Punyashhlok Ahilyadevi Holkar Solapur University, Solapur

NAAC Accredited-2022
'B++'Grade (CGPA2.96)

Name of the Faculty: Science &Technology

(As per New Education Policy 2020)

Syllabus: Geoinformatics

Name of the Course: M.Sc. I (Sem. I & II)

(Syllabus to be implemented from June 2024)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Faculty of Science and Technology
Proposed structure as per NEP-4040

Proposed structure for Two Year PG Program (M.Sc.) GEOINFORMATICS

Level / Difficulty	SEM	Major					Field Project/ RP/CC/Internship/ Apprenticeship/ Community Engagement & Services	Credits	Cumulative Credits
		Mandatory	Practical	Elective	Practical Elective	Minor			
4.5 100-400	I	**DSC1-1** Basics of GIS and GNSS (4 credits) **2331101**	**Practical DSC1-1** Basics of GIS and GNSS (2 credits) **2331104**	**DSE 1-1 (4 credits)** 1) Introduction to Geography **2331107** 2) Geodesy and GPS **2331108** 3) IT for Geoinformatics **2331109**	**Practical based on DSE 1-1 (2credits) 2331106**	Research Methodology (4 credits) **2331103**		22	
		DSC1-2 Principles of Remote sensing (4 credits) **2331102**	Practical DSC1-2 Principles of Remote sensing (2 credits) **2331105**						
Exit option: Award of PG Diploma in Discipline with 44 credits OR Continue with Discipline									
5.0/400	II	**DSC1-3** Digital Image Analysis (4 credits) **2331401**	**Practical DSC1-3** Digital Image Analysis (2 credits) **2331404**	**DSE 1-2 (4credits)** 1) Geo-instrumentation and surveying **2331407** 2) Introduction to Geology **2331408** 3) Introduction to Cartography **2331409**	**Practical based on DSE 1-2 (2credits) 2331406**		OJT/In-ouse Project/ Internship/ Apprenticeship (4) **2331403**	22	**22 PG diploma in Discipline (44)**
		DSC1-4 Spatial Modelling & Analysis (4 credits) **2331402**	**Practical DSC1-4** Spatial Modelling & Analysis (2 credits) 2331405						

Paper No: DSC 1: Basics of GIS and GNSS

Load/week:04 **Credits:04**
Marks: 60 **Internal:40**

Course objective -

1. The course focuses on the fundamentals concept Geographical Information System, and Global Positioning System
2. Introducing the spatial data, non- spatial data, hardware and software used in collection, processing and analysis of geospatial data.

Course Outcome:

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

CLO1: Students will demonstrate proficiency and conceptual understanding in using software and automated techniques to carry out thematic maps and analysis through a series of laboratory exercises and creation of reports.

CLO2: Personal effectiveness and workplace competencies are practiced through engagement in discussion boards, following course guidelines, and interactions with the instructor and other students in the class

CLO3: To be able use these skills to identify and analyzed real world problem and preparing them for a successful career in geospatial industry and research institute

CLO4: Develop an tendency towards research through the compulsory internship in industry /research/ academic institutes which promote and inculcate professional ethics and code of practice among students, enabling them to work in a team with multidisciplinary approach

Unit No.	Title and chapter	**Contact hrs**	**Weightage marks**	**Credits**
Unit1	Introduction to computer hardware components :CPU, RAM, storage devices, motherboard, etc. Overview of system software and application software's, operating systems. Input Device like keyboard, mouse, scanner, etc., Output Device like monitors, printers, etc., Introduction to programming languages and their significance. Definitions of GIS: Understanding the concept and applications of Geographic Information Systems (GIS). Components of GIS : hardware, software, data, and users. Spatial Data - Characteristics and Representation: Properties of spatial data and methods of representation. Introduction to raster and vector data models, data structure, and their applications. Overview of popular GIS Software and their functionalities.	**15 hrs**	**15**	**1**
Unit2	**Data in GIS and Data Quality :** Sources of GIS Data: Understanding the various sources of GIS data - primary and secondary sources. Data Quality: Exploring accuracy, precision, error, and uncertainty in GIS data. Sources and Types of Errors in GIS Data: Identifying common errors in GIS data and their sources. Components of GIS Data Quality: Factors influencing data quality and methods to improve it. Spatial Data Standards: Introduction to standardization and its significance in GIS data management.	**15 hrs**	**15**	**1**

