameters.
3. To develop proficiency in interpreting remote sensing data by comparing maps, photographs, and images, and applying visual image interpretation elements such as color, tone, texture, and pattern.
4. To gain hands-on experience in creating true and false color composites, identifying key features, and preparing analog land use/land cover maps in a structured lab environment.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Define** the fundamental concepts of remote sensing, including its definition, components, and types of energy sources.

CO2. **Explain** the principles of electromagnetic radiation (EMR), spectral reflectance, atmospheric interactions, and spectral signatures of earth surface features.

CO3. **Apply** knowledge of satellite orbits, sensor types, and remote sensing platforms to analyse spatial data acquisition processes.

CO4. **Analyse** visual image interpretation elements, such as tone, texture, shadow, shape, and pattern, to differentiate geographic features in remote sensing data.

CO5. **Evaluate** the advantages and limitations of remote sensing techniques, comparing maps, aerial photographs, and satellite images for spatial analysis.

CO6. **Create** land use and land cover maps using true and false colour composite images, interpretation keys, and analog mapping techniques.

Catalogue Description

This course introduces the fundamental concepts of remote sensing and electromagnetic radiation, highlighting the principles behind active and passive sensing, atmospheric interactions, and spectral reflectance patterns. Participants will explore various satellite orbits, including polar, sun-synchronous, and geosynchronous, while examining concepts such as swath, FOV, IFOV, and sensor types (push broom and whisk broom). Through guided demonstrations, learners will compare maps, photographs, and images, applying visual image interpretation elements—color, tone, texture, shape, size, pattern, and association—to accurately identify surface features. The hands-on laboratory segment focuses on generating true and false color composites, interpreting boundary information, and creating analog land use and land cover maps. Students will maintain a comprehensive laboratory notebook documenting exercises and reflections.

By the end of the course, learners will gain a solid foundation in remote sensing principles and the practical skills necessary for basic image analysis and interpretation.

Course Content

Unit 1: Concept of Remote Sensing and Electro Magnetic Radiation

Definition and Components of Remote Sensing; Energy Sources and Remote Sensing – Active and Passive; Theories of Electro Magnetic Radiation (EMR); Energy Interaction with the Atmosphere and Earth Surface Features; Atmospheric Windows; Spectral Reflectance and Response Patterns; Spectral Signature; Advantages and Limitations of Remote Sensing.

Unit II: Platform and Sensors

Concept and Types of Satellite Orbits – Polar, Sun-synchronous and Geosynchronous; Orbital Period; Concept of Swath, FOV, and IFOV; Types of Satellites; Remote Sensing Platforms – Terrestrial, Airborne, and Spaceborne; Sensor Types – Push broom and Whisk broom

Unit III: Remote Sensing Data Interpretation

Comparison between Maps, Photographs, and Images; Concept of Visual Image Interpretation; Elements of Visual Image Interpretation – Colour, Tone, Texture, Shadow, Shape, Size, Pattern, and Association.

Unit IV: Basic Remote Sensing Lab

True and False Colour Composite Images; Interpretation Keys for Standard False Colour Composites; Boundary Information of Satellite Images and Aerial Photographs; Feature Identification and Preparation of Analog Land Use and Land Cover Maps.

Unit V: Laboratory Notebook

A Laboratory Notebook consisting of the Lab Exercises mentioned above.

Recommended Readings:

1. Bhatta, B. (2008) Remote Sensing and GIS, Oxford University Press, New Delhi.
2. Campbell J. B., 2007: Introduction to Remote Sensing, Guildford Press
3. Joseph, G. 2005: Fundamentals of Remote Sensing, United Press India.
4. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: Remote Sensing and Image Interpretation, Wiley. (Wiley Student Edition).
5. Mukherjee, S. (2004) Textbook of Environmental Remote Sensing, Macmillan, Delhi.

CO-PO-PSO Correlation Matrix

CO/PO- PSO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
CO1	2	1	1	0	1	0	1	0	1	0	2	0	1	0
CO2	2	2	1	0	1	2	2	1	0	0	2	2	2	1
CO3	0	1	2	0	2	1	0	1	1	0	2	1	1	1
CO4	1	1	2	3	1	2	1	2	0	1	1	2	1	2
CO5	0	1	2	2	1	2	0	1	2	0	1	1	2	1
CO6	1	2	1	0	2	2	2	1	0	1	2	2	1	1

Title of the Course: Basic Geographic Information System

Code: GEO152

L-T-P-C: 3-0-1-4

Course Objectives

1. To learn the fundamental concepts of Geographic Information Systems (GIS), including its components, data formats, and coordinate systems.
2. To develop skills in creating, organizing, and representing spatial data through vector databases, thematic mapping, and digital cartography.
3. To know about Global Navigation Satellite Systems (GNSS) such as GPS, GALILEO, GLONASS, and GAGAN, and understand their applications for positioning.
4. To explore spatial analysis techniques—overlay operations, map algebra, and grid-based analyses—and apply them in practical GIS lab exercises.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Define** the fundamental concepts and terminologies of GIS, including basic data formats, components of GNSS, and different spatial reference systems.

CO2. **Explain** the structure and function of vector data (point, line, polygon), geodatabases, and the importance of coordinate systems and map composition in thematic mapping.

CO3. **Apply** GIS tools to create and manage spatial data, perform essential measurement tasks, and carry out vector-based operations such as overlay and attribute queries.

CO4. **Distinguish** between various spatial analysis techniques (local, focal, zonal, and global) and assess their applicability to different geospatial problems.

CO5. **Evaluate** the accuracy, usefulness, and limitations of different Global Navigation Satellite Systems (GPS, GALILEO, GLONASS, GAGAN) for diverse real-world applications.

CO6. **Combine** GNSS data and GIS layers to design comprehensive map layouts and thematic maps, documenting the steps and findings in a structured laboratory notebook.

Catalogue Description

This course introduces the essential principles of Geographic Information Systems (GIS), focusing on both theoretical and practical aspects of spatial data handling. Students will explore the components of GIS, data formats, coordinate systems, geodatabase design, and digital cartography. Emphasis will be on vector data structures (points, lines, polygons), spatial referencing, and fundamentals of thematic mapping. The curriculum also covers an overview of Global Navigation Satellite Systems (GNSS), including GPS, GALILEO, GLONASS, and GAGAN, along with their applications. Learners will examine various spatial analysis techniques ranging from basic overlay operations to map algebra and grid-based analyses such as local, focal, and zonal. In the hands-on lab, students will create geodatabases, edit vectors, perform measurements, work with diverse reference systems, conduct attribute queries, and design thematic maps.

Through practical exercises and field-based data collection, students will develop foundational GIS skills for a variety of real-world scenarios.

Course Content

Unit 1: Introduction to Geographic Information System

Components of GIS; GIS Data Formats; Vector Data Structure – Spatial and Non-Spatial Data; Concept of Geodatabase; Spatial Referencing and Coordinate Systems; Digital Cartography and Thematic Mapping: Map Composition and Representation.

Unit II: Introduction to GNSS and GPS

Introduction to Earth's Positioning System; Types and Segments of Global Navigation Satellite Systems: GPS, GALILEO, GLONASS and GAGAN; Applications of GNSS.

Unit III: Spatial Data Analysis

Overview of Tools for Spatial Analysis – Vector Based: Overlay Operations, Single Layer Operations and Multilayer Operation - weighted overlay; Map Algebra and Grid Based Operations: Local, Focal, Zonal, and Global Analyses.

Unit IV: Basic GIS Lab

Creation of Vector Database – Point, Line, and Polygon; Creation of Geodatabase; Measurement Tools, Changing Reference Systems; Spatial and Attribute Data Query; Vector Overlay; Thematic Mapping – Map Composition and Representation; Generation of Map Layouts

Unit V: Laboratory Notebook

A Laboratory Notebook consisting of the Lab Exercises mentioned above.

Recommended Readings:

1. Bhatta, B. (2008) Remote Sensing and GIS, Oxford University Press, New Delhi.
2. Chang, K-T., 2019: Introduction to Geographic Information Systems, McGraw Hill
3. Burrough, P. A., McDonnell, R. A. and Lloyd, C. D., 2015: Principles of Geographical Information Systems, Oxford University Press.
4. de Smith, M. J., Goodchild, M. F., Longley, P. A., 2018: Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools, Matador.
5. Yue-hong Chou (1997). Exploring Spatial Analysis in Geographical Information System, Onword Press, Thomson Learning.

CO-PO-PSO Correlation Matrix

CO/PO- PSO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
CO1	1	0	0	0	3	1	2	0	2	1	0	0	2	1
CO2	1	1	0	1	2	1	3	2	2	1	1	0	1	1
CO3	1	2	1	1	2	1	2	3	2	1	1	2	0	1
CO4	0	1	2	1	2	2	2	3	2	2	1	1	1	0
CO5	1	2	1	0	2	2	1	1	3	1	1	3	1	2
CO6	2	3	1	0	1	1	1	2	2	2	0	2	3	1

Title of the Course: Physical Geography

Code: GEO105

L-T-P-C: 2-0-1-3

Course Objectives

1. To understand the fundamental processes of geotectonics and geomorphology, including Earth's interior structure, plate tectonics, landform development, and river network formation.
2. To explore hydrological and oceanographic systems, analyzing groundwater movement, aquifer formations, ocean floor structures, and factors influencing coral reef development.
3. To analyze atmospheric processes and climatic patterns, including heat budget, temperature distribution, monsoon mechanisms, precipitation processes, and global climate change.
4. To develop skills in geological and climatic data interpretation, including rock and mineral identification, geological cross-sections, and synoptic weather map analysis for understanding environmental patterns.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Define** the fundamental concepts of geotectonics, including Earth's interior structure, seismic waves, plate tectonics, and landforms shaped by different geological processes.

CO2. **Explain** hydrological and oceanographic processes, such as groundwater movement, aquifer formation, surface runoff, and ocean floor configurations, including coral reef development.

CO3. **Apply** the principles of climatology to analyze atmospheric composition, heat budget, temperature distribution, monsoon mechanisms, and the impact of tropical cyclones on weather patterns.

CO4. **Analyze** soil formation processes, soil structure, pH, and ecosystem dynamics, including biomes and environmental interactions influencing biodiversity and land use.

CO5. **Assess** geological maps, rock and mineral specimens, and weather data to interpret geological structures, climatic variations, and physical environmental conditions.

CO6. **Construct** cross-sections of geological formations, interpret synoptic weather charts, and construct climographs for understanding spatial and temporal patterns in physical geography.

Catalogue Description

This course provides a comprehensive understanding of Earth's physical processes, including geotectonics, geomorphology, hydrology, oceanography, climatology, and biogeography. Students will explore the Earth's interior structure, plate tectonics, and landform development influenced by endogenic and exogenic forces. The course covers hydrological processes, groundwater movement, ocean floor structures, and climatic systems, including atmospheric circulation, monsoon mechanisms, and extreme weather events.

Additionally, students will study soil formation, ecosystem dynamics, and environmental interactions shaping landscapes. Practical sessions include rock and mineral identification, geological and weather map analysis, and interpretation of landforms using real-world datasets.

The course integrates lectures, discussions, visual presentations, and hands-on exercises to enhance critical thinking and practical problem-solving skills. Through tutorials and lab activities, students will gain a deeper understanding of Earth's dynamic systems, equipping them with essential skills in physical geography and environmental analysis.

Course Content

Unit I: Fundamentals of Geotectonics and Geomorphology:

Structure of the Earth-Interior; Discontinuity and Seismic Waves; Endogenic and Exogenic Processes; Folds and Faults — Origin and Types; Continental Drift; Sea Floor Spreading; Plate Tectonic Theory; Rock Types and Landforms Developed on Igneous, Metamorphic, and Sedimentary Rocks; Development of River Network on Folded, Faulted, Uniclinal, and Domal Structures; Weathering and Mass Wasting; Erosion; Landforms – Fluvial, Glacial, Aeolian, and Coastal.

Unit II: Introduction to Hydrology and Oceanography:

Definition, Scope, and Content of Hydrology; Global Hydrological Cycle; Sub-Surface Zonation of Ground Water; Types of Aquifers and their formations; Controlling Factors of the Movement of the Ground Water; Surface Runoff; Configuration of the ocean floor, continental shelf, continental slope, abyssal plain, mid-oceanic and oceanic trenches; Coral reefs and atolls: types and factors.

Unit III: Basic Climatology:

Nature, Composition, and Layered Structure of the Atmosphere; Insolation and Heat Budget; Horizontal and Vertical Distribution of Temperature; Temperature Inversion; Global Pressure Belts and General Circulation of Wind; Jet Stream and Index Cycle; Indian Monsoon Mechanism; Processes and Forms of Condensation, and Forms of Precipitation- Ice Crystal Theory, Collision-Coalescence Theory; Tropical Cyclone; Climatic Classification after Koppen; Ozone Depletion and Global Warming.

Unit IV: Fundamentals of Soil and Biogeography:

Factors and Processes of Soil Formation; Soil Profile; Plant-Water-Soil Relationship; Soil Structure, Texture, and pH; Soil Classification; Soil Erosion and Conservation; Concept of Ecology and Environment; Components of Environment; Habitat and Niche; Types of Ecosystems; Concept and Types of Biomes.

Unit V: Physical Geography Lab

Identification of Rocks in hand specimen – Granite, Basalt, Sandstone, Shale, Laterite, Limestone, Gneiss, Quartzite, and Marble; Identification of Minerals in Hand Specimen – Quartz, Feldspar, Gypsum, Calcite, Talc, Chalcopyrite, Bauxite, Galena.

Study of Geological Maps – Strike, Dip, Bedding Plane, Drawing Cross-Sections on Uniclinal and Folded Structure; Succession of Beds and Thickness Identification.

Study of Weather Maps - Pre-monsoon, Monsoon, and Post Monsoon; Season, Representation, and Analysis of Climatic Data with the help of a Synoptic Chart, Climograph.

Recommended Readings:

1. Husain, M. 2010, Fundamentals of Physical Geography, Second Edition, Rawat Publications, Jaipur and New Delhi.
2. Siddartha K. 2018, Earth Dynamic Surface (Transworld Media & Communications – Publication – Patna,
3. Strahler, A.N. and Strahler, A.H. 1984, Elements of Physical Geography, John Wiley, New York.
4. Selby, M.J., 2005, Earth's Changing Surface, Indian Edition, OUP
5. Singh Savindra (2019), Physical Geography, Prayag Pustak Bhawan, Allahabad.
6. Bloom, A.L. 1992, Geomorphology- Systematic Analysis of Late Cenozoic Landforms, Prentice Hall India, New Delhi.

7. Singh Savindra 2019, Geomorphology, Prayag Pustak Bhawan, Allahabad
8. Thornbury, W.D. 1969. Principles of Geomorphology, 2nd ed, Wiley-India / CBS.
9. Chorley, R.J., Schumm, S. A. and Sugden, D.E. 1984: Geomorphology, Methuen, London
10. Dayal, P. 1996: Textbook of Geomorphology, Shukla Book Depot, Patna.
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12. Selby, M. J. 1991: Earth's Changing Surface, Clarendon Press, London
13. Small, R.J. 1978: The Study of Landforms, Cambridge University Press, Cambridge
14. Sparks, B.W. 1960: Geomorphology, Longman, London.
15. Goudie, A.S. (Ed) 2004. Encyclopaedia of Geomorphology, vol. 1 & 2, Routledge.
16. Billings, M.P. 1971. Structural Geology, Pearson.
17. Frisch, W., Meschede, M., Blakey, R.C. 2011. Plate Tectonics: Continental Drift and Mountain Building. Springer.
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19. Rahgunath, H.M. 1997: Hydrology- Principles, analysis, Design, New Age International Pvt. Ltd, New Delhi
20. Singh, Vijay P. 1995: Environmental Hydrology. Kluwer Academic Publications, The Netherlands.
21. Subramanya, K. and Sharma, P.J. 2024: Engineering Hydrology, McGraw Hill
22. Chow, V.T., Maidment, D.R., and Mays L.W. 1988: Applied Hydrology, McGraw-Hill, Inc.
23. Sharma, R.C. and Vatal, M. 1980: Oceanography for Geographers, Chaitanya Publishing House, Allahabad.
24. Garrison T. 1998: Oceanography, Wordsworth Company, Belmont.
25. Sverdrup, K.A. and Armbrust, E.V. 2008: An Introduction to the World Ocean, McGraw Hill, Boston.
26. Barry, R.G. and Chorley, R.J. 2009: Atmosphere, Weather and Climate, ELBS, Methuen & Co. Ltd. London
27. Critchfield, H.J. 2011: General Climatology 4th Edition, Pearson India, New Delhi.
28. Lal, D.S. 2011: Climatology, Chaitanya Publishing House, Allahabad
29. Savindra Singh 2006: Climatology, Prayag Pustak Bhawan, Allahabad
30. Siddhartha, K. 2018: Climatology: Atmosphere Weather Climate, Kitab Mahal, New Delhi
31. Trewartha, G.T. 1968: Introduction to Climate McGraw Hill, New York.
32. Sahai, V.N. 2016: Fundamentals of Soil, Kalyani Publishers.
33. Biswas, T.D. and Mukherjee, S.K. 2017: Textbook of Soil Science, McGraw Hill Education.
34. Sehgal, J. 2015: A Textbook of Pedology: Concepts and Applications, Kalyani Publishers.
35. Savindra Singh 2015: Environmental Geography, Pravalika Publications.
36. Dash, M.C. and Dash, S.P. 2009: Fundamentals of Ecology, McGraw Hill Education.
37. Sharma, P.D. 2011: Ecology and Environment; Rastogi Publications.

CO-PO-PSO Correlation Matrix

CO/PO- PSO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
CO1	3	1	1	1	1	0	1	0	0	0	3	1	2	1
CO2	3	1	1	1	1	0	1	0	0	0	3	1	2	1
CO3	3	1	2	2	2	1	1	0	2	1	3	2	3	2
CO4	2	1	1	2	2	1	1	0	1	1	2	1	2	2
CO5	2	1	1	2	2	1	1	0	0	0	2	1	2	2
CO6	1	0	1	2	2	2	1	0	0	0	2	1	2	2

SEMESTER II

Title of the Course: Advanced Remote Sensing

Code: GEO153

L-T-P-C: 2-0-2-4

Course Objectives

1. To learn the fundamental principles of advanced remote sensing, focusing on thermal radiation, microwave scattering, hyperspectral imaging, and LiDAR scanning.
2. To develop skills in processing and interpreting specialized datasets (e.g., thermal emissivity, radar backscatter, hyperspectral bands) for diverse applications.
3. To understand the operational aspects and limitations of various sensors—thermal, microwave, hyperspectral, and LiDAR—including their data correction and calibration procedures.
4. To apply advanced analytical techniques—such as atmospheric correction, spectral unmixing, and terrain modeling—to generate meaningful outputs (e.g., NDVI, brightness temperature maps, digital surface models) and document findings in a structured laboratory notebook.

