TECHNO INDIA UNIVERSITY
WEST BENGAL

unlock endless career
opportunities with

M.Sc. in Geospatial Science

WELCOME TO THE FUTURE OF

GEOSPATIAL SCIENCE EDUCATION

A university-industry partnership program to get better industrial exposure

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GeoTeck

Title of the Course : **Master of Science in Geospatial Science**
(4-semester full-time day course)

Degree Offered : **Master of Science in Geospatial Science**

Introduction

Geospatial Science is a blend of art, science and technology, which develops and uses information science infrastructure to address the problems of Geosciences or Earth sciences and related branches of engineering. It involves the collection, integration, management, analysis, and presentation of geospatial data, models and knowledge that support disciplinary, multidisciplinary, interdisciplinary and transdisciplinary science and technological domain.
Geospatial Science entails the following four premises:

1) Collection and processing of geospatial data,
2) Development and management of databases for geospatial data,
3) Analysis and modeling of geospatial data, and
4) Development and integration of logic and computer tools and software for the first three.

Geospatial Science uses Geo-Computation and it ensures the development and use of Remote Sensing, Geographic Information System (GIS), and Global Navigation Satellite System (GNSS) in a common denominator. Geo-Computation involves using computational techniques to solve geospatial problems, along with an entirely novel approach of dealing science in a geospatial context.

Geospatial Science not only encompasses people from the domain of geography but also from other disciplines like Information Technology, Computer Application, Civil Engineering, Architecture, Archaeology, Geological Science, Environmental Science, Life Sciences, etc. who are choosing this discipline as their minor and even as major subject. With this uprising demand for Geospatial Science, it is now vital to doctor the contents of Geospatial Science curriculum towards more scientific subjects and the curriculum of the proposed course has been designed consequently.

In essence, Geospatial Science emerges as a dynamic convergence of art, science, and technology. It seamlessly weaves together diverse disciplines to unravel the intricate tapestry of our planet's geospatial intricacies. Its multifaceted approach, all-encompassing data collection, integration, management, and computational innovation, underscores its pivotal role in both specialized and interdisciplinary research and education. As the field expands beyond traditional geographical confines, drawing in professionals from Information Technology, Computer Application, Civil Engineering,

Architecture, Archeology, Mining and various other scientific domains, the evolving curriculum reflects the imperative to infuse scientific rigor into the study of Geospatial Science. This transformative journey not only empowers individuals from varied backgrounds to explore the depths of geospatial sciences but also positions Geospatial Science as an indispensable tool in addressing the complex challenges of our interconnected world.

The designed course is a multi-disciplinary masters course supported by theory and application-based courses in subjects like Remote Sensing, Geographic Information System (GIS), Database Management Systems, Geospatial Analysis, Programming languages, Photogrammetry, Global Navigation Satellite System (GNSS), LiDAR, Web and Mobile GIS, virtual reality in GIS, and Open-source geospatial technologies. This would give the students an exceptional opportunity to explore the wide applications in the multidisciplinary fields of Engineering, IT, Architecture, Construction, Infrastructure, Utilities, Environment, Planning, Management, and Governance.

Career Opportunities in Geospatial Science

The discipline of Geospatial Science is in its nascent stage and expanding at a rapid pace as more and more organizations are employing spatial data to manage their activities. Almost no developmental project is complete without geospatial information. Many countries have started specialized education in Geospatial Science after understanding its future impact. The need for Geospatial services is on the rise by 10—15% per annum. Data Bridge Market Research analyses that the global Geospatial Science market which was USD 9270.2 million in 2022, would rocket up to USD 23518.33 million by 2030, and is expected to undergo a CAGR of 11.90% during the forecast period (https://www.databridgemarketresearch.com/reports/global-geographic-information-system-gis-market).

Our Master's program intends to broaden and deepen students' expertise in geo-spatial data acquisition, data analysis and visualization. The course has been designed keeping the following things in mind:

- Nurturing professionals in the field of Geospatial Science
- Developing skills to cater to the needs of global Geospatial industry
- Developing hands-on learning expertise for spatial data handling

Geospatial Science professionals can be hired at various levels in positions like Remote Sensing Specialist, GIS Mapping Technician, GIS Data Specialist, GIS Application Specialist, GIS Business Analyst, GIS Engineer, GIS Operator, GIS Consultant, GIS Executive, GIS Programmer, GIS Developer, Geospatial Software Engineer, GIS Surveyor, GIS Technical Assistant, Photogrammetrist, Image Analyst, and many more.

In research and development sector, a Geospatial Science professional can be engaged as Scientific Officer, Coordinator, Research Associate, Scientist/Engineer (Natural Resource management, Petroleum and Mining, Agriculture, Forestry, Health, Disaster Management, Climate Change, Urban Planning and Management, etc.).

Major users of Geospatial Science applications and therefore employers are the Central and State governments, environmental agencies, national survey and mapping organizations, mineral exploration organizations, utility companies, emergency services, public health related organizations, international monitoring organizations, United Nations, transportation and infrastructure related organizations, police, military, market analysis and e-commerce companies.

The industry is promptly adopting these technologies for efficient delivery of products or processes. Companies such as Reliance Industries, Reliance Jio, L&T etc. are using geospatial technology for infrastructure project management. Various IT companies like Infosys, TCS, HCL, Acenture, Tech Mahindra, Wipro, Google, iGate etc are handling overseas projects based on Geospatial technologies. Some of the well-known industry giants like ESRI Inc., Intergraph, TomTom operates on specialized geospatial products. Many companies involved in the insurance sector are also using Geospatial technology.

Moreover, the integration of artificial intelligence (AI) with geographic information systems (GIS) is estimated to generate lucrative opportunities for the market. The emergence of geospatial artificial intelligence (GeoAI), which employs AI to extract information from geographical big data, has aided governments in the creation of smart cities, the planning of urban infrastructure, and the monitoring of changes over time in a given area.

The integration of the Internet of Things (IoT) with GIS also offers numerous growth opportunities within the market. Real-time location specific data is being produced as a result of the increasing use of Internet of Things (IoT) platforms in business operations. The combination of GIS and IoT devices gives users access to accurate data for geospatial data analysis. For instance, geographical data can be used to monitor an IoT-enabled valve or transmit telemetry data from any location in the world.