	Understanding the fundamental geometric elements in GIS - Arc, Node, and Vertices. Topology: Introduction to spatial relationships and the concept of topology in GIS.			
Unit3	**Database Structure, GIS Database, and Data Storage :** Hierarchical, Network, Relational, and Object-Oriented DBMS: Overview of different database models. SQL: Introduction to Structured Query Language and its application in GIS databases. File Geo-Database and Personal Geo-Database: Understanding file-based GIS databases. ArcSDE: Introduction to ArcSDE as a geospatial database management system. Methods of Storing Vector and Raster Data: Exploring data storage techniques like Block Code, Run-Length Encoding, Chain Coding, Quadtree.	**15 hrs**	**15**	**1**
Unit4	Types of Error: Identifying different types of errors in GIS data. Sources of Errors: understanding the sources that contribute to errors in GIS data. Edit and Correction of Errors: Techniques for editing and correcting GIS data to improve accuracy. Topology Building: Building and maintaining topological relationships in GIS datasets. Buffer analysis, Overlay analysis and point and line density. Introducing Global Navigation Satellite System (GNSS): Overview of GNSS and its applications. Satellite Orbit: Understanding the orbits of GNSS satellites. Satellite Position on Orbital Plane: Determining the position of satellites on the orbital plane. Signals and Reference System: GNSS signals and reference systems used in positioning. Observation Techniques: Techniques for observing and measuring GNSS data	**15 hrs**	**15**	**1**

Book Reference

1. GIS Fundamentals: A First Text on Geographic Information Systems" by Paul Bolstad.
3. Getting to Know ArcGIS" by Michael Law and Amy Collins.
4. Geospatial Data Science Techniques and Applications" by Raj Singh and Michael F. Goodchild.
5. Introduction to Geographic Information Systems" by Kang-Tsung Chang.
6. GIS Tutorial 1: Basic Workbook" by Wilpen L. Gorr and Kristen S. Kurland.
7. Mastering ArcGIS" by Maribeth Price.
8. Essentials of Geographic Information Systems" by Jonathan Campbell and Michael Shin.

Practical: Basics of GIS and GNSS

1) Collection of Spatial and Non-Spatial Data for GIS Exercise
2) Georeferencing and RMSE Calculation, projection and Transformation
3) Creation of Shapefile, Personal Geodatabase, and File Geodatabase
4) Correction of Topology and Error Identification. Data Conversion. Attribute Data Manipulation
5) Vector Based Queries and Thematic Map Preparation
6) Preparation of Final Layout and Export
7) GPS Survey and Database Preparation**

Paper DSC 1-1 : Principles of Remote sensing

Load/week:04 **Credits:04**
Marks: 60 **Internal:40**

Course objective

1. Give foundational knowledge about remote sensing and its types and different sensors used for remote sensing which will focus on comprehension of the physical, computational, and perceptual basis for remote sensing.
2. Gain familiarity with a variety of physical, biological, and human geographic applications of remote sensing.
3. Students should get hands-on application of remote sensing data through visual interpretation and digital image processing exercises.

Course Outcome

After successful completion of a course in student will be able

1. Students will be able to understand the concept of remote sensing and EMR spectra, geometries, and temperatures; and geometric properties of photographs and imagery.
2. To be able use these skills to identify and analyzed real world problem and preparing them for a successful career in geospatial industry and research institute
3. Be equipped with practical skills and the ability to apply their theoretical concept to design, perform experiments, analyze and interpret data and thus develop proficiency in lab management
4. Will able to understand various applications of satellite data, aerial photographs etc.

Unit No.	Title and chapter	Contact hrs	Weightage marks	Credits
Unit 1	**Concepts of Remote Sensing** Definition and Scope: Understanding the fundamentals of remote sensing and its applications. Components of Remote Sensing: Overview of the essential components involved in remote sensing. History and Development: Tracing the historical evolution and advancements in remote sensing technology. **Electromagnetic Radiation (EMR) and Spectrum** EMR Basics: Understanding the nature and properties of electromagnetic radiation. Electromagnetic Spectrum: Exploring the different regions of the electromagnetic spectrum. Theories of EMR: Wave and Particle Theory: Understanding the wave-particle duality of electromagnetic radiation. **Types of Remote Sensing** Based on Energy Source: Distinguishing between passive and active remote sensing methods. Based on Electromagnetic Spectrum: Categorizing remote sensing based on different regions of the electromagnetic spectrum.	**15 hrs**	**15**	**1**
Unit 2	**Energy Interaction with Earth's Atmosphere** Scattering: Rayleigh, Mie, and Non-selective: Understanding different types of scattering in the atmosphere. Absorption and Refraction: Exploring how electromagnetic energy interacts with atmospheric components. Atmospheric Windows: Identifying spectral regions where electromagnetic radiation can pass through the atmosphere unimpeded.	**15 hrs**	**15**	**1**