Course Outcomes

On completion of this course, the students will be able to

CO1. Define the terms thermal, microwave, hyperspectral, and LiDAR remote sensing.

CO2. Illustrate the concepts of thermal, microwave, hyperspectral, and LiDAR remote sensing.

CO3. Apply the various functions of thermal, microwave, hyperspectral, and LiDAR remote sensing.

CO4. Examine the utility of thermal, microwave, hyperspectral, and LiDAR remote sensing.

CO5. Evaluate application of thermal, microwave, hyperspectral, and LiDAR remote sensing in coal fire mapping, urban heat island studies, biomass estimation, object height determination.

CO6. Construct thermal, backscatter, classified images and digital surface models.

Catalogue Description

This course delves into advanced concepts of remote sensing, focusing on next-level image acquisition, processing, and analytical techniques. Students will explore cutting-edge sensor technology such as SAR, LiDAR, and hyperspectral imaging, while examining advanced pre-processing methods like atmospheric correction, orthorectification, and radiometric calibration. The course emphasizes integrated data analysis, covering object-based image classification, machine learning approaches, and multi-sensor fusion for extracting detailed insights from complex datasets. Through hands-on laboratory exercises, learners will gain practical experience using specialized software to address real-world case studies in environmental monitoring, urban planning, and resource management. Emphasis will be placed on accuracy assessment and interpretation, as well as on managing large volumes of geospatial data. By applying these advanced techniques, students will refine their remote sensing skillset, culminating in collaborative projects and field-based assignments. A comprehensive laboratory notebook will document all exercises, reinforcing best practices in data handling and analysis throughout the course.

Course Content

Unit 1: Thermal Remote Sensing

Thermal Radiation Principles – Radiant Energy, Radiant Flux, Irradiance, Spectral Radiant Exitance, Radiant Intensity, Spectral Radiance, Kinetic Heat, Kinetic Temperature; Blackbody Radiation Laws; Thermal Atmospheric Windows; Emissivity; Thermal Properties of Terrain; Characteristics of Thermal Sensors; Applications of Thermal Remote Sensing.

Unit II: Microwave Remote Sensing

Advantages and Limitations of Microwave Remote Sensing; Active and Passive Microwave Sensors; Wavelength, Frequency, and Pulse Length; Geometric Characteristics of SLAR Images – Azimuth and Range Direction, Depression and Incident angles; Range and Azimuth Resolution; Radar Polarization; Relief Displacement – Foreshortening, Layover, Shadow, and Speckle; Concept of Synthetic Aperture Radar; Applications of Microwave Remote Sensing.

Unit III: Hyperspectral Remote Sensing

Imaging spectrometry and hyperspectral cube; Spectral end member and spectral libraries; Atmospheric correction of hyperspectral images; n-dimensional visualization; Spectral Angle Mapper Classification; Minimum Noise Fraction; Pixel Purity Index; Spectral Feature Filtering; Spectral Unmixing; Hyperspectral Sensors; Applications of Hyperspectral Remote Sensing.

Unit IV: LiDAR Remote Sensing

Basic Components and Physical Principles of LiDAR Scanning System; Airborne and Spaceborne Laser Profilers; Advantages and Limitations of Airborne Laser Scanning; Digital Surface Models; LiDAR Accuracy; Applications of LiDAR Remote Sensing.

Unit V: Advanced Remote Sensing Lab

Calculation of NDVI Images and Generation of the Radiance Images, Brightness Temperature and Land Surface Temperature Maps; Intensity and Phase; Thermal Noise and Border Noise Correction of Microwave Images; Calibration and Co-registration; Terrain Correction and Back-Scatter Image Generation; Bad Band Removal and Atmospheric Correction of Hyperspectral Images; Classification of Hyperspectral Images.

Unit VI: Laboratory Notebook

A Laboratory Notebook consisting of the Lab Exercises mentioned above.

Recommended Readings:

1. Jensen, J. R., 2013: Remote Sensing of the Environment, Pearson.
2. Tang, H. and Li, Z-L., 2014: Quantitative Remote Sensing in Thermal Infrared – Theory and Applications, Springer
3. Jensen J. R., 2004: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.
4. Vosselman, G. and Mass, H-G. (eds.), 2010: Airborne and Terrestrial Laser Scanning, CRC Press.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: Remote Sensing and Image Interpretation, Wiley.
6. Kalacska, M. and Sanchez-Azofeifa, G. A., 2008: Hyperspectral Remote Sensing of Tropical and Subtropical Forests, CRC Press.
7. van der Meer, F. D. and de Jong, S. M., 2002: Imaging Spectrometry – Basic Principles and Prospective Applications, Kluwer Academic Publishers.

8. Shan, J. and Toth, C. K. (eds.), 2018: Topographic Laser Ranging and Scanning – Principles and Processing, CRC Press.
9. Klunzer, C. and Dech, S. (eds.), 2013: Thermal Infrared Remote Sensing – Sensors, Methods, Applications, Springer.
10. Quattrochi, D. A. and Luvall, J. C. (eds.), 2005: Thermal Remote Sensing in Land Surface Processes, CRC Press.

CO-PO-PSO Correlation Matrix

CO/PO- PSO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
CO1	2	0	0	2	2	0	2	0	0	0	3	0	0	0
CO2	2	2	0	2	2	0	0	0	2	0	1	3	0	0
CO3	2	0	3	0	2	0	3	0	3	0	3	0	3	0
CO4	0	0	3	2	0	2	3	0	2	0	2	3	3	3
CO5	0	2	0	2	3	2	0	2	3	2	2	0	0	3
CO6	3	2	3	0	0	2	3	3	2	3	3	3	3	3

Title of the Course: Cartographic Technique and Thematic Mapping

Code: GEO154

L-T-P-C: 2-0-2-4

Course Objectives

1. To understand the fundamental concepts of maps and map scales, including different types of maps, scale construction techniques, and methods of scale enlargement and reduction.
2. To develop knowledge of geodetic datums and map projections, understanding their classification, properties, and applications.
3. To enhance skills in interpreting topographical maps, analysing toposheets for geographic feature identification, morphometric analysis, settlement frequency, and road density assessment.
4. To learn thematic mapping techniques and cartographic design principles, applying appropriate colour schemes, typography, and layout methods for effective spatial representation and visualization.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Define** different types of maps, map scales, and methods of scale construction, including linear, diagonal, and Vernier scales.

CO2. **Explain** the concepts of datum, map projections, and their properties, including geodetic systems, terminologies, and different types of projections like Mercator's and Universal Transverse Mercator (UTM).

CO3. **Identify** different geographic features, using toposheets, and perform morphometric and spatial analyses such as settlement frequency and road density.

CO4. **Analyse** various thematic map types, including choropleth, isopleth, chorochromatic, and dot maps, assessing their suitability for representing different types of spatial data.

CO5. **Assess** the effectiveness of map design and cartographic techniques, including colour, typography, and layout, for clear and accurate spatial representation.

CO6. **Design** and produce thematic maps using appropriate cartographic techniques, integrating spatial data visualization principles and map reproduction methods.

Catalogue Description

This course provides a comprehensive introduction to cartographic principles and thematic mapping techniques. Students will learn about different types of maps and map scales, including their construction, enlargement, and reduction methods. The course covers key concepts in geodetic datums, map projections, and coordinate systems, including the World and Indian Geodetic Systems and widely used projections such as Mercator and Universal Transverse Mercator (UTM).

Students will develop skills in interpreting topographical maps, identifying geographic features, and conducting grid-based morphometric analysis. The course also focuses on essential cartographic design elements such as color schemes, typography, and layout for effective map representation. Various thematic mapping techniques, including choropleth, isopleth, and dot maps, will be explored.

Hands-on laboratory exercises will reinforce theoretical concepts, allowing students to create and analyze maps using cartographic techniques. A laboratory notebook documenting practical exercises will be a key part of the assessment, ensuring applied learning in spatial representation and analysis.

Course Content

Unit 1: Map and Map Scale

Map Types; Types and Construction of Map Scale – Linear, Diagonal, and Vernier; Scale Enlargement and Reduction; Area Calculation by Graphical Method.

Unit II: Datum and Projection

Shape of the Earth; World and Indian Geodetic Systems; Concept, Classification, and Choice of Map Projection; Terminologies in Map Projection; Construction and Properties of the Map Projection – Polar Zenithal Gnomonic Projection, Simple Conical Projection with One Standard Parallel, Mercator’s Projection; Properties of Universal Transverse Mercator’s (UTM) Projection.

Unit III: Topographical Maps

Toposheet Numbering Systems as followed by Survey of India (SOI); Study of SOI Toposheet at 1:50,000 scale; Identification of Macro and Micro Geographic Features from Toposheet; Grid-based Morphometric Analysis, Settlement Frequency, and Road Density; Interpretation of Toposheets.

Unit IV: Basic Cartography

Employment of Colour and Pattern in Maps; Map Design and Layout; Map Lettering and Typography; Map Reproduction; Types of Thematic Maps – Choropleth Maps, Isopleth Maps, Chorochromatic Maps, Choroschematic Maps, Quantitative and Qualitative Dot Maps, Flowline Maps.

Unit V: Laboratory Notebook

A Laboratory Notebook consisting of the Lab Exercises mentioned above.

Recommended Readings:

1. Robinson, A.H., Morrison, J.L., Muehrcke, P.C., Kimberling, A.J., and Guptill, S.C. 1995: Elements of Cartography, John Wiley & Sons.
2. Monkhouse, F.J. and Wilkinson, H.R. 1971: Maps and Diagrams, Methuen & Co Ltd.
3. Mishra, R.P., and Ramesh, A. 2002: Fundamentals of Cartography, Concept Publishing Co.
4. Sarkar, A. 2015: Practical Geography – A Systematic Approach, Orient Blackswan Private Limited.
5. Saha, P.K. and Basu, P. 2021: Advanced Practical Geography, Books & Allied (P) Ltd.

CO-PO-PSO Correlation Matrix

CO/PO- PSO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
CO1	3	0	0	1	0	1	0	1	0	1	3	0	1	1
CO2	1	2	2	3	1	2	2	1	2	0	2	3	1	3
CO3	3	0	3	3	1	1	1	1	3	2	3	3	1	3
CO4	0	1	1	3	1	0	1	2	1	1	1	2	1	2
CO5	1	0	0	3	3	1	2	0	1	2	3	0	1	1
CO6	1	1	0	1	3	1	2	3	1	2	2	3	2	3

Title of the Course: Human Geography

Code: GEO106

L-T-P-C: 2-0-1-3

Course Objectives

1. To understand the key concepts of social geography.
2. To learn components, elements and measures of social region.
3. To conceptualize fundamentals of culture, cultural groups and cultural processes controlling the formation of cultural landscapes.
4. To understand the human adaptation to the environment determined the evolution of the societies.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Define** key concepts and components of social and cultural geography, including social structure, processes, and patterns.

CO2. **Explain** the relationship between social well-being, quality of life, and social inclusion/exclusion through real-world examples.

CO3. **Analyze** cultural regions and landscapes using the principles of cultural geography, including diffusion and integration.

CO4. **Examine** case studies of human adaptation to diverse environments to identify patterns of development and environmental conflict.

CO5. **Assess** social impact using indices such as HDI, GDI, and Sopher's Disparity Index to evaluate development and inequality.

CO6. **Design** questionnaires and conduct ethnographic surveys to address social problems and gather perceptual data for analysis.

Catalogue Description

This course provides a broad introduction to the conceptual and empirical concerns of two of the major sub-disciplines of contemporary human geography. It is organized into two parts. First part explores social geography, focusing on opening up students' perspectives to the various social elements, processes and issues. The second part introduces with the cultural geography focusing on the cultural processes, cultural groups, and formation of cultural landscape with an emphasis on Indian culture. The course also offers a broader understanding to the evolution of human societies and human adaptation to environment. This course will consist of lectures and exercises. All the lectures will be devoted on discussions of basic theories and concepts focusing on practical implementation of knowledge and critical thinking. Classes will be conducted by lecture as well as power point presentation, audio-visual animation and documentary presentation as per the requirement. The tutorials will help the students to understand the theories and concepts with deep thinking, problem- solving attitude, model making etc. At the end of the course students will get a vast knowledge about society, culture and environment.

Course Content

Unit 1: Concept and Components of Social Geography

Definition, Scope, and Content of Social Geography, Social Structure, and Social Processes: Macro and Micro; Social Patterns, Concept of Space: Social Space, Material Space; Social Elements; Caste, class,

religion, race, and their spatial distribution; Social Area Analysis

Unit II: Social Wellbeing and Planning

Concepts of social well-being, quality of life: Gender and social well-being – Health and nutrition, housing, education, and empowerment; Social geographies of inclusion and exclusion: Poverty, literacy, slums, gated communities, communal conflicts, gender bias and crime; Social Impact Assessment: Concept and importance

Unit III: Cultural Geography

Concept of culture in Geography; Definition, scope, and content of cultural geography, Cultural Groups: Ethnic, linguistic, and religious; Cultural hearth and realm, Cultural regions, Cultural landscape; Cultural assimilation, integration, and diffusion

Unit IV: Human Adaptation to the Environment:

Evolution of human societies: Hunting and food gathering, pastoral nomadism, subsistence farming, and industrial society; Development–environment conflict; Human adaptation to the environment: case studies of Eskimo, Bushman, Beduin; Gonds, Masai, Maori, Gujjars

Unit V: Human Perspectives & Development Indices

Preparation of questionnaire on social problems, perception through ethnographic surveys, Indices to development and inequality: HDI, Poverty Index, GDI, Sopher's Disparity Index

Recommended Readings:

1. Ahmed, A. (2004): Social Geography, Rawat Publication, New Delhi
2. Chapman, K. (1979): People, Pattern, and Process – An Introduction to Human Geography
3. Ghosh, S (2020): A Brief Account of Human Geography, Educreation Publishing.
4. Grover, N. (2004): Cultural Geography: Form and Process, Concept Publishing Co.
5. Guha, R. C: Social Geography. Rawat Publication, New Delhi
6. Chandna, R.C. 2016. Geography of Population: Concepts, Determinants, and Patterns, Kalyani Publishers.
7. Fouberg, E.H., Murphy, A.B., de Blij H.J. 2015. Human Geography: People, Place, and Culture, 11th ed, Wiley.
8. Ghosh, S. 1998. Introduction to Settlement Geography, Sangam Books Ltd.
9. Gould, W.T.S. 2015. Population and Development, Routledge.
10. Gregory, D., Johnston, R., Pratt, G., Watts., Whatmore, S. (Eds) 2009. The Dictionary of Human Geography, 5th ed, Wiley.
11. Knox, P.L., Marston, S.A. 2014. Human Geography: Places and Regions in Global Context, 6th ed, Pearson Education Limited.
12. Knox, P.L., McCarthy, L.M. 2011. Urbanization: An Introduction to Urban Geography, 3rd ed, Pearson Education Ltd.
13. Mandal, R.B. 2001. Introduction to Rural Settlement, 2nd ed, Concept Publishing Company.
14. Moseley, W.G., Perramond, E., Hapke, H.M., Laris, P. 2013. An Introduction to Human-Environment Geography: Local Dynamics and Global Processes, Wiley-Blackwell.
15. Norton, W. 2014. Human Geography, 8th ed, Oxford University Press.
16. Pickering K. and Owen A. A. (1997): An Introduction to Global Environmental Issues, 2nd edition Rutledge, London.
17. Rubenstein, J.M. 2016. The Cultural Landscape: An Introduction to Human Geography, 12th ed, Pearson Education Limited.
18. Short, R.J. 2017. Human Geography: A Short Introduction, 2nd ed, Oxford University Press.

CO-PO-PSO Correlation Matrix

CO/PO -PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	2	1	1	2	1	1	1	0	0	0	2	1	1	0
CO2	1	2	1	2	2	1	2	1	1	0	2	2	2	1
CO3	1	1	2	2	2	1	2	1	1	1	2	2	2	2
CO4	1	1	2	3	2	1	2	1	1	1	3	2	2	2
CO5	2	1	2	3	2	2	1	1	2	1	3	2	3	2
CO6	1	1	2	2	3	2	1	1	2	1	2	2	3	3

SEMESTER III

Title of the Course: Advanced Geographic Information System

Code: GEO251

L-T-P-C: 2-0-2-4

Course Objectives

1. To understand the fundamentals of GIS data quality and editing, including topological components, errors, transformations, and error propagation techniques to ensure spatial data accuracy and precision.
2. To develop skills in spatial data analysis, including proximity analysis, point-pattern analysis, spatial interpolation, and terrain analysis for effective geographic decision-making.
3. To apply advanced network data analysis techniques, such as network connectivity evaluation, least cost path analysis, and location-allocation analysis, for solving real-world spatial problems.
4. To gain hands-on experience with GIS software, performing topological corrections, spatial interpolation, and network analysis while maintaining a laboratory notebook for continuous assessment and skill reinforcement.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Recall** the fundamental concepts of topology, spatial relationships (connectivity, containment, adjacency), transformation techniques, and sources of errors in GIS data.

CO2. **Explain** the significance of topological rules, spatial accuracy, error propagation, and the role of different transformation methods in GIS data quality and editing.

CO3. **Utilize** proximity analysis and point-pattern analysis techniques for spatial problem-solving.

CO4. **Examine** spatial interpolation methods, viewshed and hillshade analyses, and assess network complexity using alpha, beta, and gamma indices to evaluate spatial distribution patterns.

CO5. **Evaluate** the network connectivity, optimize routes using the Travelling Salesman Problem and Least Cost Path Analysis, and assess the efficiency of Location-Allocation Analysis for decision-making.

CO6. **Develop** GIS-based spatial models by integrating topological correction, spatial data analysis, and network optimization techniques, documenting findings in a structured laboratory notebook.

Catalogue Description

This course provides an in-depth exploration of advanced Geographic Information Systems (GIS) concepts, focusing on spatial data quality, editing, and analysis. Students will learn about topological rules, errors, and transformation techniques, including affine transformation and Root

Mean Square Error (RMSE) estimation. The course covers spatial analysis techniques such as proximity analysis, point-pattern analysis, and spatial interpolation. Additionally, students will engage in network data analysis, including network connectivity evaluation, least cost path analysis, and location-allocation analysis.