Faculty Members

The University has engaged highly experienced faculty members from academic sector as well as industry. Some of our internationally recognized faculty members are:

Dr. Atanu Kumar Raha, IFS (Retd), PhD
Director
Research, Education Extension and Development
Techno India University, West Bengal
Ex-principal Chief Conservator of Forests, WB
Member, WB Ecotourism Advisory Board

Dr. Basudeb Bhatta, MSc (Geoinformatics), PhD (Engineering)
Director and Co-Founder of Spatem GeoTeck Pvt. Ltd.
Ex Course Co-Ordinator of the Computer Aided Design Centre, Jadavpur University

Dr. Debasis Chakraborty, PhD
Emeritus Professor, Spatem GeoTeck Pvt. Ltd.
Ex Scientist & Head (Applications)
RRSC-East, NRSC
Indian Space Research Organisation

Dr. Aditi Sarkar, MSc (Geography), MTech (Geoinformatics), PhD (Engineering)
Chief Technical Manager, Spatem GeoTeck Pvt. Ltd.
Ex faculty of IIEST Shibpur and CAD Centre, Jadavpur University

Resource Person: Dr. Chandan Chakraborty, PhD, Professor, NITTTR Kolkata, Expertise - AI/ML and Statistics

Placement Opportunity

Techno India Group is the largest education group in West Bengal. Millions of students passed from our universities and colleges, and working in many reputed private as well as government organizations in India and abroad.

We are committed to provide placement assistance to regular, sincere and well performed students. At least 90% attendance is mandatory.

Eligibility Criteria and Course Structure

Eligibility for Admission:

1) B.E./B. Tech in Engineering or equivalent
2) B.Sc. Honours in any discipline
3) B. A. Honours (Geography/Environmental Studies)
4) BCA

Selection: First come first serve

Duration: 2-year (4-semester)

Semester	Full Marks	Full Marks	Total
I	300	250	550
II	250	250	500
III	150	250	400
IV	50	300	350
TOTAL	**750**	**1050**	**1800**

Exam Rules: Same as it is followed by the university

Course Curriculum for 2-year M.Sc. in Geospatial Science

SEMESTER - I

Sl. No.	Paper Code	Paper	Contact Hrs./ Week			Credit	Marks
			L	T	P		
Theory							
1	TIU-PGS-T101	Concepts of Computer and Programming	2	1	0	3	50
2	TIU-PGS-T102	Applied Statistics & Computing	2	1	0	3	50
3	TIU-PGS-T-103	Optical Remote Sensing and Ground Truthing	2	1	0	3	50
4	TIU-PGS-T104	Global Navigation Satellite System (GNSS)	2	1	0	3	50
5	TIU-PGS-T105	Geographic Information System (GIS)	2	1	0	3	50
6	TIU-PEN-T101	Career Advancement Skill Development (CASD)	2	1	0	3	50
Practical							
1	TIU-PGS-101L	Introduction to Python	0	0	4	4	100
2	TIU-PGS-104/105L	Geospatial Data Processing & GNSS	0	0	4	4	100
3	TIU-PES-S197	Entrepreneurship Skill Development (ESD)	0	0	2	2	50
Total Credit						**28**	**550**

SEMESTER – II

Sl. No.	Paper Code	Paper	Contact Hrs. / Week			Credit	Marks
			L	T	P		
Theory							
1	TIU-PGS-T201	DBMS and Geospatial Analysis	2	1	0	3	50
2	TIU-PGS-T202	Artificial Intelligence for Geospatial Data Analysis	2	1	0	3	50
3	TIU-PGS-T203	Digital Image Processing and Photogrammetry	2	1	0	3	50
4	TIU-PGS-T204	Thermal & Microwave Remote Sensing	2	1	0	3	50
5	TIU-PGS-S100	Career Advancement Skill Development (CASD)	2	1	0	3	50
Practical							
1	TIU-PGS-201L	Geospatial Database Management and Analysis	0	0	4	4	100
2	TIU-PGS-203L	Remote Sensing Image Processing	0	0	4	4	100
3	TIU-PES-S198	Entrepreneurship Skill Development (ESD)	0	0	2	2	50
Total Credit						**25**	**500**

SEMESTER – III

Sl. No.	Paper Code	Paper	Contact Hrs. / Week			Credit	Marks
			L	T	P		
Theory							
1	TIU-PGS-T301	Machine Learning for Geospatial Image Classification	2	1	0	3	50
3	TIU-PGS-T302	Modern GIS Trends with Augmented and Virtual Reality	2	1	0	3	50
4	TIU-PGS-T303	Career Advancement Skill Development (CASD)	2	1	0	3	50
Practical							
1	TIU-PGS-304L	Digital Photogrammetry, LiDAR, and Drone Image Processing	0	0	3	3	50
2	TIU-PGS-204L	Processing of Thermal and Microwave Image	0	0	3	3	50
3	TIU-PGS-305L	WebGIS and Google Earth Engine	0	0	3	3	50
4	TIU-PGS-306L	Project Planning and Seminar	0	0	3	3	50
5	TIU-PES-S297	Entrepreneurship Skill Development (ESD)	0	0	2	2	50
Total Credit						**23**	**400**

SEMESTER – IV

Sl. No.	Paper Code	Paper	Contact Hrs. / Week			Credit	Marks
			L	T	P		
Theory							
1	TIU-PGS-S401	Dissertation	0	0	20	20	250
2	TIU-PGS-T401	Career Advancement Skill Development (CASD)	1	1	0	2	50
3	TIU-PGS-S402	Grand viva				2	50
Total Credit						**24**	**350**
GRAND TOTAL (ALL SEMESTER)						**100**	**1800**