	Energy Interaction with Earth's Surface: Reflection, Absorption, and Transmission: Understanding how energy interacts with the Earth's surface features. Spectral Signature: Interactions with soil, water, vegetation, and other materials and their unique spectral responses.			
Unit 3	**Types of Platforms** Ground-Based Platforms: Introduction to remote sensing using ground-based instruments and sensors. Airborne Platforms: Understanding aerial remote sensing using aircraft and drones. Space borne Platforms: Overview of remote sensing satellites orbiting the Earth. **Types of Sensors:** Active and Passive Sensors: Differentiating between sensors that emit their energy and those that measure reflected or emitted energy. Resolution and its Types: Spatial, Spectral, Radiometric, and Temporal: Understanding different types of resolutions and their significance. **False Color Composite:** Creating False Color Composites: Techniques for combining different bands to create false-color images. Applications of False Color Composites: Understanding the uses of false-color composites in remote sensing analysis. Image Characteristics: Identifying various image elements, such as tone, texture, shape, size, and pattern.2 Image Interpretation Keys: Techniques for interpreting and analyzing visual images.	**15 hrs**	**15**	**1**
Unit 4	**Introduction to Aerial Photography** Aerial Photography Basics: Understanding the principles and applications of aerial photography. **Basic Photogrammetry** Photogrammetric Concepts: Introduction to photogrammetric techniques for measuring and interpreting features from aerial photographs. **Satellite Data Products** Landsat, MODIS, IRS, CartoSat, Spot, and Others: Overview of various satellite data products available for remote sensing applications. Applications of Satellite Data Products: Understanding the uses of specific satellite data products in different remote sensing studies	**15 hrs**	**15**	**1**

Book Reference

1. "Remote Sensing and Image Interpretation" by Thomas Lillesand, Ralph W. Kiefer, and Jonathan Chipman.
2. "Introduction to Remote Sensing" by James B. Campbell and Randolph H. Wynne.
3. "Remote Sensing: Principles and Applications" by Floyd F. Sabins Jr.
4. "Remote Sensing of the Environment: An Earth Resource Perspective" by John R. Jensen.
5. "Principles of Remote Sensing" by L. A. K. Rao.
6. "Digital Image Processing" by Rafael C. Gonzalez and Richard E. Woods.
7. "Remote Sensing: Models and Methods for Image Processing" by Robert A. Schowengerdt.
8. "Introduction to Photogrammetry: Principles and Applications" by Karl Kraus and Wilfried Linder.

Practical: Principles of Remote sensing

1) Introduction to Remote Sensing Software and Data
2) Image Enhancement Techniques
3) Image Interpretation and Feature Identification
4) Image Classification
5) Change Detection and Land Cover Mapping

Paper DSE 1.1: INTRODUCTION TO GEOGRAPHY

(Marks: External 60) Internal 40

Course objectives :

1. Students will learn about the fundamental and scope of geography. They can identify and analyse various geographical concepts and identify the tools and techniques in geology.
2. Understanding the structure of the Earth's layers and the formation of major landforms, such as mountains, plateaus, and plains.
3. To introduce about application of Physical Geography, Environment Geography in human activity

Course outcome:

1. Understanding the environment: Students will develop an awareness and responsibility for the environment.
2. Applying geographical knowledge: Students will learn to apply geographical knowledge to everyday living.
3. . Introduced the students to the knowledge in physical geography
4. To acquire information about climatic, earth's, anthropogenic movement and the environment changes
5. Understanding the use of maps: Students will learn about the use and importance of maps for regional development and decision making.
6. Fieldwork skills: Students will develop basic skills for carrying out fieldwork.

Unit No.	Title and chapter	Contact hrs	Weightage marks	Credits
UNIT 1	**Introduction to Geography:** Definition and Scope of Geography: Understanding the fundamentals and scope of geography as a discipline. Major Branches of Geography: Overview of physical geography, human geography, and environmental geography. Tools and Techniques in Geography: Introduction to the methods, tools, and technologies used in geographical research and analysis. Geographical Concepts: Exploring key geographical concepts, such as location, place, region, movement, and human-environment interaction.	**15 hrs**	**15**	**1**
UNIT 2	**Physical Geography** Earth's Structure and Landforms: Understanding the structure of the Earth's layers and the formation of major landforms, such as mountains, plateaus, and plains. Climate and Weather: Studying the elements of weather and climate, factors influencing climate, and climate classification systems. Biomes and Ecosystems: Exploring major terrestrial and aquatic biomes, and understanding ecosystem dynamics and interactions. Natural Hazards and Disasters: Examining natural hazards like earthquakes, volcanoes, hurricanes, and their impact on human settlements and the environment.	**15 hrs**	**15**	**1**

UNIT 3	**Human Geography** Population Geography: Analyzing population distribution, growth, migration, and demographic transitions. Cultural Geography: Understanding the influence of culture on spatial patterns, customs, traditions, and cultural landscapes. Economic Geography: Examining economic activities, trade, resources, and the spatial distribution of industries and services. Urban Geography: Introduction to urbanization, urban growth, urban systems, and the challenges of urban development. Rural Geography: Understanding rural settlements, agriculture, rural development, and the interaction between rural and urban areas.	**15 hrs**	**15**	**1**
UNIT 4	****Unit 4: Urban and Rural Geography**** Urbanization and Cities: Studying the process of urbanization, the growth of cities, urban planning, and urban issues like housing, transportation, and urban sprawl. Urban Systems and Patterns: Analyzing the organization and hierarchies of urban systems and identifying different urban patterns. Urban and Rural Contrasts: Contrasting the characteristics, functions, and challenges of urban and rural areas. Rural Development and Sustainability: Exploring sustainable development practices in rural areas and their importance in preserving natural resources and livelihoods.	**15 hrs**	**15**	**1**