Through hands-on lab sessions, students will develop proficiency in GIS software, applying topological corrections, spatial interpolation methods, and network complexity evaluations. Practical exercises will reinforce key concepts, ensuring students gain practical experience in analyzing spatial relationships and solving real-world geographic problems. A laboratory notebook documenting exercises will be a key component of continuous assessment. This course is designed to equip students with essential skills for spatial data management and decision-making in various GIS applications.

Course Content

Unit 1: Data Quality and Editing

Components of Topology; Connectivity, Containment, and Adjacency; Topological Rules; Topological Errors in GIS – Overshoot, Undershoot, Sliver Polygons; Map-to-Map and Image-to-Map Transformation; Affine Transformation; Estimation of Transformation Coefficients; Root Mean Square Error (RMSE); Errors in GIS Data; Accuracy and Precision; Error Propagation; Data Editing – Topological and Non-Topological.

Unit II: Spatial Data Analysis

Proximity Analysis – Single and Multi-Ring Buffering, Euclidean Distance; Applications of Proximity Analysis; Point-Pattern Analysis – Centrography; Mean Centre, Median Centre, Standard Distance; Standard Deviational Ellipse; Hillshade and Viewshed Analysis; Spatial Interpolation.

Unit III: Network Data Analysis

Distance and Directional Analyses; Network Connectivity and Connectivity Matrix; Evaluation of Network Complexity Using Alpha, Beta, Gamma Indices; Travelling Salesman Problem; Least Cost Path Analysis; Location-Allocation Analysis.

Unit IV: Basic GIS Lab

Topological Correction; Point-Pattern Analysis – Mean Centre, Median Centre, Standard Distance, Standard Deviational Ellipse; Spatial Interpolation; Evaluation of Network Complexity Using Alpha, Beta, Gamma Indices; Least Cost Path Analysis; Location-Allocation Analysis.

Unit V: Laboratory Notebook

A Laboratory Notebook consisting of the Lab Exercises mentioned above.

Recommended Readings:

1. Bhatta, B. (2008) Remote Sensing and GIS, Oxford University Press, New Delhi.
2. Chang, K-T., 2019: Introduction to Geographic Information Systems, McGraw Hill

3. Burrough, P. A., McDonnell, R. A., and and Lloyd, C. D., 2015: Principles of Geographical Information Systems, Oxford University Press.
4. de Smith, M. J., Goodchild, M. F., and Longley, P. A., 2018: Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools, Matador.
5. Yue-hong Chou (1997). Exploring Spatial Analysis in Geographical Information System, Onword Press, Thomson Learning.
6. Ballas, D., Clarke, G., Franklin, R.S., and Newing, A. 2017: GIS and Network Analysis, Routledge.
7. Scott, J. and Carrington, P.J. 2014: The SAGE Handbook of Societal Network Analysis, SAGE Publications Ltd.

CO-PO-PSO Correlation Matrix

CO/PO -PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	3	0	1	2	2	0	1	1	1	0	3	1	1	2
CO2	3	0	1	2	2	1	2	2	2	0	3	2	2	2
CO3	3	0	3	2	2	1	1	2	1	0	3	3	2	1
CO4	3	0	3	3	2	2	2	3	2	1	3	2	1	3
CO5	2	0	1	2	2	1	3	2	2	2	2	2	3	1
CO6	3	1	2	2	3	1	2	3	2	0	2	3	2	3

Title of the Course: Surveying Techniques in Geoinformatics

Code: GEO252

L-T-P-C: 1-0-3-4

Course Objectives

1. To learn the basic concepts of remote sensing.
2. To develop a skill in Aerial photo and Satellite Image interpretation.
3. To know about different types of Satellites, Sensors and their resolutions.
4. To learn the techniques of image processing.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Define** remote sensing, its platforms, types, and principles of aerial photography and satellite systems.

CO2. **Explain** the interaction of EMR with the atmosphere and Earth's surface in satellite remote sensing.

CO3. **Apply** image processing techniques, such as band combination and mosaicking, to satellite images.

CO4. **Analyze** satellite images to categorize land use and land cover using image interpretation techniques.

CO5. **Evaluate** the performance of different satellite sensors based on their resolution and capabilities.

CO6. **Develop** a project file using methods from the syllabus to complete a series of exercises.

Catalogue Description

This course will introduce the basics of remote sensing including the concepts of aerial photograph different types of aerial photography, techniques for acquiring aerial photograph, principals of Remote Sensing, types of satellites, sensors etc. This course will also enable students to learn the concept of image processing including selection of band combination i.e. true and false colour composite, image mosaic, and preparation of land cover/land use map using image interpretation technique. Overall the course will expose students to environ of remote sensing and its applicability. The image processing software will be introduced to the students during the lab activities. This course will consist of practical exercises while different fundamentals to be introduced to the students. The majority of the class will be spent by the students using remote sensing software to comprehend the basics of satellite imagery and allied features. Practical exercises will be submitted by the students on the data collected during the field as a part of the continuous assessment.

Course Content

Unit 1: Surveying

General Principles and Classification of Surveying; Surveying Instruments; Concept of Bearing; Closed and Open Traverse Survey using Prismatic Compass – Preparation of Field Book and Mathematical Computation; Plotting the Traverse and Error Correction.

Unit II: Levelling

Concept and Use of Levelling; Levelling Instruments; Methods of Calculation of Reduced Level (RL) – Collimation System (CL) and Rise and Fall System; Levelling using Dumpy Level – Preparation of Field Book and Mathematical Computation; Contouring.

Unit III: Total Station Survey

Surveying methods and mathematical implication of Total station; Total Station Survey in field; Downloading, Processing and Generation of Survey Plots using Software.

Unit IV: GPS and DGPS Survey

Global Positioning System (GPS) survey: Basic principles and evolution; Handheld GPS Operation - Feature Collection, Data Transfer, Area Calculation, Data Processing and Generation of Survey Plots ; Differential GPS (DGPS) Survey - Components, Types, and its Accessories, Surveying and Data Capture, Error Corrections, Integration with GIS.

Unit V: Laboratory Notebook

A Laboratory Notebook consisting of the Lab Exercises mentioned above.

Recommended Readings:

1. Bhatta, B. (2008) Remote Sensing and GIS, Oxford University Press, New Delhi.
2. Campbell J. B., 2007: Introduction to Remote Sensing, Guildford Press
3. Jensen, J. R. (2005) Introductory Digital Image Processing: A Remote Sensing Perspective, Pearson Prentice-Hall.
4. Joseph, G. 2005: Fundamentals of Remote Sensing, United Press India.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: Remote Sensing and Image Interpretation, Wiley. (Wiley Student Edition).
6. Li, Z., Chen, J. and Batsavias, E. (2008) Advances in Photogrammetry, Remote Sensing and Spatial Information Sciences CRC Press, Taylor and Francis, London
7. Mukherjee, S. (2004) Textbook of Environmental Remote Sensing, Macmillan, Delhi.
8. Nag P. and Kudra, M., 1998: Digital Remote Sensing, Concept, New Delhi.
9. Singh R. B. and Murai S., 1998: Space-informatics for Sustainable Development, Oxford and IBH Pub.

CO-PO-PSO Correlation Matrix

CO/PO -PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	3	2	1	1	1	0	1	0	0	1	2	1	2	0
CO2	1	2	1	2	2	0	1	1	1	1	2	2	2	2
CO3	1	1	3	2	2	1	1	0	1	1	2	2	2	2
CO4	2	2	2	1	1	2	2	1	0	1	2	1	2	2
CO5	0	1	2	2	1	1	2	0	0	1	1	1	1	2
CO6	1	0	1	1	2	2	1	2	1	0	2	2	2	2

Title of the Course: Disaster Management

Code: GEO107

L-T-P-C: 2-0-1-3

Course Objectives

1. Analyze sources and impacts of air, water, soil, and noise pollution using geographers' approaches.
2. Assess community vulnerabilities and develop disaster management strategies for natural and man-made hazards.
3. Critically evaluate global environmental issues and appraise sustainable development initiatives for effective resource management.
4. Examine land-use dynamics and their effects on environmental changes, including degradation and conservation strategies.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Identify** the components of the environment and their relationship in the context of pollution.

CO2. **Explain** the significance of environmental perception and its impact on pollution management.

CO3. **Analyze** the sources and impacts of various types of pollution and suggest management strategies.

CO4. **Compare** natural, quasi-natural, and man-made hazards and assess their social and environmental impacts.

CO5. **Critically** evaluate the effectiveness of international environmental policies like Montreal and Kyoto Protocols.

CO6. **Develop** an environmental management plan based on the monitoring of air, water, and soil pollutants.

Catalogue Description

This course provides an in-depth examination of environmental pollution, community vulnerabilities, and the dynamics of land use. Students will critically analyze various forms of pollution—air, water, soil, and noise—exploring their sources, impacts, and management strategies through a geographical lens. The course will also cover the concepts of hazards and disasters, focusing on vulnerability assessment and effective disaster management strategies for both natural and man-made events. Further, students will engage with global environmental issues, appraising sustainable development initiatives and international protocols aimed at addressing resource crises. The curriculum includes an exploration of land-use and land-cover dynamics, assessing their impacts on environmental change and degradation. Practical components will involve environmental monitoring techniques, enabling students to measure pollutants and analyze landscape patterns.

This course will consist of lectures and exercises. All the lectures will be devoted to discussions of fundamental theories and concepts focusing on the practical implementation

of knowledge and critical thinking. Classes will be conducted by lecture as well as PowerPoint presentation, audio-visual animation and documentary presentation, case studies analysis as per the requirement. The tutorials will help the students to understand the theories and concepts with deep thinking, problem-solving attitude, model making etc.

By the end of the course, students will be equipped with the knowledge and skills to evaluate and propose effective strategies for environmental management and sustainability.

Course Content

Unit I: Environmental Pollution

Geographers' approach to environmental studies; Environmental perception: significance; Physical Components of Environment: Lithosphere, Hydrosphere, Atmosphere, Biosphere, and their relationship; Pollution: Air, Water, Soil, Noise pollutions, their sources, impacts, and management; green technology

Unit II: Concept of Hazards and Disasters

Concepts of vulnerability, hazards, disaster, and risk; natural, quasi-natural, and man-made hazards and disasters; Social response; Natural hazards: Forest hazard, Desertification, Jhum cultivation; Social hazards: Poverty, Disease, War, and Crime - factors, impact, and redressal; Hazard and disaster reduction and management

Unit III: Environmental Issues

Global resource crisis and population equilibrium, History of Earth Summits and significance of Sustainable Development, Relevance of Montreal and Kyoto Protocols, Biodiversity conservation and Genetically Modified Organisms, Big dams, and their viable alternatives; International and Inter-State Water Dispute in the Indian subcontinent, Conservation of wetland and wasteland management

Unit IV: Impact of land use land cover dynamics on the environment

Fundamental concepts of land as the basis of environment and society; Concept of land use and land cover; factors of land-use land cover change; Impact on the environment; Land degradation types, processes, and causes of land degradation, mapping, and monitoring of land degradation; Land Capability Classification (USDA)

Unit V: Environmental Monitoring and Management

Measuring pH, EC, TDS, and DO in Water, Measurements of Air-pollutants, Soil Pollutants, Noise pollution; Land degradation and landscape pattern analysis - patches, corridors, and mosaics; measuring metrics (Shannon's Diversity Index and Simpson Diversity Index); Preparation of Environmental Management Plan

Recommended Readings:

1. Anderson J.M. (1981): Ecology for Environmental Science: Biosphere, Ecosystems and Man, Arnold, London.
2. Nobel and Wright (1996): Environmental Science, Prentice Hall, New York.
3. Odum, E.P. (1971): Fundamental of Ecology, W.B. Sanders, Philadelphia.

4. Saxena, H.M. (1994): PrayavaranevnParisthitikiBhugool (Geography of Environment and Ecology) Rajasthan Hindi Granth Academy, Jaipur.
5. Singh, Savinder (1991): Environmental Geography, PrayagPustak Bhawan, Allahabad.
6. Strahler, A.N. and Strahler, A.H. (1973): Environmental Geosciences: Interaction between natural systems and Man, John Wiley and Sons, New York.
7. Strahler, A.H. and Strahler A.N. (1977): Geography and Mans Environment, John Wiley, New York.
8. William, M.M. and John, G. (1996): Environmental Geography - Science, Landuse and Earth System, John Wiley and Sons, New York.
9. Alexander, D. (1993): Natural Disasters, Research Press, New Delhi, 619 P.
10. Blaikie, P. Cannon, Davis and Wisenes (1994): At Risk, Natural Hazards, People's Vulnerability and Disasters, Pouthledge, London, 320 P. 15.
11. Bryant, E. A. (1991): Natural Hazards: Cambridge University Press, Cambridge, Pg 294.
12. Burotn, I. Kates, R. W. and White, G. F. (1974): The Environment as a Hazard, Oxford University Press.
13. 17. Coch, N. C. (1994): Geo-Hazards, Prentice Hall, N. Y., Pg.305.
14. Environment and Development: R. Bhattacharyya, (Edited).
15. Environmental Geology: B. W. Murck and et al, John Willey.
16. Gilbert, F. White, ed. (1974): Natural hazards – Local, Natural and Global, Oxford University Press, N.Y.
17. Morrisawa, M., (1996): Geomorphology and Natural Hazards,Elscvia, Amsterdam, pg 411
18. Natural Hazard: Edited by White.
19. Smith, K. (1996): Environmental Hazards: Assessing Risk and Reducing Disaster, Routledge, Pg.398.
20. Turner, M.G., Gardner, R.H. and O'Neill, R.V. (2001): Landscape Ecology in Theory and Practice: Pattern and Process, Springer Science & Business Media, New York
22. Jana, N.C. and De, N.K. (1997): The Land - Multifaceted Appraisal and Management, Sribhumi Publishing Company, Kolkata

CO-PO-PSO Correlation Matrix

CO/PO -PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	2	1	2	1	2	2	1	0	1	1	2	2	2	1
CO2	2	1	2	2	2	2	1	0	1	1	2	2	2	2
CO3	2	2	2	2	3	3	2	1	2	1	2	2	3	2
CO4	2	2	3	2	2	2	2	1	2	1	2	3	2	3
CO5	2	1	2	2	2	2	2	0	1	1	2	2	2	2
CO6	2	2	2	3	2	2	2	2	2	1	3	2	2	3

SEMESTER IV

Title of the Course: Digital Image Processing

Code: GEO253

L-T-P-C: 2-0-2-4

Course Objectives

5. To understand the fundamentals of digital image processing, including image data formats, error sources, and correction techniques such as atmospheric, radiometric, and geometric corrections.
6. To develop skills in image enhancement techniques, including contrast stretching, histogram equalization, spatial filtering, band ratioing, and spectral indices for improving image quality and interpretation.
7. To apply classification and change detection techniques, including supervised and unsupervised classification, training site selection, and accuracy assessment using error matrices and ground control points.
8. To gain hands-on experience in digital image processing software, performing image pre-processing, enhancement, classification, and change detection while maintaining a laboratory notebook for continuous assessment.

Course Outcomes

On completion of this course, the students will be able to

CO1: Define digital image formats, sources of errors, and correction techniques for improved image accuracy.

CO2: Explain image enhancement methods, including contrast stretching, histogram equalization, and spectral indices.

CO3: Apply various processing and classification techniques for digital image analysis.

CO4: Analyse image errors using resampling, RMS error estimation, and ground control points.

CO5: Assess classification accuracy with error matrices and validation techniques.

CO6: Construct enhanced images and classified thematic maps with desired accuracy.

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Catalogue Description

This course introduces the fundamentals of digital image processing, covering image data formats, error sources, and correction techniques such as atmospheric, radiometric, and geometric corrections. Students will learn essential pre-processing techniques, including resampling, Root Mean Square (RMS) error estimation, and image registration.

The course explores image enhancement methods like contrast stretching, histogram equalization, spatial filtering, band ratioing, and spectral indices. Students will also study image classification techniques, including unsupervised (ISODATA) and supervised methods (Minimum Distance to Means, Parallelepiped, Maximum Likelihood), along with accuracy assessment using error matrices and ground control points.

Practical lab exercises will focus on layer stacking, color composites, haze correction, spatial filtering, and classification accuracy assessment. Hands-on experience with digital image processing software will reinforce theoretical concepts. A laboratory notebook documenting exercises will be required as part of the continuous assessment, ensuring students develop skills in satellite image analysis and change detection.

Course Content

Unit 1: Digital Image and Pre-processing of Digital Images

Digital Image Data Formats – BIP, BIL, BSQ, Run-length Encoding; Types and Sources of Errors and Correction – Atmospheric, Radiometric, and Geometric; Resampling and RMS Error.

Unit II: Image Enhancement

Contrast Enhancement – Gray level thresholding, level slicing, linear and non-linear contrast enhancement; Histogram Equalization; Spatial Convolution Filtering – High Pass and Low Pass; Band Ratioing and Spectral Indices; Principal Component Analysis.

Unit III: Image Classification and Change Detection

Unsupervised Classification – ISODATA; Supervised Classification – Training Site Selection; Minimum Distance to Means, Parallelepiped, Maximum Likelihood; Classification Accuracy Assessment and Error Matrix; Ground Control Points and Validation; Digital Change Detection.

Unit IV: Digital Image Processing Lab

Digital Image Bands and Layer Stacking; True and False Colour Composites; Subset and Mosaic; Haze Correction; Atmospheric Correction; Single Image and Image-to-Image Registration; Resampling; Spatial Convolution Filtering – High Pass and Low Pass; Spectral Indices; Digital Image Classification – ISODATA; Minimum Distance to Means, and Maximum Likelihood; Classification Accuracy Assessment.

Unit V: Laboratory Notebook

A Laboratory Notebook consisting of the Lab Exercises mentioned above.

Recommended Readings:

1. Campbell J. B., 2007: Introduction to Remote Sensing, Guildford Press.
2. Cha, B., Dattaa, D., Majumdar (2001): Digital Image Processing Analysis, Prentice-Hall of India, New Delhi
3. Jensen J. R., 2004: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.
4. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall, New Jersey
5. Joseph, G. 2005: Fundamentals of Remote Sensing, United Press India.
6. Lillesand, T. M., Kiefer, R. W. Chipman, J. W. (2008): Remote Sensing and Image Interpretation, John Wiley & Sons, New Delhi

7. Malay K. Pakhira, “Digital Image Processing and Pattern Recognition”, First Edition, PHI Learning Pvt. Ltd., 2011.
8. Nag, P. Kudrat, M. (1998): Digital Remote Sensing, Concept Publishing Company, New Delhi
9. Rees W. G., 2001: Physical Principles of Remote Sensing, Cambridge University Press.
10. Richards, J. A, Jia,X.(1999):Remote Sensing and Digital Image Processing, Springer, Verlag Berlin
11. Sabins, F. F. (1996): Remote Sensing: Principles an Interpretation, W. H. Freeman Company, New York
12. Singh R. B. and Murai S., 1998: Space-informatics for Sustainable Development, Oxford and IBH Pub.
13. Willliam K Pratt, “Digital Image Processing”, John Willey, 2002.