LIST OF PAPERS

THEORY PAPERS

Semester	Paper Code	Paper Title
I	TIU-PGS-T101	Concepts of Computer and Programming
	TIU-PGS-T102	Applied Statistics & Computing
	TIU-PGS-T-103	Optical Remote Sensing and Ground Truthing
	TIU-PGS-T104	Global Navigation Satellite System (GNSS)
	TIU-PGS-T105	Geographic Information System (GIS)
	TIU-PEN-T101	Career Advancement Skill Development (CASD)
II	TIU-PGS-T201	DBMS and Geospatial Analysis
	TIU-PGS-T202	Artificial Intelligence for Geospatial Data Analysis
	TIU-PGS-T203	Digital Image Processing and Photogrammetry
	TIU-PGS-T204	Thermal & Microwave Remote Sensing
	TIU-PGS-S100	Career Advancement Skill Development (CASD)
III	TIU-PGS-T301	Machine Learning for Geospatial Image Classification
	TIU-PGS-T302	Modern GIS Trends with Augmented and Virtual Reality
	TIU-PGS-T303	Career Advancement Skill Development (CASD)
IV	TIU-PGS-T401	Career Advancement Skill Development (CASD)

PRACTICAL PAPERS

Semester	Paper Code	Paper Title
I	TIU-PGS-101L	Introduction to Python
	TIU-PGS-104/105L	Geospatial Data Processing & GNSS
	TIU-PES-S197	Entrepreneurship Skill Development (ESD)
II	TIU-PGS-201L	Geospatial Database Management and Analysis
	TIU-PGS-203L	Optical Image Processing
	TIU-PES-S198	Entrepreneurship Skill Development (ESD)
III	TIU-PGS-304L	Digital Photogrammetry, LiDAR, and Drone Image Processing
	TIU-PGS-204L	Processing of Thermal and Microwave Image
	TIU-PGS-305L	WebGIS and Google Earth Engine
	TIU-PGS-306L	Project Planning and Seminar
	TIU-PES-S297	Entrepreneurship Skill Development (ESD)
IV	TIU-PGS-S401	Project and Dissertation
	TIU-PGS-S402	Grand Viva

DETAILED SYLLABUS OF THE COURSE

SEMESTER-I

Theory Paper: Concepts of Computer and Programming

Unit I: *Exploring computers and their usage* - Computers for individual users, computers for organizations, parts of a computer system, role of computer users.

Unit II: *Processing Data* -Difference between data and information, how computers process data, factors affecting processing speed, modem CPUs.

Unit III: *Data and number representation* -Number systems, bit and byte, text codes, conversion of numbers from one system to the other, binary-complement representation BCD-ASCII, 2's complement representation, binary arithmetic.

Unit IV: *Storing Data* -Categorizing storage devices, magnetic storage devices, optical storage devices, solid-state storage devices, average access time, data transfer rate, optimizing disk performance, drive-interface standards.

Unit V: *Introduction to Programming Concepts* -Overview of programming languages and their applications, Understanding variables, data types, and operators, Control structures: conditional statements and loops, Concept of web technologies – HTML and CSS basics, Python, R programming environment.

References:

1. Computers Are Your Future by Catherine LaBerta
2. Introduction to Programming Using Python by Y. Daniel Liang
3. Programming Logic and Design by Joyce Farrell
4. HTML and CSS: Design and Build Websites by Jon Duckett

Theory Paper: Applied Statistics and Computing

Unit I: *Matrix theory and Permutation* – Vector and matrix, matrix arithmetic, data representation, matrix inverse computation, solving linear equations, eigenvalues, eigenvectors, orthogonal transformation and applications, concept of permutation and combination.

Unit I: *Introduction to Statistical Concepts* - Mean, Mode, Median, Geometric mean and Harmonic Mean; Measures of variations - Range, Quintile

deviations, Mean deviation, Standard deviation and variance, Coefficient of variations. Graphical concepts – Box plot and Histogram.

Unit II: *Probability concepts* – Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem, and independence, Standard probability distributions viz., Binomial, Poisson and normal with application with their properties.

Unit III: *Sampling distribution* - Standard error. Different sampling techniques like simple random sampling, stratified random sampling, systematic sampling, cluster and multi-storage sampling.

Unit IV: *Correlation and Regression Modeling* - Correlation Analysis, Pearson's Coefficient of Correlation, Auto Correlation; Regression Analysis – Simple linear and multiple regression models; Least Square estimation (LSE), Maximum likelihood estimation (MLE), Non-linear regression – Logistic regression model for binary outcome. Goodness of fit. Applications.

References:

1. Applied Statistical Learning by Matthias Schonlau. Springer Cham, 2023.
2. Applied Statistics by RG Selvi and C Kailasam, KALYANI; First Edition (1 January 2017).
3. Introduction to Statistical Learning: with Applications in R by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani
4. Joe L. Mott, Abraham Kandel, Theodore P. Baker, Discrete Mathematics for Computer
5. Introduction to Linear Algebra by Gilbert Strang, Wellesley-Cambridge Press

Theory Paper: Optical Remote Sensing and Ground Truthing

Unit I: Concept of energy, conversion of energy, electromagnetic energy, web model, particle model, radiant flux, electromagnetic spectrum, properties of electromagnetic energy (for optical, thermal, microwave), energy-matter interactions, absorption, scattering, reflection, refraction, transmission, types of reflectors, colour theory (RGB, IHS, CMYK), light filters.

Unit II: Types of remote sensing, orbital characteristics of remote sensing satellite, remote sensing satellite, advantages and limitations of remote sensing, ideal remote sensing system, sensor resolutions (spatial, spectral, radiometric, temporal), image referencing system, Indian space program, Indian launch programs, Indian remote sensing satellites.

Unit III: Process and principle of optical remote sensing, Aerial photography, types of camera, functional concept of aerial cameras, types of filters, types of films, film size, film resolution, geometry of aerial photography, scale, vantage point.

Unit IV: Concept of digital imaging, types of sensors, imaging sensors, framing and scanning sensors, across track scanning, along track scanning, hyperspectral imaging, digital framing system.

Unit V: Sensor specifications (Landsat, Spot, all IRS, Ikonos, QuickBird, OrbView, GeoEye, WorldView, etc.).

Unit VI: Ground-truth data, requirements and instruments for ground truthing, parameters of ground truthing, factors of spectral measurement.