Books

1) Physical Geography, Savinder sing, Prayag Pustak Bhawan, 40-A university road, Allahabad- 211002
2) Systematic Agricultural Geography, Husain M., Rawet Publication, Jaipur, Delhi
3) Location Economic Activity, Hoover E. M., New York, McGraw Hill 1948
4) A New Approach to functional Classification of Town, Rafillah. S. M., Geographer, New Dehli
5) Climatology, A.K. Barua.

Practical : Introduction to Geography

1) Study of Natural resources in India : Water, Forest, Minerals, Soil,
2) Study of human resources in India :Transportation – road, rail, air and water ways, Industries, Population density
3) Quantitative Methods Semi average method, least square method, exponential growth rate of population, lorenze curve, rank size rule, crop combination by Weaver and Doi
4) Analysis of socio economic data :Choropleth map, flow line map, proportional circle and sphere, divided proportional circle, compound and superimposed pyramid
5) Analysis of Climatic Data :Weather sign and symbols, Indian daily weather report – rainy, winter and summer, Wind Rose diagram, Isopleths map – Isotherms, isobars, isohytes, Line and bar graph, temperature and rainfall dispersion diagram

Paper DSE 1-1 Geodesy and GPS

Load/week:04 **Credits:04**
Marks: 60 **Internal:40**

Course objectives:

1. Provides a conceptual overview and hands-on experience with Global Navigation Satellite System (GNSS) or Global Positioning Systems (GPS).
2. Students should teach GPS theory, techniques, and field data collection using various GPS technologies.
3. Covers geodesy, differential correction, precision and accuracy, survey controls, triangulation, vertical positions, data conversions, and creating maps from GPS data.
4. Understanding the Geometry and Control Survey in Geodesy

Course outcome:

Upon completion of the course students will be able to:

1. Plan, collect, and process geospatial data using GPS technologies. They also determine accuracy and precision of GPS data.
2. Calculate and analyze error sources for GPS data.
3. Represent GPS with other geospatial data on a map.
4. Apply GPS technologies to real world scenarios using an understanding of GPS theory and practices.
5. They can acquire good knowledge about geodesy.

Unit No.	**Title and chapter**	**Contact hrs**	**Weightage marks**	**Credits**
Unit 1	Definition and Scope of Geodesy: Understanding the fundamentals and scope of geodesy as a scientific discipline. Role of Geodesy in Earth Sciences and Applications: Exploring the importance of geodesy in various fields. Earth, Geoid, and Ellipsoid of Rotation Earth's Shape and Dimensions: Concepts of the Earth's shape and size. Understanding the geoid as a reference surface for measuring elevations. Ellipsoid of Rotation: Exploring the ellipsoidal model used to approximate the Earth's shape. Reference Surfaces and Coordinate Systems in Geodesy Introduction to Geodetic Reference Systems: Overview of global and regional geodetic reference systems. Coordinate Systems: Understanding different coordinate systems used in geodesy. Indian Geodetic System and Everest Spheroid: An in-depth study of the Indian geodetic system and the Everest spheroid. World Geodetic System 84 (WGS 84): Introduction to the widely used WGS 84 reference system.	**15 hrs**	**15**	**1**
Unit 2	**Geometry and Control Survey in Geodesy**** Geometry of Ellipsoid of Rotation : Normal Sections: Understanding the geometric properties of the ellipsoid at different sections., Principal Radii of Curvature: Calculation and significance of the principal radii of curvature. Geodetic Coordinates: Understanding the representation of points on the Earth's surface using geodetic coordinates. Natural Coordinates: Introduction to the concept of natural coordinates for geodetic computations. Classification of Control Survey.: Control Survey: Definition and significance of control surveys in geodesy. 1st and 2nd Order Horizontal Control by Triangulation and Trilateration: Techniques	**15 hrs**	**15**	**1**