CO-PO-PSO Correlation Matrix

CO/PO -PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	2	1	2	1	2	1	2	1	0	1	1	1	1	1
CO2	2	1	2	1	2	1	1	1	0	1	1	1	1	1
CO3	2	2	3	2	2	1	2	2	1	1	2	2	1	2
CO4	2	1	1	3	2	2	2	1	1	0	2	1	2	1
CO5	1	2	2	3	1	2	1	2	2	1	2	1	2	2
CO6	1	2	2	3	2	2	2	1	2	1	2	2	2	1

Title of the Course: Basic of Programming

Code: GEO254

L-T-P-C: 1-0-3-4

Course Objectives

1. To provide students with an understanding of code organization
2. To provide knowledge and develop logic to create programs and applications in C.
3. To identify tasks in which the numerical techniques learned are applicable and apply them to write programs.
4. To provide fundamental knowledge useful in understanding other programming languages.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Define** the fundamental concepts of computers, software, networks, and logical thinking for problem-solving.

CO2. **Explain** the structure, compilation, and execution of C programs, including data types, operators, decision-making, and looping statements.

CO3. **Apply** arrays, strings, and matrix operations to solve scientific and statistical problems efficiently.

CO4. **Analyse** pointer arithmetic, function calls, recursion, and file operations for optimized program execution.

CO5. **Evaluate** the use of structures, unions, and enumerators for modular and efficient C programming.

CO6. **Develop** well-structured programs using C, incorporating logical problem-solving techniques and maintaining a laboratory notebook for continuous assessment.

Catalogue Description

This course offers a comprehensive introduction to computer science and programming, focusing on the C programming language. Students will learn the fundamentals of computers, including software, hardware, and networking, along with the critical role of logical thinking in problem-solving. The course covers key programming concepts such as data types, variables, operators, decision-making, and control structures like loops and functions. As students progress, they will delve into more advanced topics like arrays, strings, pointers, and file handling, applying these concepts to solve scientific and statistical problems. The course emphasizes hands-on experience through programming assignments and projects, allowing students to develop practical coding skills. By the end of the course, students will have a solid foundation in C programming, preparing them for more advanced topics in computer science and software development. This course is ideal for beginners seeking proficiency in programming and problem-solving techniques.

Course Content

Unit I: Introduction to Computers

Introduction to Computers, Computer Software, Computer Networks, Need for logical thinking, Problem formulation and development of simple programs, Flow Chart and Algorithms.

Unit II: C Programming Basics

Introduction to C programming, Fundamentals, Structure of a C program, Compilation and linking processes, Constants, Variables, Data Types, Expressions, Operators, Decision Making and Branching, Looping statements, Solving Simple Scientific and Statistical Problems.

Unit III: Arrays and Strings

Arrays, Initialization, Declaration, One-dimensional and two-dimensional arrays, Strings-String operations, String Arrays - simple programs, sorting, searching, matrix operations.

Unit IV: Pointers and Functions

Basic concepts of Pointers, Pointer arithmetic - Example Problems, Basic file operations, Function- definition of the function, Declaration of function, Pass by value, Pass by reference, Recursion, Enumerators, Structures, Unions

Unit V: Laboratory Notebook

A Laboratory Notebook consisting of the Lab Exercises mentioned above.

Recommended Readings:

1. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013
2. Ashok N. Kamthane, "Computer programming", Pearson Education, 2007.
3. Yashavant P. Kanetkar. "Let Us C", BPB Publications, 2011.
4. Byron S Gottfried, "Programming with C", Schaums Outlines, Second Edition, Tata McGraw-Hill, 2006.
5. R.G. Dromey, "How to Solve it by Computer", Pearson Education, Fourth Reprint, 2007

CO-PO-PSO Correlation Matrix

CO/PO-PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	3	1	1	1	2	1	1	0	2	1	2	1	1	1
CO2	2	2	1	2	1	1	1	0	2	1	2	2	2	2
CO3	3	2	2	2	2	2	2	1	2	1	2	2	2	2
CO4	2	2	2	2	1	2	1	1	1	1	1	2	2	2
CO5	3	1	2	2	2	2	1	1	1	1	2	2	2	2
CO6	2	2	2	1	2	2	1	1	1	1	2	1	1	2

Title of the Course: Basic Mathematics and Statistics for Geoinformatics

Code: GEO255

L-T-P-C: 3-0-1-4

Course Objectives

1. To provide students with an understanding of basic mathematics
2. To offer knowledge of statistical techniques and differentiate between descriptive and inferential statistics for effective data analysis
3. To identify tasks in which the linear programming and matrices learned are applicable and apply them
4. To deliver fundamental knowledge useful in understanding the Geoinformatics.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Define** the fundamental concepts of matrices, including types, operations, and properties such as symmetric and skew-symmetric matrices.

CO2. **Explain** statistical concepts, including data types, scales, and frequency distributions, and analyse histogram, frequency polygon, and normal/skewed distributions.

CO3. **Apply** probability concepts, including events, conditional probability, and Bayes' theorem, to solve real-world problems involving uncertainty.

CO4. **Analyse** eigenvalues and eigenvectors of matrices to interpret transformations and their applications in various mathematical models.

CO5. **Evaluate** feasible and optimal solutions in linear programming problems by identifying feasible and infeasible regions.

CO6. **Create** mathematical models using matrices, probability, and linear programming to solve applied problems in statistics and optimization.

Catalogue Description

This course covers essential topics in mathematics, including matrices, statistics, probability, and linear programming. It begins with matrix theory, focusing on types, operations, and concepts such as eigenvalues and eigenvectors. In statistics, students learn to analyze discrete and continuous data, interpret frequency distributions, and understand normal and skewed distributions. The probability section introduces fundamental concepts like conditional probability, independent events, and Bayes' theorem. Lastly, the course explores linear programming, teaching students to solve optimization problems graphically in two variables, identify feasible and infeasible regions, and determine optimal solutions. By the end of the course, students will be equipped with the skills to analyze and solve real-world problems in geoinformatics, providing a strong foundation for advanced study in mathematics.

Course Content

Unit I: Matrices

Concept, order, types of matrices, transpose of a matrix, symmetric and skew-symmetric matrices, Operations-Addition and multiplication, Invertible matrices, Eigen Values and Eigen Vectors of a Matrix.

Unit II: Statistics

Statistical Concept, nature of statistical data: discrete, continuous, parametric and non-parametric statistics; Data types, scales, and ratings; Tabulation and Descriptive Statistics: Frequency distribution – Histogram, Frequency Polygon, Ogive, normal and skewed distribution

Unit III: Probability

Concepts of Probability, Events; occurrence of events, ‘not’, ‘and’ and ‘or’ events, exhaustive events, mutually exclusive events, Probability of an event, probability of ‘not’, ‘and’ and ‘or’ events, Conditional probability, multiplication theorem on probability, independent events, total probability, Bayes’ theorem

Unit IV: Linear Programming

Basic concept of Linear Programming, solving problems in two variables, feasible and infeasible regions, feasible and infeasible solutions, optimal feasible solutions

Recommended Readings:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 9th Edition, New Delhi, 2014.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014
3. Hamdy A Taha, "Operations Research- An Introduction" by TAHA, Prentice Hall, 2009.
4. F.S. Hiller, G.J. Liberman, B. Nag and P. Basu "Introduction To Operations Research, Mc Graw Hill Education (India), 2012
5. Balagurusamy, E, Reliability engineering, Tata-McGraw Hill Publishers, New Delhi, 1984

CO-PO-PSO Correlation Matrix

CO/PO- PSO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
CO1	2	0	2	1	2	1	1	1	2	0	2	3	2	2
CO2	2	1	2	1	2	1	1	1	2	0	2	3	2	2
CO3	2	1	2	2	2	3	1	2	2	0	3	2	2	3
CO4	1	1	2	3	2	2	2	2	2	0	2	3	2	3
CO5	1	0	1	2	3	2	2	1	2	0	2	3	2	2
CO6	2	1	2	2	2	2	1	2	2	1	3	2	2	3

SEMESTER V

Title of the Course: Photogrammetry

Code: GEO351

L-T-P-C: 2-0-2-4

Course Objectives

1. To understand the fundamentals of aerial cameras and films, including their types, components, functions, and the spectral sensitivity of black & white and colour films.
2. To develop skills in photogrammetric analysis, including scale determination, relief displacement calculation, and object height estimation from vertical aerial photographs.
3. To apply stereoscopic techniques and parallax measurement, using stereo pairs and mirror stereoscopes for land use and land cover mapping.
4. To gain hands-on experience in digital photogrammetry, performing aerial triangulation, ortho-photo generation, and digital terrain model (DTM/DEM/DSM) creation while maintaining a laboratory notebook for continuous assessment.

Course Outcomes

On completion of this course, the students will be able to

- CO1. **Define** different types of aerial cameras, films, their components, and functions, along with film characteristics such as density, resolution, and spectral sensitivity.
- CO2. **Illustrate** different photogrammetric concepts, including scale determination, relief displacement, and object height calculation from aerial photographs.
- CO3. **Perform** stereoscopic analysis using parallax measurements and mirror stereoscopes to generate land use and land cover map.
- CO4. **Analyze** flight planning parameters and photogrammetric transformations, including space resection, intersection, and aerial triangulation.
- CO5. **Assess** the accuracy and limitations of digital photogrammetric products, such as ortho-photo, rectified photo, digital terrain models (DTM/DEM), and true orthophoto.
- CO6. **Develop** photogrammetric workflows, integrating aerial triangulation, bundle block adjustment, and digital surface model (DSM) generation for precise spatial data analysis.

Catalogue Description

This course introduces the fundamentals of photogrammetry, covering aerial cameras, film characteristics, and their role in image acquisition. Students will learn about the principles of photogrammetric measurements, including scale determination, relief displacement, and object height calculations from vertical aerial photographs.

The course explores stereoscopy and parallax concepts, enabling students to measure object heights using stereo pairs and generate land use/land cover maps with mirror stereoscopes. It also covers digital photogrammetry, including transformations between image and object space, aerial triangulation, and bundle block adjustment techniques. Students will gain insights

into the generation of digital photogrammetric products such as ortho-photos, rectified images, and digital terrain models (DTM/DEM/DSM).

Practical lab exercises will focus on flight planning, stereo analysis, ortho-photo creation, and digital surface model generation. A laboratory notebook will document hands-on exercises, ensuring students develop essential photogrammetric skills for spatial data analysis and mapping applications.

Course Content

Unit 1: Aerial Cameras and Films

Aerial Cameras – Types, Components, and Functions; Cross section of Films; Film Density and Characteristic Curves; Spectral Sensitivity of Black & White and Colour Films; Film Resolution.

Unit II: Scale and Relief Displacement

Map vs. Aerial Photographs vs. Satellite Imageries; Photogrammetric Terminology; Determination of Scale of Aerial Photographs; Calculation of Relief Displacement and Object height from Vertical Aerial Photographs.

Unit III: Stereoscopy and Parallax

Parallax Measurement and Object Height Determination using Stereo Pairs; Flight Planning – Concepts and Numerical Problems; Generation of Land Use and Land Cover Map using Mirror Stereoscope.

Unit IV: Digital Photogrammetry

Transformation between image and object space: collinearity equations, Interior & exterior orientation, Space resection, Space forward intersection and limitations, Aerial triangulation and bundle block adjustment. Product generation: Ortho-photo and DTM generation: DTM/DEM and DSM, Rectified photo, Orthophoto and True Orthophoto.

Unit V: Laboratory Notebook

A Laboratory Notebook consisting of the Lab Exercises mentioned above.

Recommended Readings:

1. Wolf P. R. and Dewitt B. A. 2000: Elements of Photogrammetry: With Applications in GIS, McGraw-Hill.
2. Punmia, B.C., Jain, A.K., and Jain, A.K. 1967: Surveying, Vol. III, Laxmi Publications (P) Ltd.
3. Kanetkar, T.P. and Kulkarni, S.V. 2012: Surveying and Levelling, Part 2, Pune Vidyarthi Griha Prakashan.
4. Linder, W. 2003: Digital Photogrammetry – Theory and Applications, Springer.
5. Mikhail, E.M., Bethel, J.S., and McGlone, J.C. 2012: Introduction to Modern Photogrammetry, Wiley.

CO-PO-PSO Correlation Matrix

CO/PO -PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	1	1	0	1	1	2	1	2	0	1	2	2	1	1
CO2	0	1	1	2	2	1	2	2	2	1	2	2	1	2
CO3	1	2	0	2	1	2	2	2	1	1	2	3	2	1
CO4	1	1	2	2	1	2	1	2	2	2	1	2	1	3
CO5	2	1	1	1	2	2	2	1	2	1	1	1	2	2
CO6	2	2	1	1	2	1	2	1	2	2	2	1	2	2

Title of the Course: Python for Geospatial Analysis

Code: GEO352

L-T-P-C: 1-0-3-4

Course Objectives

1. To understand Python basics, Numpy, and its applications in geospatial analysis and statistics.
2. To learn data cleaning techniques using Pandas, including handling missing values and outliers.
3. To develop skills in advanced geospatial data processing with Geopandas, spatial operations, and image processing.
4. To gain proficiency in working with Arcpy for shapefiles, geodatabases, and spatial analysis.
5. To apply Python and geospatial techniques to real-world case studies using scikit-learn.

Course Outcomes:

On completion of this course, the students will be able to:

CO1: **Recall** the fundamental concepts algorithms and statistics.

CO2: **Illustrate** different applications of ArcPy, NumPy, Pandas, GeoDataFrames, etc.

CO3: **Apply** different Python libraries.

CO4: **Examine** the utility of Python machine learning and real-world applications.

CO5: **Evaluate** Python coding in geoscience and geospatial data processing.

CO6: **Develop** Python codes for statistical and geoscientific analysis.

Catalogue Description

This course provides a comprehensive introduction to Python programming and its applications in geospatial data analysis. This course covers the basics of Python, including its need, key libraries like Numpy for statistical and linear algebra operations, and Matplotlib and Seaborn for data visualization. It also introduces Arcpy for geospatial data processing, focusing on shapefiles, geodatabases, and spatial analysis. This course delves into data-cleaning techniques using Pandas, including handling missing values, detecting and correcting outliers, and preprocessing data for geoscientific applications. This course covers advanced geospatial data processing, including Geopandas for spatial operations, image processing with Python libraries like PIL, OpenCV, and scikit-image, and techniques like georeferencing and map algebra. This course also features case studies to apply Python in real-world geospatial analysis, integrating machine learning using scikit-learn for enhanced data insights. This course equips learners with the skills to work with complex geospatial datasets.

Course Content

Unit I: Basic of Python

Introduction, Need of Python Programming, Applications Basics of Python, Programming, Introduction to Numpy: arrays, array operations and basic functions. Statistical operations and linear algebra with Numpy. Introduction to Arcpy and its functionalities. Working with shapefiles and geodatabases. Spatial analysis and geoprocessing with Arcpy. Basics of Matplotlib: plotting, styling and customizing plots, creating geospatial visualizations. Introduction to Seaborn: Statistical data visualization.

Unit II: Data Cleaning

Introduction to data cleaning using Pandas: Handling of missing value: imputation, removal and interpolation. Detecting outliers and correcting outliers. Data preprocessing: scaling, normalization and transformation. Encoding categorical variables. Feature engineering for geoscientific data.

Unit III: Advanced geospatial data processing and analysis

Introduction to Geopandas: creating and manipulating GeoData Frames. Spatial operations: joins, buffers and overlays. Introduction to image processing concepts: filtering, edge detection and thresholding. Python libraries for image processing: PIL, Opencv and scikit-image. Spatial data preprocessing: data cleaning and transformations. Handling large geospatial datasets. Mosaicking of images, handling image alignment and blending. Georeferencing: techniques for georeferencing images, applying transformation and projection. Map algebra: Raster data operations: local, focal, zonal and global.

Unit IV: Case Studies

Introduction to scikit-learn. Case study: Real-world application of Python integrated with Geospatial information.

Unit V: Laboratory Notebook

A Laboratory Notebook consisting of the Lab Exercises mentioned above.

Recommended Readings:

1. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
2. John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press, 2013
3. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
4. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3", Second edition, Pragmatic Programmers, LLC, 2013.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO/PO-PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	3	1	2	2	2	2	1	2	0	1	2	2	3	2
CO2	3	2	2	2	1	2	2	1	0	1	2	2	2	3
CO3	3	2	1	2	3	2	2	2	0	1	2	3	2	2
CO4	2	2	2	3	1	2	2	3	0	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	1	2	2	2	3	2
CO6	3	2	1	3	2	3	2	2	0	2	3	2	2	3

Title of the Course: Geo-Statistics

Code: GEO353

L-T-P-C: 1-0-3-4

Course Objectives

1. Understand the significance of statistical techniques in geoinformatics
2. Calculate and interpret measures of central tendency and dispersion, including mean, median, mode, and standard deviation, while applying hypothesis testing methods.
3. Analyze relationships between variables through regression analysis, including simple and nonlinear regression, and utilize time series methods for data interpretation.
4. Develop a comprehensive project that demonstrates the application of statistical methods and data analysis techniques, culminating in a viva voce presentation.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Define** statistical concepts and types of data, including parametric and non-parametric classifications.

CO2. **Illustrate** central tendency and dispersion measures using diagrams like boxplots and violin plots.

CO3. **Construct** frequency distributions, histograms, and trend lines for analysing statistical datasets.

CO4. **Differentiate** between normal and skewed distributions and evaluate residuals in regression models.

CO5. **Critically** assess statistical hypotheses using tests like Student's T-Test and Chi-square test.

CO6. **Develop** a comprehensive project file integrating methods from the syllabus into practical exercises.

Catalogue Description

This course provides a comprehensive introduction to geostatistics, focusing on statistical and probabilistic methods for spatial data analysis. It covers fundamental concepts of matrices, including operations, eigenvalues, and eigenvectors, essential for geospatial modeling. The course introduces descriptive statistics, frequency distributions, and data visualization techniques such as histograms, frequency polygons, and ogives to analyze spatial patterns.