References:

1. Bhatta, B. (2020): *Remote Sensing and GIS*, 3rd ed., Oxford Univ. Press.
2. Campbell, J.B. (1996): *Introduction to Remote Sensing*, 2nd edition, Taylor and Francis, London.
3. Jensen, J.R. (2006): *Remote Sensing of the Environment: An Earth Resource Perspective*, Prentice Hall, Upper Saddle River, New Jersey.
4. Lillesand, T.M. and Kiefer, R. W. (1994): *Remote Sensing and Image Interpretation*, 3rd edition, John Wiley and Sons, New York.
5. Sabins, F.F. (1997): *Remote Sensing: Principles and Applications*, 3rd edition, W.H. Freeman & Company, New York.

Theory Paper: Global Navigation Satellite System (GNSS)

Unit I: Fundamentals of geodesy, Geodetic reference systems, Geoid and geoidal heights and undulations. Geodetic datum and datum transformation, Coordinate systems, geographical coordinate system, shape of the earth, and geoid, WGS 1984 datum, Indian geodetic datum, Projection systems.

Unit II: Navigation and positioning, points of reference, history of navigation systems, global navigation satellite system (GNSS), GPS, GLONASS, Galileo, Beidou, space segment, control segment, user segment.

Unit III: Working principle of GNSS, triangulation and trilateration, almanac and ephemeris, timing and ranging, GNSS signals and range determination, radio wave.

Unit IV: GNSS signals—carriers and codes, navigation message, GNSS time, ranging codes, modulated carrier wave and phase shift, observables—pseudorange and carrier phase, pseudorange measurement, carrier phase

measurement, GNSS errors and solutions, positioning methods, point positioning, relative/differential positioning, single difference, double difference, triple difference, kinematic positioning.

Unit V: GNSS augmentation (EGNOS, WAAS, MSAS, GAGAN, DGPS) and other navigation satellite systems (Quasi-Zenith Satellite System, Indian Regional Navigational Satellite System), GNSS receivers, classification of GNSS receivers, applications of GNSS, surveying and mapping with GNSS.

References:

1. Kanetkar, R.P. and Kulkarni, S.V. (1988): *Surveying and Levelling,* Part-I, Vaidyarthi Griha Prakashani, Pune.
2. Shepherd, F.A. (1983): *Engineering Surveying*, Edward Arnold, London.
3. Bhatta, B. (2021): *Global Navigation Satellite Systems: New Technologies and Applications,* 2nd ed., CRC Press, New York.

Theory Paper: Geographic Information System (GIS)

Unit I: Introduction to GIS, concept about geographical data, difference between GIS and information system in general, GIS components, function and advantages of GIS, differences from CAD and AM/FM technology, three views of GIS, dimensions of geographic data, scope and application areas, limitations.

Unit II: Spatial data models, idea of conceptual, logical and physical models; spatial entity and object, conceptual data model, logical data model, various raster data models (field-based raster, object-based raster), various object-based vector data models (spaghetti, vertex dictionary, DIME, Topological), field-based vector (point model, isoline, lattice, triangulated irregular network), object oriented data model, object-class concept (classification of objects), file formats of spatial data.

Unit III: Process of GIS, data capture, data source, encoding raster data, encoding vector data, encoding attribute data, geocoding, quality issues, vector cleaning, linking of spatial and attribute data.

Unit IV: Map scale: types & importance; General maps: types and applications; Thematic maps: types and applications; interpretation of topographical map, projection, selection of projection, projection transformation, classification of projections, cylindrical projection, conical projection, azimuthal projection, projection parameters (linear parameters, angular parameters), common types of projections; compilation of map (frame, title, legend, scale, charts, north arrow, label, grids, supplementary information, map symbols and colours, etc.), representation of statistical data (choropleths, isopleths, dots, unimodal, 2D and 3D diagrams).

References:

1. Land Resources Assessment, Oxford Publications.
2. Chang, K. (2008): Introduction to Geographical Information System, Fourth Edition, Tata McGraw Hill.
3. Bhatta, B. (2020): *Remote Sensing and GIS*, 3rd ed., Oxford Univ. Press.
4. Chaisman, N. (1992): *Exploring Geographical Information Systems*, John Wiley and Sons Inc., New York.

Paper: Career Advancement Skill Development (CASD)

Unit I: Concepts in Communication: Communication as sharing; context of communication; the speaker/writer and the listener/reader; medium of communication; barriers to communication; accuracy, brevity, clarity and appropriateness in communication;

- Non-verbal skills,
- Paralanguage and Body language

Unit II: Semantics: A selected list of Synonyms, Antonyms, Homophones and Homonyms. Form and function of words. Syntax: Sentence structures, Verb patterns and their usage

Unit III: Writing Skills: Types of writing (Expository, Descriptive, Analytic, Argumentative, Narrative etc) and their main features. Resumes and CV's and Cover letters. Memos and Notices. Basics of Formal Reports.

Practical Paper: Introduction to Python

Unit I: *Introduction to Python Language* - IDLEs (Google Colab, Anaconda etc) Dynamic Types, Naming Conventions, String Values, String Operations, String Slices, String Operators, Numeric Data Types, Conversions, Control Flow and Syntax, Indenting, The if Statement, Relational Operators, Logical Operators.

UNIT II: *Functions and Modules* -Introduction, Defining Your Own Functions, Parameters, Function Documentation, Keyword and Optional Parameters, Passing Collections to a Function, Variable Number of Arguments, Scope, Functions - "First Class Citizens", Passing Functions to a Function, Mapping Functions in a Dictionary, Lambda, Modules, Standard Modules – sys, Standard Modules – math, Standard Modules – time, The dir Function.

UNIT III: *I/O and Error Handling In Python* -Introduction, Data Streams, Creating Your Own Data Streams, Access Modes, Writing Data to a File, Reading Data From a File, Additional File Methods, Using Pipes as Data Streams, Handling IO Exceptions, Working with Directories, Metadata, Errors,

Run Time Errors, The Exception Model, Exception Hierarchy, Handling Multiple Exceptions.

UNIT IV: *Python Packages for Geospatial Data Analysis* – Understanding geospatial data formats (GeoJSON, GeoTIFF, Geopackage (GPKG) etc.); Geopandas – Plotting with GeoPandas; Folium for interactive maps, Rasterio and Geoplot.