	and applications of triangulation and trilateration in control surveys. Surfaces and Plumb Lines: Understanding reference surfaces and plumb lines used in control surveys. Fundamental Equation of Physical Geodesy: Introduction to the fundamental equation used in geodetic computations			
Unit 3	**Fundamentals of GPS and GPS Observations** Introduction to GPS: Overview of the Global Positioning System and its components. Space Segment, User Segment, and Control Segment: understanding the different segments of the GPS system. Observation Principle and Signal Structure: Explanation of the principle of GPS observations and signal characteristics. Intentional Limitation of System Accuracy: Discussing intentional degradations in civilian GPS accuracy. Accuracy of GPS Measurement. Point Positioning and Relative Positioning:	**15 hrs**	**15**	**1**
Unit 4	**GPS Receivers and Surveying Techniques**** GPS Receivers : Receiver Concepts and Main Receiver Components: Understanding the basic components and functionalities of GPS receivers. Examples of GPS Receivers: Reviewing various GPS receiver models and their applications. Classical Receivers and Navigational Receivers: Introduction to different types of GPS receivers. Methods of Surveying with GPS Static and Kinematic Positioning: Techniques for static and kinematic GPS surveying. Navigation with GPS: Applications of GPS for navigation purposes. introduction to DGPS Surveys: Understanding the principles and applications of DGPS surveys.	**15 hrs**	**15**	**1**

Theory: Geodesy and GPS

Book Reference

1. "Geodesy" by Wolfgang Torge and Jürgen Müller.
2. "Introduction to Geodesy: The History and Concepts of Modern Geodesy" by James R. Smith.
3. "Geodesy for Geomatics and GIS Professionals" by J. Chris McGlone and Christine M. McGlone.
4. "GPS Satellite Surveying" by Alfred Leick, Lev Rapoport, and Dmitry Tatarnikov.
5. "Understanding GPS: Principles and Applications" by Elliott D. Kaplan and Christopher J. Hegarty.
6. "Geodetic Datums Made Simple: Step by Step Guide" by Michael Craymer and Jay Hyder.
7. "Geodetic Coordinate Systems: Reference Frames, Earth Rotation Models, and Localization" by Paul Tregoning and Chris Rizos.

Practical: Geodesy and GPS

1) Demonstration of GPS Receiver Setup and Data Logging

2) Static GPS Survey at Control Points : survey area selection, data collection by students in survey area.

3) Data Transfer and Post-Processing : Guide students in recording data during the GPS survey, including positions, time stamps, and satellite information. Data Transfer: Instruct students on transferring GPS data from each receiver to the computer using the appropriate software. Post-Processing: Use GPS data processing software to post-process the data and obtain accurate positions for each control point.

4) Differential Corrections and Data Integration**

1. Differential Corrections: Discuss the significance of differential corrections in improving GPS accuracy and reducing errors.

2. Differential GPS (DGPS): Explain the concept of DGPS and how it enhances the accuracy of GPS measurements.

6) GPS Data Integration into GIS Software

a. GPS Data Import: Guide students in importing the post-processed GPS data into GIS software or other data analysis tools.
b. Overlay GPS Points: Overlay the GPS points on the map or reference data to assess their accuracy and compare them with ground truth locations.

7) Accuracy Assessment

1. Ground Truth Comparison: Students will compare the GPS points with the ground truth data to assess their accuracy.
2. Horizontal and Vertical Accuracy Calculation: Calculate the horizontal and vertical accuracy of the GPS measurements based on the ground truth data.

8) Error Analysis and Mitigation and report preparation

1. Sources of Errors: Discuss common sources of errors in GPS measurements, such as atmospheric conditions, multi-path interference, and satellite geometry.
2. Error Mitigation: Instruct students in ways to mitigate errors, such as using differential corrections, averaging measurements, and selecting suitable surveying techniques.

Paper 1-1 : IT FOR GEOINFORMATICS

(Marks: External 60) **Internal 40**
Credit : 04

Course Objective:

1. This course aims to enable the students to gain knowledge in operating Computer applications and Programming.
2. The object of the course is to advantages of BDMS, RDBMS and various models
3. The students can learn application of computer in various earth science fields.

Course outcomes

1. On successful completion of these modules, students should be capable of operating Computer Applications like MS Office and networking concepts,
2. Students would be able to use computers for computing statistics and plotting data.

Unit No.	**Title and chapter**	**Contact hrs**	**Weightage marks**	**Credits**
Unit 1	An introduction to computers, development of computers, Hardware and Software. Operating systems, Input devices to the computers, Storage devices, central processing unit, Computer output devices	15 hrs	15	1
Umit 2	Advantage of DBMS conceptual & implementation models. Hierarchical, network & Relational Models, RDBMS: components, concept, database schema, table relationship – one to one, one to many, many to many database design.	15 hrs	151	1
Unit 3	Normalization data, definition & manipulation using SQL. SQL – query processing, operation on tables, Union, intersection, product, natural join, integrity constraints, database security, role of data base Administrator	15 hrs	5	1
Unit 4	Examples for Geoinformatics applications in image processing, Geological applications mineral exploration, mapping, exploration Geographical applications related mapping of settlement, agricultures and Environmental applications in biodiversity, wildlife, forestry, Land use land cover.	15 hrs	15	1