Students will explore probability concepts, including conditional probability, Bayes' theorem, and probability distributions, to model spatial variability and uncertainty in geoscientific data. The course also covers linear programming, optimizing solutions for spatial decision-making problems.

Hands-on exercises will reinforce concepts through data tabulation, probability computations, and statistical modeling using real-world geospatial datasets. Practical applications include solving optimization problems and understanding spatial dependence using statistical tools. By the end of the course, students will be equipped with the knowledge and skills to analyze and interpret spatial data for informed decision-making in geostatistical applications.

Course Content

Unit I: Basic Concepts

Significance of statistical techniques, Descriptive and Inferential Statistics, nature of statistical data: discrete, continuous, parametric and non-parametric statistics; Data types, scales, and ratings; Tabulation and Descriptive Statistics: Frequency distribution – Histogram, Frequency Polygon, Ogive, normal and skewed distribution; Probability of distribution/occurrences - Normal Distribution, sampling techniques: random, systematic and stratified.

Unit II: Measures of Central Tendency and Dispersion

Measures of central tendency: mean, median, mode, partition values – quartile, deciles, and percentile and data visualization- boxplot, violin plot; Measures of dispersion: mean deviation, quartile deviation, variance, standard deviation, and Coefficient of variation; Hypothesis testing- Student's T-Test, Chi-square test, and Analysis of variance; Association and Correlation – Rank correlation and Product Moment Correlation (Karl Pearson)

Unit III: Data Analysis

Bivariate scatter diagram and regression trend line - Simple Regression and nonlinear regression; Residuals from regression; Residual Mapping, Time Series Analysis - Moving average, semi average, and least square method.

Unit IV: Laboratory Notebook and viva voce

A project file comprising at least one exercise (as per requirement) from each one using any method on the above-mentioned themes.

Recommended Readings:

1. Alvi, Z. 1995: Statistical Geography-Methods & Application, Rawat Publications, Jaipur.
2. Berry B. J. L. and Marble D. F. (eds.): Spatial Analysis – A Reader in Geography.
3. Clark, W.A.V. and Hosking, P.L. 1986: Geographical Methods for Geographers, John Wiley and Sons, New York
4. Croxton, F.E., Cowden, D.J. & Klein, S 1969: Applied General Statistics, Prentice Hall of India Pvt. Ltd., New Delhi
5. Dickinson, G.C. (1973): Statistical Mapping and Presentation of Statistics
6. Ebdon D., 1977: Statistics in Geography: A Practical Approach
7. Goon, A.M., Gupta, M.K. & Dasgupta, B. 1992: Basic Statistics, Volume 1, The World Press Pvt. Ltd., Kolkata
8. Goon, A.M., Gupta, M.K. & Dasgupta, B. 1992: Fundamentals of Statistics, Volume 1, The World Press Pvt. Ltd., Kolkata
- Gregory, S. 1985: Statistical Methods and the Geographer, Longman, London
9. Hammond P. and McCullagh P. S., 1978: Quantitative Techniques in Geography: An Introduction, Oxford University Press.
10. King L. S., 1969: Statistical Analysis in Geography, Prentice-Hall

11. Mahmood A., 1977: Statistical Methods in Geographical Studies, Concept.
12. Mahmood, A. 1998: Statistical Methods in Geographical Studies, Rajesh Publications, New Delhi
13. Norcliffe, G.B. 1977: Inferential Statistics for Geographers-An Introduction, Hutchinson and Co., London
14. Pal S. K., 1998: Statistics for Geoscientists, Tata McGraw Hill, New Delhi

CO-PO-PSO Correlation Matrix

CO/ O- PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3	PS O4
CO1	2	2	1	1	2	2	1	2	1	0	2	2	2	0
CO2	2	3	2	3	2	2	1	2	2	1	2	2	2	3
CO3	2	2	2	2	2	2	2	0	2	1	2	3	2	2
CO4	2	3	2	1	1	1	2	3	2	2	2	0	3	2
CO5	2	3	2	2	2	2	2	1	2	2	2	3	2	2
CO6	2	2	2	1	1	2	2	2	2	3	2	2	2	2

Title of the Course: Internship

Code: GEO354

L-T-P-C: 0-0-4-4

Course Objectives

1. To enhance students' understanding of industry practices through firsthand observations during site visits.
2. To develop critical analysis skills by evaluating interactions with industry professionals and organizations.
3. To encourage collaborative learning by engaging in group discussions and reflections post-industry visits.
4. To improve written communication skills through the preparation and submission of a comprehensive Industry Interaction Report.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Recall** key observations and insights gained from industry interactions and visits.

CO2. **Explain** the significance of the industry visit and its relevance to the course.

CO3. **Apply** concepts learned in class to analyze industry practices and their impact.

CO4. **Examine** and compare different industry processes observed during the visit.

CO5. **Critique** industry practices based on theoretical knowledge and personal observations.

CO6. **Develop** recommendations or suggestions for improvements in the industry based on visit findings.

Catalogue Description

This course will help students to show their knowledge in industries or different research institutes. This course directly provides exposure of practical experiences of the learned skills and tool sets. Students shall involve themselves with the activities of different institute and industries. Finally, they need to submit a details report of the activities and experience to the university. This course tremendously helps in boosting confidence of the student.

Course Content

An Industry Interaction Report to be prepared and submitted individually by each student, based on actual industrial interaction and visits, done jointly or in groups with other students.

CO-PO-PSO Correlation Matrix

CO/PO-PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	2	1	1	2	1	1	1	1	1	0	2	2	2	2
CO2	2	2	1	2	1	2	2	1	1	0	2	1	2	2
CO3	2	1	1	2	1	1	2	1	1	0	2	2	2	2
CO4	2	2	2	3	2	2	2	2	2	0	2	2	2	2
CO5	2	1	2	2	2	2	2	2	2	1	1	2	2	2
CO6	2	1	2	2	2	2	3	2	2	1	2	2	2	2

SEMESTER VI

Title of the Course: Web GIS and Google Earth Engine

Code: GEO355

L-T-P-C: 1-0-3-4

Course Objectives

1. To understand Web GIS basics, cloud GIS, GeoWeb services, and create smart maps using Runtime SDK.
2. To learn about web services, volunteered geographic information (VGI), and use hosted feature services for VGI.
3. To explore Google Earth Engine, including data filtering, importing/exporting raster/vector data, and image manipulation.
4. To apply advanced spatial analysis techniques, including land surface temperature estimation and digital image classification methods.

Course Outcomes

On completion of this course, the students will be able to

CO1: Recall the basic concepts of web GIS and GEE.

CO2: Interpret the interactive and dynamic maps.

CO3: Identify the components of web and map services and GEE.

CO4: Categorize the applications of web GIS and GEE.

CO5: Evaluate the web services standards and interoperability.

CO6: Create web layers, interactive and dynamic maps.

Catalogue Description

This course provides an in-depth exploration of Web GIS and spatial data analysis techniques. This course introduces Web GIS concepts, cloud GIS, GeoWeb services, and Geoportal applications, with practical skills in creating web layers, maps, and smart mapping using Runtime SDK. This course covers web services and Volunteered Geographic Information (VGI), teaching students how to publish and use hosted feature services to collect VGI. The Leaflet library will also be introduced for building interactive maps. This course also focuses on Google Earth Engine (GEE), including how to filter and display image data, import/export raster/vector data, and perform basic image filtering. This course teaches spatial data analysis using GEE, focusing on calculating spectral indices for vegetation, water, and other land features, as well as performing time-series analysis, digital image classification, and estimating Land Surface Temperature. This course equips students with practical skills for working with spatial data using advanced GIS tools.

Course Content

Unit I: Web GIS Basics and Application

Web GIS basics and applications; Cloud GIS - Geoweb Services and Geoportal Application; Create web layers, maps and Smart mapping, Runtime SDK

Unit II: Web Service and VGI

Web services overview, volunteered geographic information, web editing and feature Service; Publish and use hosted feature services to collect VGI; Overview of Leaflet library for interactive maps.

Unit III: Introduction to GEE

Introduction to Google Earth Engine; Filtering and displaying image data; Import and Export Raster and Vector Data; Image filtering

Unit IV: Spatial Data Analysis using GEE

Calculating spectral indices: assessing vegetation, water, glacier, burnt area, and built-up area; Time series data analysis; Iteration; Digital Image Classification - traditional and advanced classifiers; Estimation of Land Surface Temperature.

Unit V: Laboratory Notebook and viva voce

A project file comprising at least one exercise (as per requirement) from each one using any method on the above-mentioned themes.

Recommended Readings:

1. Pinde Fu, 2015, Getting to Know Web GIS. ESRI Press. Redlands, CA. ISBN-13: 978-1589483842 ISBN-10: 1589483847.
2. Android Programming Tutorials: Easy-To-Follow Training-Style Exercises on Android Application Development. CommonsWare, LLC, 2009. 0981678025.
3. Cardille, J.A., Crowley, M.A., Saah, D., and Clinton, N.E. (eds.) 2024. Cloud-Based Remote Sensing with Google Earth Engine – Fundamentals and Applications. Springer.
4. Kumar, L. and Mutanga, O. (eds.) 2019. Google Earth Engine Applications. MDPI.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	1	0	1	3	0	1	0	2	2	3	1	2	1
CO 2	1	1	1	2	2	2	1	1	2	2	3	2	1	3
CO 3	2	0	3	2	3	1	2	1	1	3	1	3	3	2
CO 4	3	1	2	3	2	1	3	2	1	1	2	2	2	3
CO 5	0	1	1	0	1	2	2	0	2	1	2	3	1	1
CO 6	2	2	1	1	2	3	1	2	2	2	1	2	3	2

Title of the Course: Open-Source GIS

Code: GEO356

L-T-P-C: 1-0-3-4

Course Objectives

1. To understand basic concepts of open-source GIS, QGIS, and georeferencing, along with vector and raster processing.
2. To learn image processing techniques in Saga GIS, including FCC creation, enhancement, classification, and change detection.
3. To explore Geoportal applications like OpenStreetMap and ISRO Bhuvan for GNSS data collection, mapping, and analysis.
4. To develop proficiency in spatial data manipulation, analysis, and visualization using QGIS, Saga GIS, and PostGIS tools.

Course Outcomes

CO1: Recall the fundamental concepts of Open-Source GIS and Database Management Systems.

CO2: Demonstrate the various functions available in QGIS, Saga GIS, PostGIS, and PostgreSQL.

CO3: Apply different Open-Source GIS and Database Management Systems in geospatial applications.

CO4: Distinguish between the functions available in Open-Source GIS and commercial GIS software packages.

CO5: Evaluate the significance of OpenStreet Map, Google Earth, and ISRO's Geoportal.

CO6: Create various spatial outputs using different Open-Source GIS software packages.

Catalogue Description

This course provides comprehensive knowledge of open-source GIS tools and spatial data management. This course focuses on QGIS, covering its evolution, standards, and protocols. Students will learn georeferencing, vector creation, attribute editing, geoprocessing, and map composition using QGIS, along with plugin integration. This course introduces Saga GIS, emphasizing image processing techniques such as FCC creation, image enhancement, data compression, classification (both unsupervised and supervised), and change detection. This course covers PostGIS, teaching students about spatial databases, SQL, geometry construction, spatial relationships, indexing, and spatial problem-solving. This course explores Geoportal applications like OpenStreetMap and ISRO Bhuvan, with practical skills in GNSS data collection, map preparation, and spatial analysis. Through hands-on learning, students will develop skills in geospatial data manipulation, analysis, and visualization using a variety of open-source GIS software.

Course Content

Unit I: Open-Source GIS: QGIS

Basic concepts of open-source GIS, evolution of free and open-source GIS, standard and protocol of open-source GIS, Open Geospatial Consortium, introduction to QGIS, Georeferencing, vector creation, attribute joining and editing, vector and raster-based Geoprocessing using QGIS, plugin and external software support with QGIS, layout preparation and map composition,

Unit II: Open-Source GIS: Saga GIS

introduction to Saga GIS, FCC creation, image subsetting, image enhancement, data compression- PCA, image indices, image classification (unsupervised & supervised), accuracy assessment, change detection, layout creation.

Unit III: Open-Source Database Management System

Fundamental of Post GIS, relationship in between PostGIS and PostgreSQL, installation of PostGIS, creating a spatial database, loading spatial data, simple SQL, geometries, geometry construction functions, advanced geometry construction, spatial relationships, spatial joining, spatial joining based problem solving, spatial indexing and associated problem solving, validity, equality, linear referencing with PostGIS, nearest neighbour searching.

Unit IV: Geoportal Applications

Geoportal Applications –Openstreet Map and ISRO Bhuvan Collection and retrieval of GNSS positions, preparation of maps from GNSS data, GNSS data; Introduction to, Identification of Spatiotemporal Change and elevation profiling from Google Earth, Working with ISRO Bhuvan Geoportal – Data extraction, vector overlay and data import.

Unit V: Laboratory Notebook and viva voce

A project file comprising at least one exercise (as per requirement) from each one using any method on the above-mentioned themes.

Recommended Readings:

1. Scott Madry., 2021: Introduction to QGIS, Locate press.
2. Hans van der Kwast, Kurt Menke., 2019: QGIS for Hydrological applications, Locate press.
3. Jensen J. R., 2004: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.
4. Joseph, G. 2005: Fundamentals of Remote Sensing, United Press India.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: Remote Sensing and Image Interpretation, Wiley. (Wiley Student Edition).
6. Olaya, V. 2004: A Gentle Introduction to SAGA GIS, can be access from <http://www.saga-gis.org/en/index.html>
7. Leo S. Hsu, Regina O. Obe, Leo Hsu, 2011: PostGIS in Action, Manning Publications
8. Thomas J. Kraft, Stephen Vincent Mather, Paolo Corti., 2014: PostGIS Cookbook, Packt publications.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	0	1	1	0	1	0	0	1	0	3	1	1	0
CO 2	3	1	2	1	2	1	1	0	1	1	2	3	2	1
CO 3	2	2	3	1	2	2	0	1	1	1	3	2	2	2
CO 4	2	1	1	3	1	2	2	1	2	2	1	2	3	2
CO 5	1	0	2	1	0	3	1	0	2	0	3	1	2	1
CO 6	0	1	1	3	3	2	2	1	1	1	2	3	3	3

Title of the Course: Database Management Systems

Code: GEO357

L-T-P-C: 1-0-3-4

Course Objectives

1. To understand database concepts, architecture, and different types of database models, including the relational model.
2. To learn normalization techniques, functional dependencies, and various normal forms for relational database design.
3. To gain proficiency in SQL joins (inner, outer, cross) and subqueries for working with multiple tables.
4. To develop skills in optimizing queries and using aggregate functions, sorting, and filtering data in SQL.

Course Outcomes

On completion of this course, the students will be able to

CO1: Recall the concepts of data and knowledge levels.

CO2: Illustrate the ideas of SQL and data normalization.

CO3: Apply the SQL and Join and Subqueries in database management systems.

CO4: Analyze the different functions of SQL and Subqueries.

CO5: Evaluate the utility of knowledge base and expert systems.

CO6: Elaborate the functioning of SQL, database, and normalization.

Catalogue Description

This course provides a foundational understanding of Database Management Systems (DBMS) and SQL. This course introduces core database concepts, including the distinction between data and information, DBMS architectures, and various database models, focusing on the relational model and ER diagrams. This course explores database normalization, teaching functional dependencies, integrity constraints, and different normal forms such as 1NF, 2NF, 3NF, and BCNF. This course covers SQL commands for creating and manipulating databases, tables, and querying data using DDL and DML. Students will also learn to apply constraints, aggregate functions, and filtering techniques. This course focuses on SQL joins and subqueries, enabling students to handle multiple tables and advanced queries. By the end, students will be proficient in database design, query optimization, and effective data management using SQL.

Course Content:

Unit I: Introduction to Database management system

Database concepts: Data vs information, Database vs file system. DBMS architecture: single tier, two tier, three tier. Types of database model: Hierarchical model, Network model, Relational model, Object-oriented model. Relational data base model. ER models: Entity Set, Relation Ship Set, Cardinality Properties, Type of Entities. Keys: Primary key, Foreign key,

Composite key. Relationships: one to one, one to many, many to many. Aggregation, Specialization and Generalization.

Unit II: Normalization

Relational database design: Integrity Constraint, Domain Constraint, Referential Integrity, Functional Dependencies, Closure of Set, Cover and Canonical Cover, Types of Anomalies, Armstrong's axioms, Extended Armstrong's axioms.

Data Base Decomposition: Domain and data dependency, Normal forms: 1NF, 2 NF, 3 NF, BCNF, Dependency preservation, Lossless design.

Unit III: Introduction to SQL

Data definition language (DDL). Data manipulation language (DML). Creating databases and tables. Alter tables. Dropping databases and tables. Insert data into table. Updating the data. Deleting data. Querying data: SELECT statement. SQL data types. Applying constraints: NOT NULL, UNIQUE etc. Common data types in SQL. Filtering data using WHERE clause. Comparison operator. Logical operator. BETWEEN, IN, LIKE and IS NULL. Sorting data using ORDER BY clause. Using LIMIT clause. Aggregate functions and grouping: COUNT, SUM, AVG, MAX, MIN functions. Using GROUP BY clause. Filtering groups with HAVING clause.

Unit IV: Joins and Subqueries

Types of joins: Inner join, Left (outer) join, Right (outer) join, Full (outer) join, cross join. Joining multiple tables. Subqueries and Nested Queries: Using subqueries in SELECT, FROM WHERE clause. Subqueries with EXISTS and NOT EXISTS. Using ANY and ALL with subqueries.

Unit V: Laboratory Notebook and viva voce

A project file comprising at least one exercise (as per requirement) from each one using any method on the above-mentioned themes.

Recommended Readings:

1. Database System Concepts, 6th Edition by Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill
2. Principles of Database and Knowledge – Base Systems, Vol 1 by J. D. Ullman, Computer Science Press.
3. “Fundamentals of Database Systems”, 5th Edition by R. Elmasri and S. Navathe, Pearson Education
4. “Foundations of Databases”, Reprint by Serge Abiteboul, Richard Hull, Victor Vianu, Addison-Wesley.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	1	0	0	2	1	0	1	0	0	2	0	0	1
CO 2	2	1	2	1	3	1	1	1	2	1	3	2	1	2
CO 3	2	0	3	1	2	0	1	1	3	0	3	2	2	2
CO 4	3	1	2	1	2	0	1	1	2	0	3	2	2	2
CO 5	2	1	1	1	2	3	2	2	2	1	2	2	1	2
CO 6	1	0	1	3	2	1	0	2	1	0	2	3	2	3

Title of the Course: Field Project

Code: GEO358

L-T-P-C: 0-0-4-4

Course Objectives

1. To analyze and select appropriate field techniques for rural or urban problem studies.
2. To design effective questionnaires and survey schedules for data collection on various issues.
3. To prepare comprehensive project reports, focusing on data analysis and interpretation.
4. To conduct individual case studies on disaster management, emphasizing primary and secondary data collection.