References:

- Dive into Python, Mike
- Learning Python, 4th Edition by Mark Lutz
- Programming Python, 4th Edition by Mark Lutz

Practical Paper: Spatial Data Processing and GNSS

Unit I: QGIS: Interface & Plugins concepts, Raster handling/processing, Georeferencing (image to image), Georeferencing (image to ground), Working with vector layer (R2V conversion), vector editing etc. Vector styling, labeling, Import CSV file, Coordinate extraction, Join external file with vector layer, Projection transformation, Field Calculation, vector data capturing from Google map, Google earth and OpenStreetmap, Bing maps, OpenStreetMap etc., vector layer conversion (KML, GML, geojson etc.).

Unit II: ArcgisPro: Georeferencing (image to image), Georeferencing (image to ground), Working with vector layer (R2V conversion), metadata creation and editing, vector layer creation, setting projection for map and layers, change map into different projection to see the effect, design Geodatabase, vector (generation/editing), transform longitude, latitude information into point layer, vector editing etc. Vector styling, labeling, Import CSV file, Coordinate extraction, Join external file with vector layer, Projection transformation, Field Calculation, vector data capturing from Google map, Google earth and OpenStreetmap, Bing maps, OpenStreetMap etc., vector layer conversion (KML, GML, geojson etc.), perform attribute and spatial query, prepare Thematic map, display map labels, generate layout for map publication.

Unit III: Planning the GNSS survey, general factors for GNSS surveying, accuracy considerations, obstructions, occupation time, recording rate, measurement redundancy, satellite geometry, point or line offset, survey of control points, survey of geographic features with attribute information, designing of attribute database; Static.

Unit IV: Mobile GNSS, differential GNSS survey.

Unit V: RTK and PPK, mapping with surveyed data, stakeout.

Practical Paper: Entrepreneurship Skill Development (ESD)

Unit I: Recognize and evaluate potential business opportunities within geospatial science, understanding market needs and trends. Master the structure and organization of research and review papers.

Unit II: Develop comprehensive business plans and effective strategies for launching and sustaining geospatial science-based ventures.

Unit III: Understand and apply financial principles for budgeting, projection, and management specific to geospatial startups.

Unit IV: Navigate legal and ethical considerations associated with entrepreneurship in geospatial science/technology, including intellectual property and safety regulations.

Unit V: Develop strong communication, networking, and presentation skills to foster innovation, collaboration, and successful business development within the geospatial sector.

SEMESTER-II

Theory Paper: DBMS and Geospatial Analysis

Unit I: Introduction to DBMS, architecture, administration roles, data dictionary, DBMS users, Traditional models, three-level architecture, hierarchical model, network model and relational model, File organization, Security.

Unit II: Relational model – definitions and properties, keys, integrity rules, relational algebra, joins, set operations, Tuple relational calculus SQL constructs, embedded SQL, Query & Query Optimisation Techniques.ER model concepts.

Unit III: Database design, conceptual, logical and physical models, ER diagram and model, Functional Dependency (Armstrong's Axioms), Normal forms (1NF, 2NF, 3NF, BCNF) Indexing- Primary, Secondary, Multilevel. Distributed database, temporal database and object-oriented database.

Unit IV: Concept of spatial database/geodatabase, spatial indexing, feature subtype and domain, topology rules, supported geometry types, spatial operators and functions, spatial query and aggregation.

Unit V: Geospatial data analysis methods, database query (query by attribute data, query by spatial data, proximity analysis), geospatial measurement (measurement of density, measurement of distance, measurement of neighbourhood), vector overlay (point in polygon, line on polygon, polygon on polygon), raster overlay, multi-criteria analysis, raster calculation, network analysis (network tracing, network routing, network allocation), zonal statistics, surface analysis (deriving countour, slope/aspect analysis, hillshade, viewshed, watershed, surface intersection), hydrological analysis, geovisualization, classification and reclassification, map comparison, chart, report, layout, 3D visualization.

References:

1. C. J. Date, A. Kannan and S. Swamynathan, An Introduction to Database Systems, Pearson Education, Eighth Edition, 2009.
2. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, Database System Concepts, McGraw-Hill Education (Asia), Fifth Edition, 2006.
3. Shio Kumar Singh, Database Systems Concepts, Designs and Application, Pearson Education, Second Edition, 2011.
4. Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management, Thomson Learning-Course Technology, Seventh Edition, 2007.
5. Patrick O'Neil and Elizabeth O'Neil, Database Principles, Programming and Performance, Harcourt Asia Pte. Ltd., First Edition, 2001.

Theory Paper: Artificial Intelligence for Geospatial Data Analysis

Unit I: *Introduction to Geospatial Data* - Basics of geographic information systems (GIS), spatial data types, coordinate systems, and spatial analysis techniques; Geospatial Data Processing: Preprocessing geospatial data, feature extraction, and transformation techniques.

Unit II: *Fundamentals of AI* - Machine learning, deep learning, and their applications in various domains.

Unit III: *Feature Engineering for Geospatial Data* - Extracting Meaningful Features from Geospatial Information, Spatial Feature Engineering Techniques, Temporal Feature Extraction, Feature Scaling and Normalization, Dimensionality Reduction Methods.

Unit IV: *Geospatial Data Analysis* - Statistical analysis, spatial autocorrelation, clustering, and spatial regression techniques.

Unit V: *Machine Learning for Geospatial Data* - Supervised and unsupervised learning algorithms applied to geospatial data, including classification, regression, and clustering.

Unit VI: *Performance evaluation* – AI model performance using precision, recall, F1-score, ROC analysis, and few case studies for practical understanding.

References:

- Geospatial Data and Analysis by Aurelia Moser, Jon Bruner, Bill Day Released February 2017 Publisher(s): O'Reilly Media, Inc. ISBN: 9781491940556.
- Handbook of Geospatial Artificial Intelligence by Gao, Hu and Li, CRC Press, 2023.
- Artificial Intelligence in Geography by Stan Openshaw, Christine Openshaw, Wille Pub., 1997.
- https://www.ibm.com/products/environmental-intelligence-suite/geospatial-ai

Theory Paper: Digital Image Processing and Photogrammetry

Unit I: Visual image interpretation: Border/marginal information of photographic product, image reading, image measurement, image analysis, elements of optical image interpretation (location, size, shape, shadow, tone, colour, texture, pattern, height/depth, site, situation, association), interpretation keys, interpretation of thermal image (diurnal heating effect, thermal properties of water and land), interpretation of radar image (tone, colour, shape, structure, size, speckle, antenna pattern, texture).