Reference Books :-

1) Principles of GIS for Land Resources Assessment by P.A. Burrough, Oxford : Science publications, 1986.
2) Geographic Information Systems – An introduction by Tor Bernhardsen, John Wiley and Sons, Inc, New York, 4002.
3) GIS – A computing Perspective by Micheal F. Worboys, Taylor & Francis, 1995
4) Introduction to computer and operating system – sharada sahasrabudhe ,pune
5) Elmasri R. and Navathe S.B., "**Fundamentals of Database** Systems", Benjamin/Cummings Publishing Co. Inc.(Addison-Wesley world student series), 4002
6) Date C.J., "An Introduction to Database Systems", Vol-I, Addison-Wesley.
7) A.Silberschatz, H.F.Korth and S.Sudarshan, "Database System Concepts", McGraw-Hill

International Editions, Computer Science Series

PRACTICAL IT FOR GEOINFORMATICS

1	MS -Word	Report, typing, files and ppt
2	MS-Access	Database management system
3	MS-excel	Line, Bar, Pie, Scatter,

Research Methodology

Total load : 56 **Credits:04**

Marks: External :60 **Internal:40**

Unit No.	Title and chapter	Contact hrs	Weightage	Credits
Unit 1:	Formulation of Research Problem: Criteria of quality research, types of research, significance, literature review, purpose, process of literature review, analysis of an article, search engine, formulation of research problems. Research ethics and plagiarism	15 hrs	15	1
Unit 2:	Definition of problem, objectives of research, planning of experiments, data collection and record keeping, results and discussions, presentation of research outcome as a research paper or filing patent	15 hrs	15	1
Unit 3:	Indices, publications, types, Impact factor, calculation of Impact Factor, uses, Calculation of immediacy Index, SCOPUS index, h – index, advantages, criticism ISSN, ISBN numbers.	15 hrs	15	1
Unit 4:	Various search engines available on internet, normal vs advanced search, key –words, formulation of search statement, Listing various journals in relevant topic, Science abstracts, e – database. Application of Computers in research, internet browsing, tool bar options, provisions of MS – word, MS – Excel, MS – PowerPoint, Coral draw, SPSS	15 hrs	15	1

Reference Books:

1. Research Methods - Ram Ahuja, Rawat Publications
2. Philosophy of Science – Mario Bunge, Transaction Publishers
3. Research Methodology - Methods and Techniques, C. R. Kothari New Age
4. Fundamentals of Statistics - Goon, Gupta and Das Gupta (Vol. I & Vol. II)

Course objectives:

1. Students can learn formulation, types and quality of research problems.
2. To explain the importance of the literature review in research & carrying out a literature search, its review, writing a review.
3. To explain various research designs and their characteristics and explaining art of interpretation and the art of writing research reports.
4. To discuss leading International Instruments concerning Intellectual Property Rights

Course outcomes:

1. At the end of the course the student will be able to:
2. Discuss research methodology and the technique of defining a research problem
3. Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
4. Explain various research designs and their characteristics.
5. Explain the art of interpretation and the art of writing research reports

SEMSTER II

DSC 1-3: Digital Image Analysis

Load/week:04 **Credits:04**
Marks: 60 **Internal:40**

Course objective

1. This course will introduce fundamental technologies of digital image processing i.e. compression, information extraction and analysis.
2. Students will also gain understanding of algorithm, analytical tools, and practical implementations of various digital image applications.

Course Learning Outcome

1. After successful completion of a course in student will be able
2. Students will demonstrate proficiency and conceptual understanding in using software or manual techniques which will prove how digital technology has come over traditional technology to carry out remote sensing image processing and analysis through a series of laboratory exercises and reports
3. Acquire of fundamental and advanced knowledge of the different aspect in DIP with the means ability to specialize in a specific field.
4. Workplace competencies are strengthened as students apply the analytical and evaluative tools to GIS mapping and apps
5. Be able to demonstrate proficiency in quantitative reasoning and analytical skills

Unit No.	Title and chapter	Contact hrs	Weightage marks	Credits
Unit 1:	**Introduction to Digital Image Processing** Understanding digital images and their significance in remote sensing and geospatial applications. Types of Digital Images: Overview of various types of digital images - satellite images, aerial photographs, etc. Sources of Errors in Digital Images: Identifying atmospheric, radiometric, and geometric errors that affect image quality. **Image Rectification** Geometric Correction: Techniques for geometrically correcting images to remove distortions caused by sensor and terrain variations. Radiometric Correction: Methods to normalize image brightness and contrast for consistent analysis. Noise Removal: Procedures for removing random and systematic noise from digital images.	15 hrs	15	1
Unit 2:	**Contrast Enhancement Techniques:** Linear Contrast Enhancement: Adjusting image pixel values linearly to improve visual interpretation. Non-Linear Contrast Enhancement: Non-linear techniques like histogram equalization for enhancing image contrast. Logarithmic and Exponential Enhancements: Application of logarithmic and exponential functions for image enhancement. Gaussian Stretch and Density Slicing: Techniques to stretch pixel values and display specific intensity ranges. **Spatial Filtering Techniques :** Low-Frequency Filtering: Smoothing techniques like averaging and Gaussian filtering. High-Frequency	15 hrs	15	1