Course Outcomes

On completion of this course, the students will be able to:

CO1. **Recall** various field techniques and tools used in rural/urban environmental studies.

CO2. **Explain** the significance of selecting appropriate field techniques for socio-economic and physical surveys.

CO3. **Use** observation methods and questionnaires to collect data in rural/urban fieldwork.

CO4. **Analyze** physical and socio-economic data collected during field surveys to identify key issues.

CO5. **Evaluate** the effectiveness of disaster management projects based on field-based case studies.

CO6. **Design** a comprehensive field report with methodology, analysis, and interpretation based on collected data.

Catalogue Description

Field trips are enriching experiences for students to test their knowledge gained throughout the program. This course is designed to gain a new knowledge or clarifying concepts learned in the classroom. Field excursion will provide opportunities to the students to explore the knowledge of physical, social and cultural geography to find the solution for environmental pollution, economic development and social progress. Through this course students can foster interest and motivation to learn and research in various aspects of Geography. Concomitantly writing of the project and their oral presentation will help to improve their thinking, writing and communication skills. This course will consist of lectures, hands-on training to handle various field instruments, field visits, data collection, data analysis, report writing and presentation. The focus will be on enhancing problem identification capacity, data collection from field and their analysis. The majority of classes will be invested on field, and in laboratory for data analysis and interpretation. Students will be given tasks for preparing questionnaires, data tabulation and analysis, laboratory testing, identifying and relating the factors for physical and social conditions. Submission of the prepared report and its presentation should be done by the students at the end of the course.

Course Content

Unit 1: Selection of study area:

Selection of either a rural area or an urban area based on cadastral or municipal maps to study specific problems (Rural / Urban / Physical / Human / Environmental). Field Techniques and Tools: Merits, Demerits, and Selection of the Appropriate Technique; Observation (Participant / Non-Participant), Questionnaires (Open/ Closed / Structured / Non-Structured); Interview with Special Focus on Focused Group Discussions; Space Survey (Transects and Quadrants, Constructing a Sketch), Field Tour Planning: Collection of Material for Physical and Socio-Economic Surveys.

Unit II: Physical and Socio-Economic Status Analysis and Report Writing:

Identification of physical problem, data collection and post field discussion, Preparation of Questionnaire and Survey schedule for assessing data of households, industrial and market for perception study; Post field discussion., Designing the Field Report: Aims and Objectives, Methodology, Analysis, Interpretation, and Writing the Report

Unit III: Project on Disaster Management:

The Project Report is based on any field-based case studies among the following disasters and one disaster preparedness plan of the respective college or locality: i. Flood, ii. Drought, iii. Cyclones and Hailstorms, iv. Earthquake, v. Landslides, vi. Human-Induced Disasters: Fire Hazards, Chemical, Industrial Accidents

Unit IV: Field Notebook and viva – voce:

Limits with guidelines: a) Each student will prepare an individual report based on primary and secondary data collected during fieldwork. b) The duration of the fieldwork should not exceed 10 days. c) The text of the report should not exceed 20 typed A4 pages (8000 to 12,000 words excluding figures, tables, photographs, maps, references, and appendices) with line spacing of 1.5 and neatly drawn maps and diagrams with photographs and should be submitted in soft binding. d) The report should be written in English. e) Each lesson of the report should be signed by the concerned teacher who conducted the fieldwork. f) Recurrence of visits to the same field area is prohibited. g) Students will give a seminar after completing the project.

Recommended Readings:

1. Basu, R. and Bhaduri, S. ed, (2007): Contemporary Issues and Techniques in Geography, Progressive Publishers, Kolkata.
2. Hammond, R, and McCullagh, P. (1978): Quantitative Techniques in Geography: An Introduction, Oxford University Press, Oxford.
3. Mukherjee, N. (2002): Participatory Learning and Action: with 100 Field Methods. Concept Publs. Co., New Delhi.
4. Robinson, A. (1998): "Thinking Straight and Writing That Way", in Writing Empirical Research Reports: A Basic Guide for Students of the Social and Behavioural Sciences, eds. by F. Pryczak and R. Bruce Pryczak, Publishing: Los Angeles.

CO-PO-PSO correlation Matrix

CO/PO -PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	2	1	1	1	2	1	1	0	0	1	2	2	1	1
CO2	2	1	1	1	3	1	1	0	1	1	3	2	2	2
CO3	1	1	2	2	2	2	1	0	0	0	3	2	3	2
CO4	1	2	2	3	2	2	2	0	1	1	2	2	3	2
CO5	0	1	2	3	3	2	2	1	2	2	2	3	3	3
CO6	0	1	1	3	3	2	2	1	3	3	2	2	3	3

SEMESTER VII

Title of the Course: Spatial Data Science with R

Code: GEO451

L-T-P-C: 1-0-3-4

Course Objectives

1. To understand the basics of R programming, including data types, variables, functions, and control statements.
2. To learn data manipulation techniques and create custom visualizations, including box plots, histograms, and scatterplots.
3. To develop skills for handling GIS and remote sensing data in R, including raster and vector data operations.
4. To apply spatial statistics techniques like Point Pattern Analysis, Moran's I, and Hotspot Mapping for spatial analysis.

Course Outcomes

On completion of this course, the students will be able to:

CO1: **Recall** the basics of R programming, remote sensing, GIS.

CO2: **Demonstrate** various data manipulation, visualization, remote sensing, and GIS functions in R.

CO3: **Apply** R programming in different remote sensing, GIS, and spatial statistical analyses.

CO4: **Examine** the advantages of R programming in handling and visualizing spatial data.

CO5: **Assess** the utility of R programming in performing spatial and statistical analyses.

CO6: **Develop** different spatial outputs using R programming.

Catalogue Description

This course provides a comprehensive introduction to R programming and its application in data manipulation, visualization, and spatial analysis. This course covers the basics of R programming, including data types, variables, control structures, and functions. This course focuses on data manipulation and visualization, teaching students to create and customize various graphs like histograms, box plots, and scatterplots. This course introduces basic remote sensing and GIS functions in R, including raster and vector data handling, projection assignment, and index development (NDVI, NDBI, NDWI) for Landsat, MODIS, and Aster data. This course covers spatial statistics, including Point Pattern Analysis, Moran's I, and Hotspot Mapping. By the end of the course, students will be proficient in using R for spatial data analysis, GIS functions, and remote sensing applications.

Course Content

Unit I: Basics of R programming

Introduction of R programming, data types, variables, vectors, scalars, data frames, lists, matrices, arrays, classes, arithmetic and boolean operators and values, structures, control statements, loops, recursion, Scoping Rules, Loop functions.

Unit II: Data manipulation and Data Visualisation

Functions, math functions, linear algebra operation, probability distributions: normal, binomial, poisson; graphics: creating graphs, customizing graphs box plot, histogram, pie graph, line chart, scatterplot.

Unit III: Basic Remote Sensing and GIS Function in R

Setting up R: Setting up RStudio, Introduction to RStudio, Package installations, File Organization, Working directory; GIS and RS Data handling in R: Read raster data in R, projection assignment, reprojection, resampling, preparation of FCC in R, subsetting, band arithmetic; development of different indices (NDVI, NDBI, NDWI etc.) with Landsat 5, Landsat 8, Aster and MODIS data; Read vector data in R, explore .shp file attributes in R, basic visualisation with .shp file, splitting and merging of .shp file, Spatial Attribute Analysis.

Unit IV: Spatial Statistics with R

Point Pattern Analysis and Hotspot Mapping; Areal Pattern analysis and - Moran's I; Gettis's G; Spatial correlation and Spatial prediction

Recommended Readings:

1. Bivand, R. S., Pebesma, E. J., Gómez-Rubio, V., & Pebesma, E. J. (2008). Applied spatial data analysis with R (Vol. 747248717, pp. 237-268). New York: Springer.
2. Wickham, H., & Grolemund, G. (2016). R for data science: import, tidy, transform, visualize, and model data. " O'Reilly Media, Inc."
3. Xie, Y., Allaire, J. J., & Grolemund, G. (2018). R markdown: The definitive guide. CRC Press.
4. Irizarry, R. A. (2019). Introduction to data science: data analysis and prediction algorithms with R. CRC Press.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: Remote Sensing and Image Interpretation, Wiley.(Wiley Student Edition).
6. Singh R. B. and Murai S., 1998: Space-informatics for Sustainable Development, Oxford and IBH Pub.
7. Anselin, L., & Rey, S. J. (2010). Perspectives on spatial data analysis. In Perspectives on Spatial Data Analysis (pp. 1-20). Springer, Berlin, Heidelberg.
8. Alvi, Z. 1995: Statistical Geography-Methods & Application, RawatPublications,Jaipur.
9. Croxton, F.E., Cowden, D.J. & Klein, S 1969: Applied General Statistics, PrenticeHall of India Pvt. Ltd.,New Delhi

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	2	1	1	3	2	3	2	0	1	0	3	2	1	0
CO 2	2	1	2	3	2	3	2	0	1	1	3	2	2	0
CO 3	3	1	3	2	3	2	2	1	2	0	3	3	3	2
CO 4	3	1	2	2	3	1	2	1	1	0	2	3	2	3
CO 5	3	2	3	2	2	2	2	0	2	1	3	3	2	2
CO 6	3	1	3	3	2	3	3	0	2	0	2	2	2	3

Title of the Course: Introduction to Artificial Intelligence and Machine Learning in Geoinformatics

Code: GEO452

L-T-P-C: 1-0-3-4

Course Objectives

1. To understand the fundamentals of AI and ML, their significance, challenges, and applications in geospatial data analysis.
2. To develop skills in using Python libraries and ML frameworks, such as Scikit-learn, TensorFlow, and PyTorch, for geospatial data modeling and visualization.
3. To apply machine learning techniques, including regression models, spatial clustering, and predictive modeling, for geospatial analysis and environmental forecasting.
4. To gain hands-on experience with deep learning applications, such as Artificial Neural Networks (ANNs), Convolutional Neural Networks (CNNs), and Recurrent Neural Networks (RNNs), for geospatial problem-solving and trajectory prediction.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Define** fundamental concepts of AI and ML in geoinformatics, including their significance, challenges, and emerging trends.

CO2. **Explain** the integration of machine learning frameworks (Scikit-learn, TensorFlow, PyTorch) with geospatial data and the role of Python libraries in geospatial analysis.

CO3. **Apply** ML models for spatial analysis, including regression models for spatial prediction, spatial clustering, and predictive modeling techniques like Random Forest and Gradient Boosting.

CO4. **Analyze** deep learning techniques, such as Artificial Neural Networks (ANNs), Convolutional Neural Networks (CNNs), and Recurrent Neural Networks (RNNs) for geospatial applications.

CO5. **Assess** the effectiveness of AI/ML algorithms in geospatial forecasting and trajectory prediction by validating results and optimizing models.

CO6. **Develop** AI-powered geospatial solutions, integrating ML frameworks, deep learning techniques, and interactive visualizations for geospatial decision-making.

Catalogue Description

This course provides an introduction to Artificial Intelligence (AI) and Machine Learning (ML) in geospatial applications. Students will explore the significance, challenges, and emerging trends of AI and ML in geoinformatics, along with the integration of ML with geospatial data.

The course covers essential Python libraries and ML frameworks (Scikit-learn, TensorFlow, PyTorch) for geospatial analysis and visualization.

Students will learn to apply ML techniques such as regression models for spatial prediction, clustering methods, and predictive modeling using Random Forest and Gradient Boosting. Deep learning applications, including Artificial Neural Networks (ANNs), Convolutional Neural Networks (CNNs), and Recurrent Neural Networks (RNNs) for trajectory analysis, will also be explored.

Hands-on lab exercises will include model implementation, geospatial data processing, and visualization. A laboratory notebook documenting these exercises will form part of the continuous assessment, ensuring students gain practical experience in AI-driven geospatial analysis.

Course Content

Unit 1: Integration of AI and ML in Geoinformatics

Overview of AI and ML; Significance, Challenges, Opportunities, and Emerging Trends of AI and ML in Geospatial Applications; Integration of ML with Geospatial Data.

Unit II: AI/ML Modelling

Python Libraries for Geospatial Analysis; Setting up a Geospatial Python Environment; Integration with ML framework (Scikit-learn, TensorFlow, PyTorch); Building Interactive Geospatial Visualizations.

Unit III: ML for Geospatial Applications

Regression Models for Spatial Prediction; Spatial Clustering Techniques; Forecasting Environmental Variables; Predictive Modelling using Random Forest and Gradient Boosting.

Unit IV: Deep Learning Applications in Geoinformatics

Artificial Neural Network (ANN) Applications in Geospatial Problems; Convolution Neural Networks (CNNs) for Geospatial Data; Recurrent Neural Networks (RNNs) for Trajectory Prediction and Analysis.

Unit V: Laboratory Notebook

A Laboratory Notebook consisting of the Lab Exercises mentioned above.

Recommended Readings:

1. Lee, C-W, Han, H., and Lee, H. (Eds.) 2021: Artificial Intelligence Methods Applied to Urban Remote Sensing and GIS, MDPI AG.
2. Kumar, S., Setia, R., and Singh, K. (Eds.) 2023: Artificial Intelligence and Machine Learning in Satellite Data Processing and Services, Springer.
3. Troiano, L. et al. (Eds.) 2022: Advances in Deep Learning, Artificial Intelligence and Robotics, Springer.
4. Vinod Chandra, S.S. and Anand Hareendran, S. 2014: Artificial Intelligence and Machine Learning, PHI.

5. Jeon, G. (Ed.) 2022: Artificial Intelligence-Based Learning Approaches for Remote Sensing, MDPI AG.

CO-PO-PSO Correlation Matrix

CO/PO-PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	1	1	1	1	2	1	1	1	0	0	2	2	2	1
CO2	2	2	1	2	2	2	1	2	1	1	2	2	2	1
CO3	1	0	2	2	2	3	2	3	0	1	2	2	1	2
CO4	2	1	2	2	2	2	1	2	1	1	2	2	2	1
CO5	1	1	2	2	2	2	2	1	2	1	2	2	2	1
CO6	1	1	1	1	1	2	2	2	1	2	2	2	2	2

Title of the Course: Research Methodology

Code: GEO453

L-T-P-C: 2-0-2-4

Course Objectives

1. To introduce students to the fundamental concepts of geographic research and guide them in framing research questions, objectives, and hypotheses.
2. To provide knowledge of sampling techniques, statistical populations, and the characteristics of a good sample in research methodology.
3. To enable students to collect, process, and analyse qualitative and quantitative data, utilizing appropriate methods and representation techniques.
4. To equip students with skills for academic report writing, including literature review, citation management, and effective use of academic databases for structured research.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Define** key terms and concepts related to research, including types, motivations, and objectives.

CO2. **Explain** the significance and process of conducting a literature review and citation methods.

CO3. **Select** and evaluate research problems, and formulate research objectives based on specific criteria.

CO4. **Differentiate** between sampling methods and apply principles to sample size calculation.

CO5. **Assess** the coherence, reliability, and validity of data used in scientific research.

CO6. **Write** an introduction, methods, and results sections of a scientific research paper.

Catalogue Description

The primary objective of this course is to develop a research orientation among the students and to acquaint them with fundamentals of research methods and research writing capability. Specifically, the course aims at introducing them to the basic concepts used in research and to scientific research methods useful for geographers and their approach. It includes discussions on sampling techniques, literature review, research designs and techniques of analysis. Through the field study and term project students will be able to explore their understanding of the research methods. The project will be based on local environmental problem.

Course Content

Unit I: Fundamentals of Research

Meaning of Research, Nature, and objectives of the research; Research Types: descriptive-analytical, pure-applied, conceptual-empirical, qualitative-quantitative; Motivations in Research

Unit II: Research Process

Needs and objectives of Literature Review; Conducting literature survey- searching literature, reviewing selected literature, developing theoretical and conceptual frameworks, Reporting literature review; Citation methods- footnote, text note, end note, bibliography, annotated bibliography, and citation rules; Research Problems- meaning, importance, and sources; selecting, defining, stating and evaluating a research problem; Selection of research objectives; Exercises on writing introduction of a research article; Research Strategies: Case studies, Experiments, Ethnography, Phenomenology, Grounded Theory, Action Research

Unit III: Data Collection Methods

The questionnaire, Interview, Focus Group, Participant Observation; Sampling- Concept, principles, and factors affecting inferences drawn from a sample; Sampling: Probability and Non-Probability sampling- types and criteria for selection; Sample size calculation and developing sampling Frames.

Unit IV: Reading and Writing a Scientific Research Paper

Introduction Section: Background, Hypothesis/Research Question, Premise, Logic, Novelty; Material and Method Section: Research Design, Data/Materials used, Sampling Strategy, Techniques used; Result Section: Coherence, Reliability, and validity of data; Important observations; Discussion Section: Interpretation of results and main conclusions.

Recommended Readings:

1. Best and Kahn, Research Methodology, PHI Limited.
2. Kothari, C.R. Research Methodology (Methods and Techniques), New Age Publisher.
3. Kerlinger, Foundation of Research.
4. Fundamentals of modern statistical methods by Rand R. Wilcox.
5. Power Analysis for Experimental Research a Practical Guide for the Biological, Medical and Social Sciences by R. Barker Bausell, Yi-Fang Li Cambridge University Press.
6. Design of Experience: Statistical Principles of Research Design and Analysis, by Robert O. Kuehl Brooks/Cole.

CO-PO-PSO Correlation Matrix

CO/PO-PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	3	0	1	1	1	0	0	0	1	0	3	2	2	1
CO2	2	3	2	3	0	2	1	1	2	1	2	3	3	2
CO3	1	1	0	1	1	0	0	0	1	0	2	2	3	2
CO4	3	2	1	2	2	1	2	1	1	0	2	1	3	3
CO5	0	1	1	2	1	1	0	1	1	2	2	1	2	2
CO6	1	2	1	3	2	3	2	2	2	1	2	1	2	3

Title of the Course: Term paper leading to Dissertation

Code: GEO454

L-T-P-C: 0-0-4-4

Course Outcomes

On completion of this course, the students will be able to:

CO1: **Recall** the fundamental concepts of research objectives, process, hypothesis.