Unit II: Digital image processing (Preprocessing): Image processing system, digital image, data formats (BIP, BIL, BSQ), header information, preprocessing (destriping, missing scan line removal, random noise removal, vignetting removal, sun angle and topography correction, atmospheric correction, geometric correction, resampling and interpolation, mosaicking, subsetting).

Unit III: Image Enhancement: magnification, reduction, colour-composite, transact, contrast stretch, min-max stretch, average and standard deviation stretch, piecewise stretch, histogram equalization, histogram normalization, reference stretch, density slicing, thresholding, filtering, convolution filter, statistical filter, frequency domain filter, crisp filter).

Unit IV: Image Transformation: Addition, subtraction, multiplication, indices, principal component transformation, colour space transformation, Fourier transformation, image fusion.

Unit V: Image classification: Unsupervised, supervised, information class and spectral class, minimum distance, maximum likelihood, parallelepiped, feature space, K-means clustering, ISODATA clustering, accuracy assessment, post classification processing.

Unit VI: Photogrammetry: Types of photogrammetry, image acquisition from aerial platform (metric camera, stereo metric camera, digital metric camera, aerial imaging scanners), image acquisition from satellite platform (off nadir stereo image, fore-aft camera concept, scene-specific imaging concept) geometric distortion in imagery (relief displacement, radial distortion, tangential scale distortion, scan skew, earth-rotation skew, platform attitude skew), orientation and triangulation, stereo model, principles of stereoscopic vision, stereoscopic 3D viewing, lens stereoscope, mirror stereoscope, quad buffered stereo, line interleaved stereo, anaglyph stereo, stereoscopic measurement, parallax, orthorectification, outputs of digital photogrammetry.

References:

1. Bhatta, B. (2020): *Remote Sensing and GIS*, 3rd ed., Oxford Univ. Press.
2. Campbell, J.B. (1996): *Introduction to Remote Sensing*, 2nd edition, Taylor and Francis, London.
3. Jensen, J.R. (2006): *Remote Sensing of the Environment: An Earth Resource Perspective*, Prentice Hall, Upper Saddle River, New Jersey.
4. Lillesand, T.M. and Kiefer, R. W. (1994): *Remote Sensing and Image Interpretation*, 3rd edition, John Wiley and Sons, New York.
5. Sabins, F.F. (1997): *Remote Sensing: Principles and Applications*, 3rd edition, W.H. Freeman & Company, New York.

Theory Paper: Thermal and Microwave Remote Sensing

Unit I: Radiant and kinetic temperature, blackbody radiation, thermal imaging, thermal capacity, thermal conductivity, thermal inertia, thermal image and temperature mapping, thermal remote sensing sensors.

Unit II: Passive microwave remote sensing, active microwave remote sensing, radar imaging, radar bands, polarization, viewing geometry.

Unit III: Spatial resolution of radar, real aperture radar, synthetic aperture radar, speckle, layover, foreshortening, radar shadow, surface roughness, dielectric properties of terrain, airborne and space-borne radar systems.

Unit IV: Interferometric SAR.

References:

1. Bhatta, B. (2020): *Remote Sensing and GIS*, 3rd ed., Oxford Univ. Press.

2. Campbell, J.B. (1996): *Introduction to Remote Sensing*, 2nd edition, Taylor and Francis, London.
3. Jensen, J.R. (2006): *Remote Sensing of the Environment: An Earth Resource Perspective*, Prentice Hall, Upper Saddle River, New Jersey.
4. Lillesand, T.M. and Kiefer, R. W. (1994): *Remote Sensing and Image Interpretation*, 3rd edition, John Wiley and Sons, New York.
5. Sabins, F.F. (1997): *Remote Sensing: Principles and Applications*, 3rd edition, W.H. Freeman & Company, New York.

Theory Paper: Career Advancement Skill Development (CASD)

Unit I: *Concepts in Communication* - Communication as sharing; context of communication; the speaker/writer and the listener/reader; medium of communication; barriers to communication; accuracy, brevity, clarity and appropriateness in communication; Non-verbal skills, Paralanguage and Body language.

Unit II: *Semantics* - A selected list of Synonyms, Antonyms, Homophones and Homonyms. Form and function of words. Syntax: Sentence structures, Verb patterns and their usage.

Unit III: *Writing Skills* - Types of writing (Expository, Descriptive, Analytic, Argumentative, Narrative etc) and their main features. Resumes and CV's and Cover letters. Memos and Notices. Basics of Formal Reports.

Practical Paper: Geospatial Database Management and Analysis

Unit I: *MS Access* - Database designing (table, form, and report creation), Sort and Filter Records, SQL query, relationship between tables and joins, Import & export table data, Use visual basic for applications (VBA), create macro.

Unit II: *PostgreSQL* - Installation, architectural fundamentals, pgAdmin IV, database creation, Data definition, manipulation, Queries, data types, functions and operations, SQL for database operations, Graphical query builder.

Unit III: *PostGIS* - installation, spatial database creation, loading spatial data, PostGIS data types, Spatial relationships and joins, SQL based spatial operations, PostGIS functions, Advanced Spatial Queries, view spatial data in a PostGIS database from QGIS.

Unit IV: Join and relate external attribute data with vector layer, create topology and perform topological editing, merge and dissolve features, spatial adjustment for vector layer, address geocoding, Create fishnet, geotagged photos to points, add Basemap, add data from ArcGIS online.

Unit V: Geoprocessing on vector layer and model building, Proximity analysis, Points in Polygon Analysis, raster overlay analysis, interpolation analysis, density analysis, network analysis, Heatmaps analysis, Distance matrix analysis, surface interpolation, DEM surface analysis.