	Filtering: Edge enhancement using high-pass filters like Sobel, Laplacian, etc. Band Rationing and Band Combination: Combining different bands to highlight specific features and information.			
Unit 3:	**Unit 3: Digital Image Classification :** Understanding the concept of image classification and its role in information extraction. Supervised Classification: Using predefined training sites and statistical information for classification. Unsupervised Classification: Clustering algorithms to automatically classify pixels into groups based on spectral similarity. Maximum Likelihood Classifier: Application of maximum likelihood method for classifying pixels based on probability. Euclidean Distance Classifier: Using Euclidean distance to classify pixels. Mahalanobis Distance Classifier: Application of Mahalanobis distance for classification. Parallelepiped Classifier: Defining class boundaries using min-max values. **Classification Accuracy Assessment :** Methods for assessing the accuracy of image classification results. Error Matrix: Calculating and interpreting an error matrix for accuracy assessment. GCP and Ground Validation: The use of ground control points (GCPs) and field data for validation and accuracy improvement.	15 hrs	15	1
Unit 4:	**Unit 4: Object-Oriented Classification : Segmentation** Segmentation methods for dividing an image into meaningful objects or regions. Advantages of object-oriented classification over pixel-based classification. **Object-Oriented vs. Pixel-Based Classification** Understanding the differences and advantages of object-oriented and pixel-based classification approaches. **Algorithms for Object-Oriented Classification** Overview of algorithms commonly used in object-oriented classification.	15 hrs	15	1

Book Reference

1. "Digital Image Processing" by Rafael C. Gonzalez and Richard E. Woods.
2. "Remote Sensing and Image Interpretation" by Thomas Lillesand, Ralph W. Kiefer, and Jonathan Chipman.
3. "Remote Sensing Digital Image Analysis: An Introduction" by John A. Richards and Xiuping Jia.
4. "Introduction to Remote Sensing" by James B. Campbell and Randolph H. Wynne.
5. "Digital Image Processing: An Algorithmic Introduction Using Java" by Wilhelm Burger and Mark J. Burge.
6. "Image Processing, Analysis, and Machine Vision" by Milan Sonka, Vaclav Hlavac, and Roger Boyle.
7. "Introduction to Image Processing and Analysis" by John C. Russ.
8. "Pattern Recognition and Machine Learning" by Christopher M. Bishop

Practical: Digital Image Analysis

****Session 1: Geometric Correction and Mosaic Fusion****

1. Keyboard Geometric Correction: Perform keyboard geometric correction on a satellite image to rectify geometric distortions.
2. Image-to-Image Geometric Correction: Perform image-to-image geometric correction to align two overlapping satellite images.
3. Mosaic Fusion: Mosaic multiple satellite images of the same area and perform fusion to create a seamless composite image.

Session 2: Generation of AOI and Vector Layer
1. Area of Interest (AOI) Creation: Generate an AOI for a specific study area and define its boundaries.
2. Vector Layer Creation: Create a vector layer with point, line, and polygon features, and assign attributes.
Session 3: Image Subset and Viewer Methods
1. GCP Method for Subset: Perform subset extraction using Ground Control Points (GCP) to focus on specific areas of interest.
2. AOI Method for Subset: Perform subset extraction using the Area of Interest (AOI) defined in the previous session.
3. Image Viewer and Shapefile: Visualize the image subset using an image viewer and overlay vector shapefiles.
Session 4: Image Enhancement Techniques
1. Spatial Enhancement: Apply low-pass and high-pass filters for noise reduction and feature enhancement.
2. Spectral Enhancement: Implement Principal Component Analysis (PCA) and Independent Component Analysis (ICA) for spectral enhancement.
3. Radiometric Enhancement: Perform histogram equalization, brightness inversion, and other radiometric enhancement techniques.
Session 5: Image Classification and Accuracy Assessment
1. Image Classification: Classify the enhanced image using supervised and unsupervised classification methods.
2. Accuracy Assessment: Assess the accuracy of the classified image using ground truth data and an error matrix.
Session 6: Model Builder and Indices
1. Model Builder: Create a geo-processing model using Model Builder to automate a specific GIS workflow.
2. Indices Calculation: Calculate various vegetation indices such as NDVI, Vegetation Index Ratio, TNDVI, etc., for vegetation analysis.
3. Noise Reduction: Apply noise reduction filters to enhance image quality and reduce unwanted artifacts.
Note: The lab exercises will be conducted using GIS and remote sensing software (e.g., ArcGIS, ENVI, QGIS).

DSC 1-4 : Spatial Modeling & Analysis

Load/week:04 **Credits:04**
Marks: 60 **Internal:40**

Course objective

1. The course focuses on fundamental aspects of spatial data modeling specifically on the aspect of two dimensional and three-dimensional (3D) modeling, structuring of raster and vector analysis and its types.
2. It also looks into integration of non-spatial data and its application.