CO2: **Compare** different research types and data collection methods.

CO3: **Organize** literature review and samples.

CO4: **Classify** different sampling types and citation methods.

CO5: **Evaluate** research problems.

CO6: **Construct** the dissertation file with literature review and research objectives.

Course Content

Unit I: Review of Literature

Unit II: Identifying the Research Questions & Objective of the study

Unit II: Documentation and Presentation on Literature review and Viva

Recommended Readings:

Good research articles published from reputed journals on their specific research domain.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	2	1	0	2	1	2	1	0	2	1	2	1	0	1
CO 2	2	2	1	2	1	2	2	0	2	1	2	2	2	2
CO 3	2	1	2	2	2	2	2	0	2	2	2	2	2	2
CO 4	2	2	2	2	1	2	2	0	2	1	2	2	2	2
CO 5	1	2	2	2	2	2	2	1	2	2	2	2	2	1
CO 6	2	2	2	2	2	2	3	0	2	2	2	2	2	3

Title of the Course: Startup Skill Development

Code: GEO405

L-T-P-C: 3-0-1-4

Course Objectives

1. To understand the fundamentals of entrepreneurship, startup types, and the role of innovation in geospatial ventures.
2. To explore various business models, funding options, and legal frameworks relevant to geospatial startups.
3. To develop strategic planning skills, including risk management, marketing, branding, and customer acquisition strategies.
4. To gain practical knowledge in business plan development, pitching to investors, and scaling up a startup.

Course Outcomes:

On completion of this course, the students will be able to:

Upon completion of this course, students will be able to:

CO1: Remember fundamental concepts and terminologies of entrepreneurship, startups, and business models.

CO2: Understand the processes and stages of startup development, including ideation, market analysis, and fundraising.

CO3: Apply geoinformatics knowledge to develop innovative and practical solutions for startup ventures.

CO4: Analyze market trends, customer needs, and competitive landscapes to identify viable business opportunities.

CO5: Evaluate business models, funding strategies, and risk management plans for geospatial startups.

CO6: Create a preliminary startup business plan or proposal tailored to the geoinformatics domain.

Catalogue Description

This course introduces the principles of entrepreneurship and how they apply to geospatial startups. This course covers the basics of entrepreneurship, startup definitions, and the role of technology and innovation in startup success, with a focus on geoinformatics. This course emphasizes business ideation, market dynamics, customer needs, and competitor analysis, helping students identify opportunities and gaps in the geospatial domain. This course explores business models (B2B, B2C, SaaS), funding options (venture capital, angel investors), and legal considerations, including intellectual property rights. This course teaches startup execution strategies, including business plan creation, risk management, marketing, branding, and team building. Students will learn how to prepare a prototype, pitch to investors, and scale a startup. By the end, students will have a solid understanding of launching and managing a successful geospatial startup.

Course Content

Unit 1: Introduction to Startups and Entrepreneurship

Entrepreneurship: Definition, types, and characteristics, Understanding startups: Definitions, lifecycle, and types, Role of innovation and technology in startups, Importance of geoinformatics in entrepreneurial ventures, Challenges and opportunities in geospatial startups.

Unit 2: Business Ideation and Market Analysis

Generating and validating ideas for geospatial startups, understanding market dynamics and customer needs, Basics of market research and competitor analysis, Identifying gaps in the geospatial domain for startup opportunities, case studies of successful geoinformatics startups.

Unit 3: Business Models, Funding, and Legal Frameworks

Types of business models (B2B, B2C, SaaS, etc.) in geospatial startups, Basics of financial planning, bootstrapping, and fundraising, Venture capital, angel investors, and government funding schemes, Intellectual property rights (IPR) and legal considerations for startups, the role of incubators, accelerators, and startup ecosystems.

Unit 4: Startup Execution and Strategic Planning

Developing a business plan: Vision, mission, and goals; risk management and strategic decision-making; marketing, branding, and customer acquisition strategies; scaling up: Operational and team-building strategies; preparing a prototype and pitching to investors.

References

1. Blank, S., & Dorf, B. (2020). *The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company*. Wiley.
2. Ries, E. (2011). *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*. Crown Business.
3. Osterwalder, A., & Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. Wiley.
4. Sarasvathy, S. D. (2001). *Effectuation: Elements of Entrepreneurial Expertise*. Edward Elgar Publishing.
5. Startup India Portal (<https://www.startupindia.gov.in/>): Guidelines, funding schemes, and resources.
6. Articles and case studies on geospatial startups (e.g., DroneDeploy, Planet Labs, Mapbox).

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	2	1	0	0	1	0	1	2	1	1	1	0	2	1
CO 2	2	1	1	0	2	2	1	1	2	1	1	2	2	0
CO 3	0	0	2	2	3	1	2	2	0	1	2	3	2	2
CO 4	2	1	1	2	1	1	2	2	1	2	2	1	2	1
CO 5	0	0	2	3	1	2	1	1	2	2	2	2	2	1
CO 6	2	0	0	2	2	1	2	3	2	2	1	2	2	3

SEMESTER VIII

Title of the Course: Business Communication

Code: GEO456

L-T-P-C: 4-0-0-4

Course Objectives

1. To understand phonetics, speech organs, intonation, and pronunciation practices for effective communication.
2. To learn the structure of words, parts of speech, morphemes, and lexical ambiguity for vocabulary development.
3. To enhance reading and listening comprehension skills through strategies for effective reading and listening.
4. To improve speaking skills through practical exercises, storytelling, and strategies for speaking effectively on various topics.

Course Outcomes:

On completion of this course, the students will be able to:

CO1: **Recall** the fundamental concepts of Communicative English.

CO2: **Illustrate** the components of Communicative English.

CO3: **Apply** the grammatical knowledge in writing and speaking good English.

CO4: **Examine** the articles, prepositions, tense, voice, idioms, vocabulary etc. in writing and speaking good English.

CO5: **Appraise** the significance of advanced methods of communicative English skill development, including audio clipping, argumentative talks, etc.

CO6: **Develop** good communicative English skills.

Catalogue Description

This course focuses on the key aspects of language learning, including phonetics, grammar, and communication skills. This course introduces the basics of phonetics, covering vowels, consonants, vocal cord systems, and speech organs, helping students understand pronunciation and sound structure. This course explores morphology, parts of speech, and vocabulary development, including inflection, derivation, and lexical ambiguity. This course focuses on tenses, sentence formation, and the use of idioms, phrasal verbs, and different types of phrases. This course emphasizes effective reading and listening strategies, followed by speaking exercises aimed at improving fluency and communication on various topics. This course equips students with the foundational skills for effective verbal and written communication.

Course Content

Unit I

Phonetics; Vowels; Consonants; Vocal cord systems; Speech organs; Oral sounds and nasal sounds; Phonology; Sound structure; Intonation; Understanding pronunciation; Pronouncing individual sounds; Practices.

Unit II Articles; Prepositions; Morphemes; Morphology; Understanding the word hierarchy; Inflection and derivation; Parts of Speech; Lexical ambiguity; Pluralization; Affixes; Learning vocabulary; Practice vocabulary.

Unit III

Tense; Voice changes; Narrations; Idioms; Putting words together; Formation of phrases; Different types of phrases; Putting the phrases together; Identify different phrases; Phrasal Verbs; Sentences formation; Sentence types; Sentence functions.

Unit IV

Reading short passages; Strategies to read effectively; Listening short audio clips; Strategies to listen effectively; Story telling demonstration; Listening practice; Speaking effectively; Strategies to speak effectively; Practice speaking on different topics.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	1	0	1	1	1	0	0	1	1	2	1	1	1
CO 2	1	3	1	1	1	0	1	0	1	2	1	2	1	1
CO 3	1	1	3	1	0	2	1	1	1	0	2	2	2	2
CO 4	2	0	1	3	1	1	2	2	1	0	1	1	2	1
CO 5	1	0	2	1	3	2	2	1	1	1	1	2	2	2
CO 6	0	1	1	2	2	3	1	1	2	2	1	2	2	3

Title of the Course: Spatial Data Science with MATLAB

Code: GEO457

L-T-P-C: 1-0-3-4

Course Objectives

1. To understand MATLAB programming fundamentals for spatial science applications.
2. To learn spatial data handling and processing techniques.
3. To develop skills in spatial analysis algorithms and modelling.
4. To integrate MATLAB with GIS software tools.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Define** the fundamental concepts of MATLAB, including its interface, syntax, data types, and control flow structures.

CO2. **Explain** the processes of importing, exporting, and transforming spatial data in MATLAB, including raster data processing techniques.

CO3. **Apply** spatial analysis methods, including distance and proximity analysis, interpolation techniques, and network analysis, for geospatial problem-solving.

CO4. **Analyse** spatial models such as land-use suitability analysis and statistical methods for geospatial data interpretation.

CO5. **Evaluate** spatial visualizations, raster transformations, and MATLAB-GIS integration for improved decision-making in geospatial applications.

CO6. **Create** geospatial models and visualizations using MATLAB, integrating statistical and GIS-based techniques for real-world applications.

Catalogue Description

This course teaches MATLAB programming applied to spatial data analysis. Topics include MATLAB basics, spatial data handling (raster, vector, GeoTIFF, shapefiles), and data processing. Students learn spatial analysis techniques such as interpolation, distance analysis, and geospatial modelling. Visualization of spatial data, automation with scripting, and batch processing are also covered. The course emphasizes integrating MATLAB with GIS tools for enhanced spatial analysis. The final project allows students to apply their skills to real-world spatial science problems, making them proficient in spatial data manipulation, analysis, and visualization using MATLAB.

Course Content

Unit I: Introduction to MATLAB

MATLAB interface: Command window, editor, workspace, and figure window, Basic MATLAB syntax and structure, Variables, arrays, Data types in MATLAB, Arithmetic operations, logical operations, comparison operators, Control Flow and Loops

Unit II: Spatial Data Processing

Importing and exporting spatial data formats, Spatial data analysis: Data cleaning and transformations, Raster data processing using MATLAB, Operations on raster grids: reclassification, filtering

Unit III: Geospatial Analysis and Modelling

Distance and proximity analysis, Spatial interpolation techniques, Network analysis, spatial modelling: suitability analysis, land-use modelling, Statistical analysis for spatial data

Unit IV: Visualization, Output, and Integration

Plotting spatial data in MATLAB, Visualizing rasters and vector layers, MATLAB-GIS integration, Exporting spatial results from MATLAB to other GIS tools

Unit V: Laboratory Notebook and viva voce

A project file comprising at least one exercise (as per requirement) from each one using any method on the above-mentioned themes.

Recommended Readings:

1. Attaway, S. (2013). MATLAB: A Practical Introduction to Programming and Problem Solving. 3rd ed. Burlington, MA: Elsevier.
2. Moore, H. (2010). MATLAB for Engineers. 2nd ed. Boston, MA: Pearson.
3. Chang, K.-T. (2015). Introduction to Geospatial Information Science. 2nd ed. Hoboken, NJ: Wiley.
4. Amato, G. S. (2017). Geospatial Modeling and Analysis with MATLAB. Boca Raton, FL: CRC Press.
5. R., E. D. (2016). Geospatial Analysis and Visualization with MATLAB. 1st ed. Cambridge: Cambridge University Press.
6. Coggins, J. R. R. (2016). MATLAB for Spatial Sciences. Boca Raton, FL: CRC Press.

CO-PO-PSO Correlation Matrix

CO/PO-PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	3	1	0	1	1	1	0	0	1	1	2	1	1	1
CO2	1	3	1	1	1	0	1	0	1	2	1	2	1	1
CO3	1	1	3	1	0	2	1	1	1	0	2	2	2	2
CO4	2	0	1	3	1	1	2	2	1	0	1	1	2	1
CO5	1	0	2	1	3	2	2	1	1	1	1	2	2	2
CO6	0	1	1	2	2	3	1	1	2	2	1	2	2	3

Title of the Course: Spatial Data Science with AUTOCAD

Code: GEO458

L-T-P-C: 1-0-3-4

Course Objectives

1. To learn map making, data analysis, and visualization using CAD tools and external data sources.
2. To gain proficiency in data management, including conversion, layer export, and connection to external databases.
3. Develop skills in building footprint mapping using CAD, satellite images, aerial photos, and OpenStreet Maps.
4. To explore the role of AI in improving accuracy and efficiency in building footprint mapping.

Course Outcomes:

On completion of this course, the students will be able to:

CO1: Define the various concepts and components of CAD and BIM.

CO2: Interpret the CAD and BIM data.

CO3: Apply CAD techniques and GEE codes to identify various spatial features with special reference to building footprint, LULC, LST, etc.

CO4: Categorize various functions and tools of CAD and BIM.

CO5: Assess the utility of CAD-based data management and mapping.

CO6: Develop maps and images using CAD and BIM techniques.

Catalogue Description

This course provides practical knowledge in map making and data management using AUTOCAD. This course focuses on connecting and analysing data from multiple sources using CAD, including creating and styling map features, performing proximity analysis, and generating reports. This course covers data management techniques, such as converting drawing layers to feature classes, connecting to external databases, and creating themes for MapGuide publishing. This course introduces BIM concepts, emphasizing its benefits in project management, implementation, and procurement. This course teaches building footprint mapping techniques using CAD, satellite imagery, and drone photos, with an emphasis on the role of AI in improving mapping accuracy. By the end of the course, students will be able to effectively manage, analyse, and visualize spatial data in real-world contexts.

Course Content

Unit I: Map Making and Data Analysis using CAD

Connecting data from multiple sources; Styling map features; Zooming and changing display; Creating map features; Object identification from data table; Object editing; Legend making;

Map publishing; Exploring data portals; Data Analysis – Visualization of surface data; Data analysis with external information using Join function; Proximity analysis; Report generation.

Unit II: Data Management using CAD

Data Management – Data conversion from drawing layers to feature classes; Drawing Layer Export; Connection to parcel data; Splitting a polygon feature; Connection to external database; Calculation; Theme creation; Publish to MapGuide.

Unit III: Building Information Modelling

Concepts and benefits of BIM; Agile Project Management; Building Management System; Project-based Learning and use of simulated projects; BIM Implementation and Procurement Routes

Unit IV: Building Footprint Mapping using CAD

Building footprint mapping from satellite images, aerial and drone photographs, and OpenStreet Maps; Role of AI in building footprint mapping.

Unit V: Laboratory Notebook and viva voce

A project file comprising at least one exercise (as per requirement) from each one using any method on the above-mentioned themes.

Recommended Readings:

1. AutoCAD Map 3D Tutorials. Autodesk.
2. Ellis, R. and Martin, R. 2018. A Practical Guide to AutoCAD Map 3D 2019. CADapult Press
3. Dastbaz, M. et al. (eds) 2017. Building Information Modelling, Building Performance, Design and Smart Construction. Springer

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	2	1	0	0	1	0	1	2	1	1	1	0	2	1
CO 2	2	1	1	0	2	2	1	1	2	1	1	2	2	0
CO 3	0	0	2	2	3	1	2	2	0	1	2	3	2	2
CO 4	2	1	1	2	1	1	2	2	1	2	2	1	2	1
CO 5	0	0	2	3	1	2	1	1	2	2	2	2	2	1
CO 6	2	0	0	2	2	1	2	3	2	2	1	2	2	3

Title of the Course: Dissertation and Comprehensive viva

Code: GEO459

L-T-P-C: 0-0-12-12

Course Objectives

1. Analyze data to address specified research problems and achieve research objectives effectively.
2. Appraise ethical considerations in research and development, fostering professional integrity and responsibility.
3. Design comprehensive research reports and scientific articles suitable for publication in academic contexts.
4. Construct a personalized research design to facilitate ongoing learning and inquiry throughout their careers.

Course Outcomes

On completion of this course, the students will be able to:

CO1. **Recall** geographical theories and hypotheses related to the study of geographical phenomena.

CO2. **Explain** the comparison of geographical characteristics between two places or phenomena.

CO3. **Apply** comparative methods to analyze changes in geographical characteristics over time.

CO4. **Analyze** geographical problems affecting habitats, economies, and societies.

CO5. **Assess** the effectiveness of theories in explaining geographical phenomena and changes over time.

CO6. **Design** a research methodology for studying geographical problems related to human habitats and society.

Catalogue Description

This course focuses on the comprehensive development of research skills in geography, guiding students through the process of conducting an original geographical study. Students will engage in data analysis, ethical considerations, report writing, and research design. Through individual dissertation projects, learners will explore geographical theories, compare phenomena, and address societal issues, culminating in a presentation of their findings.

Course Content

Dissertation Paper comprises an Object-specific goal-oriented Geographical Study based on the following types: 1) those which test a hypothesis or theory, as virtually all aspects of Geography have theories attached to them, 2) those which compare the geographical characteristics of two places or phenomena. A variation on this theme is a comparison of the geographical characteristics of one place or phenomena at two or more stages of time, i.e., a study of changes over time, and 3) those which study a geographical problem related to the habitat, economy, and society of people.

- 1) Each Examinee shall prepare a Dissertation Paper individually under the supervision of a Departmental Faculty on his / her own chosen Theme.
- 2) The Report must be documented in triplicate (1 = examinee, 2 = seminar library, 3 = supervisor) under the following Heads – *Introduction & Conceptual Background; Statement of the Problem; Objectives of Study; Literature Review; Methodology including data/information/map collection; Location of the Study Area; Analysis, Display and Interpretation of Data (relating to each Objective separately); and Conclusion.*
- 3) The Dissertation Paper should contain *Acknowledgement, Preface, Table of Content, List of Tables,*
- 4) *List of Figures, List of Photographs, List of References, Appendix, and Bibliography/ Reference.*
- 5) Pages containing Illustrations (Sketches, Graphs, Diagrams, Maps, Photographs, etc.) = 25(maximum).
- 6) Word Limit = 8000 (maximum) excluding Tables and Appendix (Computer typed, Line Spacing= 1½, Arial Narrow / Times New Roman / Helvetica 10 / 11 / 12).
- 7) Each Examinee shall submit a copy of the Report before the actual day of Examination (to be announced by the convener each year).
- 8) Each Examinee shall present his / her Paper before an audience comprising Internal / External
- 9) Examiners and others on the day of Examination using OHP or LCD Projector (maximum 25 slides about —*concept / idea / theme; major objectives; methodology; study area; observations and analysis; conclusion.*)
- 10) Time allotted for each presentation = 20 minutes (maximum).
- 11) Marks on Report and Presentation shall be separately awarded by the Internal and External
- 12) Examiners and then averaged.

Recommended Readings:

Good research articles published from reputed journals on their specific research domain.