Unit VI: Hydrological analysis, raster reclassification, raster calculation, zonal statistics, distance analysis such as Euclidean (straight-line) and Cost-weighted distance, suitable site finding using multi-criteria analysis, 3D analysis on map and Globe, animation, report and graph preparation.

Practical Paper: Optical Image Processing

Unit I: Visual interpretation, opening an image, zoom, pan, band combination, image info, pixel inquiry, multilayer arrangement, image co-ordinates, header file, saving, Image profile (choosing appropriate band/s),

Unit II: Georeferencing (image to image, image to ground, image to map), mosaicking, AOI tools, subsetting (spatial and spectral).

Unit III: Contrast enhancement, convolution filter, crisp filter, index (iron oxide, clay, NDVI, SAVI, NDBI), colour space transformation, FFT, fusion, change detection.

Unit IV: Unsupervised classification, supervised classification, accuracy assessment, unsupervised classification of NDVI and other index image, post-classification vectorisation, layer stack, supervised classification using optical bands in addition to principal component images and indexed image, sub-pixel classification, object based classification, post-classification filtering, classification of change image, pseudo color image preparation, map composition, import/export.

Unit V: Modeler, reflectance calculation.

Practical Paper: Entrepreneurship Skill Development (ESD)

Unit I: Recognize and evaluate potential business opportunities within Geospatial Technology, understanding market needs and trends. Master the structure and organization of research and review papers.

Unit II: Develop comprehensive business plans and effective strategies for launching and sustaining geospatial-based ventures.

Unit III: Understand and apply financial principles for budgeting, projection, and management specific to geospatial startups.

Unit IV: Navigate legal and ethical considerations associated with entrepreneurship in geospatial domain, including intellectual property and safety regulations.

Unit V: Develop strong communication, networking, and presentation skills to foster innovation, collaboration, and successful business development within the microbiology sector.

SEMESTER-III

Theory Paper: Machine Learning for Geospatial Image Classification

Unit I: *Introduction to Geospatial Image Classification* – Overview of remote sensing and GIS applications, Basics of image classification and its significance in geospatial analysis.

Unit II: *Preprocessing and Feature extraction* – Image acquisition and preprocessing techniques, image enhancement, Spectral features, Texture analysis, Principal Component Analysis for dimensionality reduction.

Unit III: *Supervised Learning for Geospatial Image Classification* – Introduction to supervised ML algorithms (Decision Trees, Random Forest, SVM etc.), Model training, Overfitting, Underfitting, Bias and Variance etc.

Unit IV: *Unsupervised Learning for Geospatial Image Classification* – Clustering algorithms (k-means, Hierarchical clustering etc.), Dendogram, Cluster validity and pattern identification.

Unit V: *Deep Learning for Geospatial Image Classification* – Introduction to Convolutional Network Networks (CNN), Transfer learning for remote sensing applications.

Unit VI: *Python for AI/ML* – Implementation of AI and ML selective algorithms using Python for geospatial image data classification.

References:

1. Deep Learning for Remote Sensing Images with Open-Source Software by Rémi Cresson Released July 2020 Publisher(s): CRC Press, 2020.
2. GIS and Machine Learning for Small Area Classifications in Developing Countries by Ojo, Adegbola, CRC Press.

3. Image Analysis, Classification and Change Detection in Remote Sensing by MJ Canty, CRC Press, 2019.
4. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
5. Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

Theory Paper: Modern GIS Trends with Augmented and Virtual Reality

Unit I: Multidimentional GIS, virtual-reality in GIS, Spatial Data Infrastructure (SDI), Services-based GIS, WebGIS, Mobile GIS, Online Mapping APIs, big data operations into spatial analysis, Real-Time GIS, Mobile GIS app development, Vector tiling.

Unit II: Open data, open standards and open source a trend within the GIS industry, open data policy, opensource software, national geospatial policy.

Unit III: Evolution of GIS from desktop to Web, WebGIS application or Geoportal, types of Webmaps used in Geoportal, components of WebGIS, potentials of WebGIS, evolution of WebGIS technology, WebGIS architectures, comparative assessment of WebGIS components, virtualGIS.

Unit IV: Applications of geospatial science in Land-cover/land-use, agriculture, forestry, geology, geomorphology, health monitoring, urban, hydrology, mapping, oceanography, crime mapping, public Health Engineering, business development, transportation, disaster management.

References:

1. Deitel Nieto, H.M. *et al.* (2003): *Internet and World Wide Web - How to program*, Second Edition, Prentice Hall of India, New Delhi.
2. Ford, A. and Dixon, T. (1996): *Spinning the Web*, 2/e. International Thomson Computer Press.
3. Fu, P. and Sun, J. (2010): *Web GIS: Principles and applications*, ESRI.
4. Powell, T.A. (2003): *The Complete Reference - Web Design*, Tata McGraw Hill Publishing Company, New Delhi.
5. Ramalho, J.A. (2000): *Advanced HTML 4.0 with DHTML*, BPB Publications, New Delhi.

Theory Paper: CASD-Scientific writing

Course outcome:

- Develop effective scientific communication skills
- Master the structure and organization of research and review papers
- Convey complex microbiological concepts clearly and concisely
- Acquire proficiency in proper citation methods

- Understand and apply ethical considerations in scientific writing

Practical Paper: Digital Photogrammetry, LiDAR and Drone Mapping

Unit I: Non-oriented and oriented digital stereo model (DSM), checking the accuracy of DSM, measuring 3D information, collecting and editing 3D GIS data, automated DTM extraction, DEM editing, orthorectification.

Unit II: LiDAR scanning technique and devices, products of LiDAR, applications, advantages and limitations, LiDAR data processing, colour generation, classification, DEM, DSM, Contour.

Unit III: Drone mapping, types of drone, drone rules in India, mission planning, spatial resolution, accuracy issues, advantages and limitations, outputs of drone image processing, mission planning, spatial resolution/flight altitude calculation, flight mission control.

Unit IV: Drone Image Processing for daylight and multispectral data, image alignment, GCP integration, point cloud generation and classification, mesh, texture, DSM, DEM, Contour, Orthoimage, Video, RTK/NRTK/NTRIP/PPK flight, volumetric analysis.