CO-PO-PSO Correlation Matrix

CO/PO-PSO	P O 01	P O 02	P O 03	P O 04	P O 05	P O 06	P O 07	P O 08	P O 09	P O 10	PS O 01	PS O 02	PS O 03	PS O 04
CO1	2	1	0	2	1	2	1	0	2	1	2	1	0	1
CO2	2	2	1	2	1	2	2	0	2	1	2	2	2	2
CO3	2	1	2	2	2	2	2	0	2	2	2	2	2	2
CO4	2	2	2	2	1	2	2	0	2	1	2	2	2	2
CO5	1	2	2	2	2	2	2	1	2	2	2	2	2	1
CO6	2	2	2	2	2	2	3	0	2	2	2	2	2	3



ADAMAS UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY
CO – PO & PSO MAPPING

Name of the Programme: B.Sc. (Geoinformatics)

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO151	1.00	1.33	1.50	0.83	1.33	1.50	1.00	1.00	0.67	0.33	1.67	1.33	1.33	1.00
CO1	2	1	1	0	1	0	1	0	1	0	2	0	1	0
CO2	2	2	1	0	1	2	2	1	0	0	2	2	2	1
CO3	0	1	2	0	2	1	0	1	1	0	2	1	1	1
CO4	1	1	2	3	1	2	1	2	0	1	1	2	1	2
CO5	0	1	2	2	1	2	0	1	2	0	1	1	2	1
CO6	1	2	1	0	2	2	2	1	0	1	2	2	1	1
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO152	1.00	1.50	0.83	0.50	2.00	1.33	1.83	1.83	2.17	1.33	0.67	1.33	1.33	1.00
CO1	1	0	0	0	3	1	2	0	2	1	0	0	2	1
CO2	1	1	0	1	2	1	3	2	2	1	1	0	1	1
CO3	1	2	1	1	2	1	2	3	2	1	1	2	0	1
CO4	0	1	2	1	2	2	2	3	2	2	1	1	1	0
CO5	1	2	1	0	2	2	1	1	3	1	1	3	1	2
CO6	2	3	1	0	1	1	1	2	2	2	0	2	3	1
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04

GEO105	2.33	0.83	1.17	1.67	1.67	0.83	1.00	0.00	0.50	0.33	2.50	1.17	2.17	1.67
CO1	3	1	1	1	1	0	1	0	0	0	3	1	2	1
CO2	3	1	1	1	1	0	1	0	0	0	3	1	2	1
CO3	3	1	2	2	2	1	1	0	2	1	3	2	3	2
CO4	2	1	1	2	2	1	1	0	1	1	2	1	2	2
CO5	2	1	1	2	2	1	1	0	0	0	2	1	2	2
CO6	1	0	1	2	2	2	1	0	0	0	2	1	2	2
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO153	1.50	1.00	1.50	1.33	1.50	1.00	1.83	0.83	2.00	0.83	2.33	1.50	1.50	1.50
CO1	2	0	0	2	2	0	2	0	0	0	3	0	0	0
CO2	2	2	0	2	2	0	0	0	2	0	1	3	0	0
CO3	2	0	3	0	2	0	3	0	3	0	3	0	3	0
CO4	0	0	3	2	0	2	3	0	2	0	2	3	3	3
CO5	0	2	0	2	3	2	0	2	3	2	2	0	0	3
CO6	3	2	3	0	0	2	3	3	2	3	3	3	3	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO154	1.50	0.67	1.00	2.33	1.50	1.00	1.33	1.33	1.33	1.33	2.33	1.83	1.17	2.17
CO1	3	0	0	1	0	1	0	1	0	1	3	0	1	1
CO2	1	2	2	3	1	2	2	1	2	0	2	3	1	3
CO3	3	0	3	3	1	1	1	1	3	2	3	3	1	3
CO4	0	1	1	3	1	0	1	2	1	1	1	2	1	2
CO5	1	0	0	3	3	1	2	0	1	2	3	0	1	1
CO6	1	1	0	1	3	1	2	3	1	2	2	3	2	3
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
GEO106	1.33	1.17	1.67	2.33	2.00	1.33	1.50	0.83	1.17	0.67	2.33	1.83	2.17	1.67
CO1	2	1	1	2	1	1	1	0	0	0	2	1	1	0
CO2	1	2	1	2	2	1	2	1	1	0	2	2	2	1
CO3	1	1	2	2	2	1	2	1	1	1	2	2	2	2
CO4	1	1	2	3	2	1	2	1	1	1	3	2	2	2
CO5	2	1	2	3	2	2	1	1	2	1	3	2	3	2

CO6	1	1	2	2	3	2	1	1	2	1	2	2	3	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO251	2.83	0.17	1.83	2.17	2.17	1.00	1.83	2.17	1.67	0.50	2.67	2.17	1.83	2.00
CO1	3	0	1	2	2	0	1	1	1	0	3	1	1	2
CO2	3	0	1	2	2	1	2	2	2	0	3	2	2	2
CO3	3	0	3	2	2	1	1	2	1	0	3	3	2	1
CO4	3	0	3	3	2	2	2	3	2	1	3	2	1	3
CO5	2	0	1	2	2	1	3	2	2	2	2	2	3	1
CO6	3	1	2	2	3	1	2	3	2	0	2	3	2	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO252	1.33	1.33	1.67	1.50	1.50	1.00	1.33	0.67	0.50	0.83	1.83	1.50	1.83	1.67
CO1	3	2	1	1	1	0	1	0	0	1	2	1	2	0
CO2	1	2	1	2	2	0	1	1	1	1	2	2	2	2
CO3	1	1	3	2	2	1	1	0	1	1	2	2	2	2
CO4	2	2	2	1	1	2	2	1	0	1	2	1	2	2
CO5	0	1	2	2	1	1	2	0	0	1	1	1	1	2
CO6	1	0	1	1	2	2	1	2	1	0	2	2	2	2
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO107	2.00	1.50	2.17	2.00	2.17	2.17	1.67	0.67	1.50	1.00	2.17	2.17	2.17	2.17
CO1	2	1	2	1	2	2	1	0	1	1	2	2	2	1
CO2	2	1	2	2	2	2	1	0	1	1	2	2	2	2
CO3	2	2	2	2	3	3	2	1	2	1	2	2	3	2
CO4	2	2	3	2	2	2	2	1	2	1	2	3	2	3
CO5	2	1	2	2	2	2	2	0	1	1	2	2	2	2
CO6	2	2	2	3	2	2	2	2	2	1	3	2	2	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO253	2.00	1.50	2.17	2.00	2.17	2.17	1.67	0.67	1.50	1.00	2.17	2.17	2.17	2.17
CO1	2	1	2	1	2	2	1	0	1	1	2	2	2	1

CO2	2	1	2	2	2	2	1	0	1	1	2	2	2	2
CO3	2	2	2	2	3	3	2	1	2	1	2	2	3	2
CO4	2	2	3	2	2	2	2	1	2	1	2	3	2	3
CO5	2	1	2	2	2	2	2	0	1	1	2	2	2	2
CO6	2	2	2	3	2	2	2	2	2	1	3	2	2	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO254	2.50	1.67	1.67	1.67	1.67	1.67	1.17	0.67	1.50	1.00	1.83	1.67	1.67	1.83
CO1	3	1	1	1	2	1	1	0	2	1	2	1	1	1
CO2	2	2	1	2	1	1	1	0	2	1	2	2	2	2
CO3	3	2	2	2	2	2	2	1	2	1	2	2	2	2
CO4	2	2	2	2	1	2	1	1	1	1	1	2	2	2
CO5	3	1	2	2	2	2	1	1	1	1	2	2	2	2
CO6	2	2	2	1	2	2	1	1	1	1	2	1	1	2
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO255	1.67	0.67	1.83	1.83	2.17	1.83	1.33	1.50	2.00	0.17	2.33	2.67	2.00	2.50
CO1	2	0	2	1	2	1	1	1	2	0	2	3	2	2
CO2	2	1	2	1	2	1	1	1	2	0	2	3	2	2
CO3	2	1	2	2	2	3	1	2	2	0	3	2	2	3
CO4	1	1	2	3	2	2	2	2	2	0	2	3	2	3
CO5	1	0	1	2	3	2	2	1	2	0	2	3	2	2
CO6	2	1	2	2	2	2	1	2	2	1	3	2	2	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO351	1.17	1.33	0.83	1.50	1.50	1.67	1.67	1.67	1.50	1.33	1.67	1.83	1.50	1.83
CO1	1	1	0	1	1	2	1	2	0	1	2	2	1	1
CO2	0	1	1	2	2	1	2	2	2	1	2	2	1	2
CO3	1	2	0	2	1	2	2	2	1	1	2	3	2	1
CO4	1	1	2	2	1	2	1	2	2	2	1	2	1	3
CO5	2	1	1	1	2	2	2	1	2	1	1	1	2	2
CO6	2	2	1	1	2	1	2	1	2	2	2	1	2	2

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO352	2.83	1.83	1.67	2.33	1.83	2.17	1.83	2.00	0.17	1.50	2.17	2.17	2.33	2.33
CO1	3	1	2	2	2	2	1	2	0	1	2	2	3	2
CO2	3	2	2	2	1	2	2	1	0	1	2	2	2	3
CO3	3	2	1	2	3	2	2	2	0	1	2	3	2	2
CO4	2	2	2	3	1	2	2	3	0	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	1	2	2	2	3	2
CO6	3	2	1	3	2	3	2	2	0	2	3	2	2	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO353	2.00	2.50	1.83	1.67	1.67	1.83	1.67	1.67	1.83	1.50	2.00	2.00	2.17	1.83
CO1	2	2	1	1	2	2	1	2	1	0	2	2	2	0
CO2	2	3	2	3	2	2	1	2	2	1	2	2	2	3
CO3	2	2	2	2	2	2	2	0	2	1	2	3	2	2
CO4	2	3	2	1	1	1	2	3	2	2	2	0	3	2
CO5	2	3	2	2	2	2	2	1	2	2	2	3	2	2
CO6	2	2	2	1	1	2	2	2	2	3	2	2	2	2
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO354	2.00	1.33	1.50	2.17	1.50	1.67	2.00	1.50	1.50	0.33	1.83	1.83	2.00	2.00
CO1	2	1	1	2	1	1	1	1	1	0	2	2	2	2
CO2	2	2	1	2	1	2	2	1	1	0	2	1	2	2
CO3	2	1	1	2	1	1	2	1	1	0	2	2	2	2
CO4	2	2	2	3	2	2	2	2	2	0	2	2	2	2
CO5	2	1	2	2	2	2	2	2	2	1	1	2	2	2
CO6	2	1	2	2	2	2	3	2	2	1	2	2	2	2
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO355	1.83	1.00	1.33	1.50	2.17	1.50	1.67	1.00	1.67	1.83	2.00	2.17	2.00	2.00
CO1	3	1	0	1	3	0	1	0	2	2	3	1	2	1
CO2	1	1	1	2	2	2	1	1	2	2	3	2	1	3

CO3	2	0	3	2	3	1	2	1	1	3	1	3	3	2
CO4	3	1	2	3	2	1	3	2	1	1	2	2	2	3
CO5	0	1	1	0	1	2	2	0	2	1	2	3	1	1
CO6	2	2	1	1	2	3	1	2	2	2	1	2	3	2
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO356	1.83	0.83	1.67	1.67	1.33	1.83	1.00	0.50	1.33	0.83	2.33	2.00	2.17	1.50
CO1	3	0	1	1	0	1	0	0	1	0	3	1	1	0
CO2	3	1	2	1	2	1	1	0	1	1	2	3	2	1
CO3	2	2	3	1	2	2	0	1	1	1	3	2	2	2
CO4	2	1	1	3	1	2	2	1	2	2	1	2	3	2
CO5	1	0	2	1	0	3	1	0	2	0	3	1	2	1
CO6	0	1	1	3	3	2	2	1	1	1	2	3	3	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO357	2.17	0.67	1.50	1.17	2.17	1.00	0.83	1.33	1.67	0.33	2.50	1.83	1.33	2.00
CO1	3	1	0	0	2	1	0	1	0	0	2	0	0	1
CO2	2	1	2	1	3	1	1	1	2	1	3	2	1	2
CO3	2	0	3	1	2	0	1	1	3	0	3	2	2	2
CO4	3	1	2	1	2	0	1	1	2	0	3	2	2	2
CO5	2	1	1	1	2	3	2	2	2	1	2	2	1	2
CO6	1	0	1	3	2	1	0	2	1	0	2	3	2	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO358	1.00	1.17	1.50	2.17	2.50	1.67	1.50	0.33	1.17	1.33	2.33	2.17	2.50	2.17
CO1	2	1	1	1	2	1	1	0	0	1	2	2	1	1
CO2	2	1	1	1	3	1	1	0	1	1	3	2	2	2
CO3	1	1	2	2	2	2	1	0	0	0	3	2	3	2
CO4	1	2	2	3	2	2	2	0	1	1	2	2	3	2
CO5	0	1	2	3	3	2	2	1	2	2	2	3	3	3
CO6	0	1	1	3	3	2	2	1	3	3	2	2	3	3

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO451	2.67	1.17	2.33	2.50	2.33	2.33	2.17	0.33	1.50	0.33	2.67	2.50	2.00	1.67
CO1	2	1	1	3	2	3	2	0	1	0	3	2	1	0
CO2	2	1	2	3	2	3	2	0	1	1	3	2	2	0
CO3	3	1	3	2	3	2	2	1	2	0	3	3	3	2
CO4	3	1	2	2	3	1	2	1	1	0	2	3	2	3
CO5	3	2	3	2	2	2	2	0	2	1	3	3	2	2
CO6	3	1	3	3	2	3	3	0	2	0	2	2	2	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO452	1.33	1.00	1.50	1.67	1.83	2.00	1.50	1.83	0.83	1.00	2.00	2.00	1.83	1.33
CO1	1	1	1	1	2	1	1	1	0	0	2	2	2	1
CO2	2	2	1	2	2	2	1	2	1	1	2	2	2	1
CO3	1	0	2	2	2	3	2	3	0	1	2	2	1	2
CO4	2	1	2	2	2	2	1	2	1	1	2	2	2	1
CO5	1	1	2	2	2	2	2	1	2	1	2	2	2	1
CO6	1	1	1	1	1	2	2	2	1	2	2	2	2	2
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO453	1.67	1.50	1.00	2.00	1.17	1.17	0.83	0.83	1.33	0.67	2.17	1.67	2.50	2.17
CO1	3	0	1	1	1	0	0	0	1	0	3	2	2	1
CO2	2	3	2	3	0	2	1	1	2	1	2	3	3	2
CO3	1	1	0	1	1	0	0	0	1	0	2	2	3	2
CO4	3	2	1	2	2	1	2	1	1	0	2	1	3	3
CO5	0	1	1	2	1	1	0	1	1	2	2	1	2	2
CO6	1	2	1	3	2	3	2	2	2	1	2	1	2	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO454	1.83	1.67	1.50	2.00	1.50	2.00	2.00	0.17	2.00	1.50	2.00	1.83	1.67	1.83
CO1	2	1	0	2	1	2	1	0	2	1	2	1	0	1
CO2	2	2	1	2	1	2	2	0	2	1	2	2	2	2

CO3	2	1	2	2	2	2	2	0	2	2	2	2	2	2
CO4	2	2	2	2	1	2	2	0	2	1	2	2	2	2
CO5	1	2	2	2	2	2	2	1	2	2	2	2	2	1
CO6	2	2	2	2	2	2	3	0	2	2	2	2	2	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO405	1.33	0.50	1.00	1.50	1.67	1.17	1.50	1.83	1.33	1.50	1.50	1.67	2.00	1.33
CO1	2	1	0	0	1	0	1	2	1	1	1	0	2	1
CO2	2	1	1	0	2	2	1	1	2	1	1	2	2	0
CO3	0	0	2	2	3	1	2	2	0	1	2	3	2	2
CO4	2	1	1	2	1	1	2	2	1	2	2	1	2	1
CO5	0	0	2	3	1	2	1	1	2	2	2	2	2	1
CO6	2	0	0	2	2	1	2	3	2	2	1	2	2	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO456	1.33	1.00	1.33	1.50	1.33	1.50	1.17	0.83	1.17	1.00	1.33	1.67	1.67	1.67
CO1	3	1	0	1	1	1	0	0	1	1	2	1	1	1
CO2	1	3	1	1	1	0	1	0	1	2	1	2	1	1
CO3	1	1	3	1	0	2	1	1	1	0	2	2	2	2
CO4	2	0	1	3	1	1	2	2	1	0	1	1	2	1
CO5	1	0	2	1	3	2	2	1	1	1	1	2	2	2
CO6	0	1	1	2	2	3	1	1	2	2	1	2	2	3
	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO457	1.33	1.00	1.33	1.50	1.33	1.50	1.17	0.83	1.17	1.00	1.33	1.67	1.67	1.67
CO1	3	1	0	1	1	1	0	0	1	1	2	1	1	1
CO2	1	3	1	1	1	0	1	0	1	2	1	2	1	1
CO3	1	1	3	1	0	2	1	1	1	0	2	2	2	2
CO4	2	0	1	3	1	1	2	2	1	0	1	1	2	1
CO5	1	0	2	1	3	2	2	1	1	1	1	2	2	2
CO6	0	1	1	2	2	3	1	1	2	2	1	2	2	3

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PSO 01	PSO 02	PSO 03	PSO 04
GEO458	1.33	0.50	1.00	1.50	1.67	1.17	1.50	1.83	1.33	1.50	1.50	1.67	2.00	1.33
CO1	2	1	0	0	1	0	1	2	1	1	1	0	2	1
CO2	2	1	1	0	2	2	1	1	2	1	1	2	2	0
CO3	0	0	2	2	3	1	2	2	0	1	2	3	2	2
CO4	2	1	1	2	1	1	2	2	1	2	2	1	2	1
CO5	0	0	2	3	1	2	1	1	2	2	2	2	2	1
CO6	2	0	0	2	2	1	2	3	2	2	1	2	2	3
GEO459	1.83	1.67	1.50	2.00	1.50	2.00	2.00	0.17	2.00	1.50	2.00	1.83	1.67	1.83
CO1	2	1	0	2	1	2	1	0	2	1	2	1	0	1
CO2	2	2	1	2	1	2	2	0	2	1	2	2	2	2
CO3	2	1	2	2	2	2	2	0	2	2	2	2	2	2
CO4	2	2	2	2	1	2	2	0	2	1	2	2	2	2
CO5	1	2	2	2	2	2	2	1	2	2	2	2	2	1
CO6	2	2	2	2	2	2	3	0	2	2	2	2	2	3