Practical Paper: Processing of Thermal and Microwave Image

Unit I: Visual interpretation of thermal and microwave image; diurnal heating effects, thermal properties of water and land; RADAR image tone, texture, shape, structure, size, speckle, antenna pattern, dielectric properties, surface roughness, surface geometry, polarization.

Unit II: Heat map generation, hot spot mapping.

Unit III: Calibrating the SAR data, multilook processing, speckle reduction, terrain correction.

Unit IV: Polarimetric analysis of SAR image, multiband analysis, classification of SAR image, different applications.

Unit V: SAR Interferometry.

Practical Paper: WebGIS and Google Earth Engine

Unit I: HTML, CSS.

Unit II: JavaScript, OpenLayers.

Unit III: Geoportal using open-source MapServer package, open-source Geoserver software for publishing GIS data on the web, implement OGC open standards like WMS, WFS etc.

Unit IV: Google Earth Engine

Practical Paper: Project Planning and Seminar

Unit I: GIS Project planning

Unit II: GIS project implementation

Unit III: Project management

Unit IV: Estimation and costing of commercial projects, cost-benefit analysis

Unit V: Seminar and Presentation on a project

Practical Paper: Entrepreneurship Skill Development (ESD)

Unit I: Recognize and evaluate potential business opportunities within Geospatial Technology, understanding market needs and trends. Master the structure and organization of research and review papers.

Unit II: Develop comprehensive business plans and effective strategies for launching and sustaining geospatial-based ventures.

Unit III: Understand and apply financial principles for budgeting, projection, and management specific to geospatial startups.

Unit IV: Navigate legal and ethical considerations associated with entrepreneurship in geospatial domain, including intellectual property and safety regulations.

Unit V: Develop strong communication, networking, and presentation skills to foster innovation, collaboration, and successful business development within the microbiology sector.

SEMESTER-IV

Sessional Paper: Dissertation

Six-months dissertation work on any selected topic on Geospatial Science. One hard copy and one soft copy in PDF format of the dissertation is necessary to be submitted. Students shall present and defend their dissertation in front of other students, faculties, and subject experts in a seminar.

Theory Paper: Career Advancement Skill Development (CASD)

Unit I: Communication skill development for interview

Unit II: Skill development for technical interview

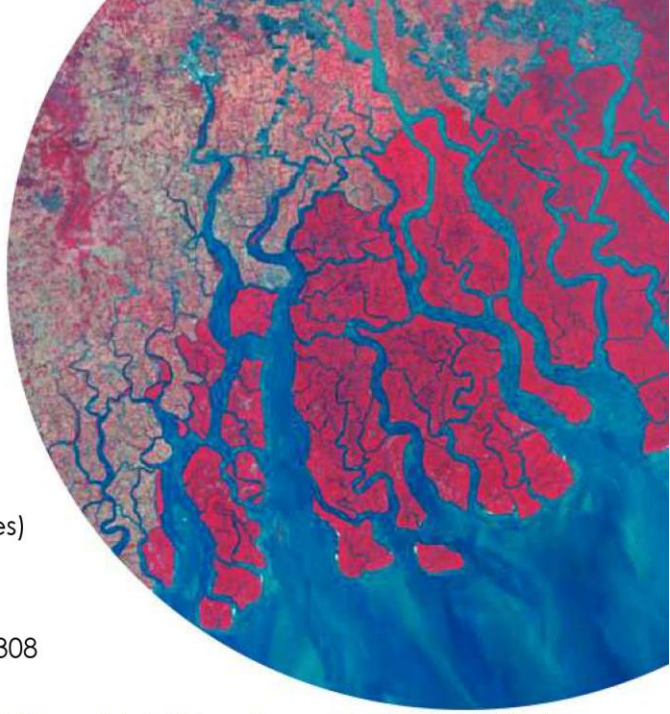
Unit III: Skill development for HR interview

Unit IV: Ethics and body language in interview

Unit V: Writing a cover letter, preparing an impressive resume

Grand Viva

A viva will be conducted on the entire syllabus of the course in presence of internal/external examiner.



Name of the course: M.Sc. in Geospatial Science

Duration: 2 years (4 semesters)

Eligibility: (1) B.E./B. Tech. in Engineering or equivalent
(2) B.Sc. Honours in any discipline
(3) B. A. Honours (Geography/Environmental Studies)

Website: www.technoindiauniversity.ac.in

Admission Helpline: 7003902105 / 8768222515 / 9831817308

Other Courses available in Techno India University : Ph.D., B.Tech., M.Tech., MBA, MCA, MHA, M.Pharm, M.Arch, Diploma, Pharmacy, Law, Nursing, Architecture, BBA, BCA, Hospital Mgmt, Hotel Mgmt, Media Sc, BA, B.Sc, B.Com, MA, M.Sc, M.Com, Film Making, Design. For admission enquiry please contact at 9831817308.

Technology exposure:

(1) Programming & WebGIS
(2) Advanced GNSS Surveying Techniques (PPK, RTK, STATIC)
(3) Optical Image Processing & Classification
(4) Geospatial Data Processing
(5) LiDAR data processing
(6) Drone mapping and data processing
(7) Google Earth Engine
(8) SAR Image Processing

Renowned faculty members: Some of our faculty members are internationally recognized for their work, publication, and teaching.

Placement: Placement Assistance will be provided after successful completion of the course.

Contact

Techno India University, West Bengal

2nd Floor EM-4, Sector-V, Salt Lake, Kolkata - 700091 (Near Swastha Bhawan/PWC, Beside Times of India Office) West Bengal, India

Contact: 7003902105 / 8768222515 / 9831817308

Website:www.technoindiauniversity.ac.in

Spatem GeoTeck Private Limited

C-81/2 Gosthatala New Scheme, Kamdahari, Garia Kolkata - 700084

Contact: 9903486788 / 91 33 40158042

Website: www.geoteck.co.in

Professional Career Opportunities

Remote Sensing Specialist
GIS Engineer
Geospatial Software Engineer
Photogrammetrist
GIS Developer/ Programmer
Image Analyst
Geospatial Analyst
Drone Data Analyst
Research Associate
GIS Consultant