Course Learning Outcome

After successful completion of a course in student will be able

1. Student will able to apply spatial tool and techniques in spatial datasets for carry out Surface and 3D analysis.
2. Students will demonstrate proficiency and conceptual understanding spatial model making process.
3. Be equipped with practical skills and the ability to apply their theoretical concept to design, perform experiments, analyze and interpret data and thus develop proficiency in lab management
4. Acquire of fundamental and advanced knowledge of the different aspect in Geoinformatics with the means ability to specialize in a specific field.

Unit No.	Title and chapter	Contact hrs	Weightage marks	Credits
Unit 1:	**Introduction to Spatial Modelling** Spatial Problems and Modelling: Introduction to spatial modelling and its significance in solving real-world spatial problems. Conceptual Models: Understanding the steps involved in creating conceptual models for spatial problem-solving. Types of Spatial Models: Differentiating between descriptive and process models and exploring various types of process models.	**15 hrs**	**15**	**1**
Unit 2:	**Raster Data Modelling** Understanding Raster Data: Introduction to raster datasets, their composition, and coordinate space representation. Discrete and Continuous Raster Data: Differentiating between discrete and continuous data in raster datasets. Resolution and Raster Encoding: Exploring resolution and encoding methods used in raster data representation. Representing Features in Raster: Methods for representing spatial features and assigning attributes in raster datasets.	**15 hrs**	**15**	**1**
Unit 3:	**Spatial Analysis and Operations** Overview of Spatial Analysis: Understanding spatial analysis and its significance in geographical problem-solving.	**15 hrs**	**15**	**1**

	Spatial Analysis Operators and Functions: Introducing local, focal, zonal, and global functions for spatial analysis. Surface Analysis: Performing slope, hill shade, contour, watershed analysis, 15aspect, and hydrologic analysis using raster data. Mapping Distance and Density: Analyzing shortest paths, mapping density, and conducting cell and neighbourhood statistics. Reclassification: Techniques for reclassifying raster data to create thematic maps			
Unit 4:	**Network Analysis :** Introduction to Network Analysis, Geometric and Logical Networks, network Distribution, Hierarchical and Matrix Networks. **Interpolation Methods and Spatial Variation** Interpolation Techniques: Exploring trend surface analysis, Inverse Distance Weighting (IDW), and Kriging for spatial data interpolation. Measures of Arrangement and Dispersion: Analyzing spatial patterns and variation using autocorrelation and semi-variograms. Digital Elevation Model (DEM) and Triangulated Irregular Network (TIN): Understanding DEM and TIN models for representing terrain surfaces. Spatial Variation Mapping: Creating spatial variation maps to visualize the distribution of spatial phenomena.	**15 hrs**	**15**	**1**

Book Reference

1. "Spatial Modeling Principles in Earth Sciences" by Peter A. Burrough and Rachael A. McDonnell.
2. "GIS and Spatial Analysis for the Social Sciences: Coding, Mapping, and Modeling" by Robert Nash Parker and Emily K. Asencio.
3. "GIS and Spatial Analysis in Veterinary Science" by Christopher J. Morris and James W. McNab.
4. "Spatial Analysis: Statistics, Visualization, and Computational Methods" by Christopher A. Williams, Soe W. Myint, and Darren M. Scott.
5. "Geocomputation: A Practical Primer" by Chris Brunsdon and Alexis Comber.
6. "GIS and Spatial Analysis for Landscape Ecology: Concepts and Applications" by Jongman, Rob H. G., et al.
7. "Spatial Data Analysis: Theory and Practice" by Robert Haining.

Practical: Spatial Modelling & Analysis

A) Spatial and Tabular Query

1. Perform Spatial Query: Use GIS software to execute spatial queries to extract features within a specified spatial extent or attribute value.
2. Tabular Query: Conduct tabular queries to filter and retrieve specific attribute data based on defined conditions.

B) Overlay Analysis

1. Overlay Analysis: Apply overlay operations (e.g., union, intersection, difference) to combine multiple spatial datasets and extract new information.

C) Extract Analysis

1. Extract by Mask: Use extract analysis to extract raster data within the extent of a specified polygon or AOI (Area of Interest).
2. Extract by Attribute: Perform an extract analysis based on specific attribute values to isolate relevant features.

D) Proximity Analysis

1. Buffer Analysis: Create buffer zones around specific features to identify areas within a certain distance.
2. Nearest Neighbour Analysis: Analyze the proximity of features to identify the nearest neighbouring feature for each location.

E) Spatial Interpolation

1. Inverse Distance Weighting (IDW) Interpolation: Perform IDW interpolation to estimate values at unsampled locations based on nearby data points.
2. Kriging Interpolation: Apply Kriging interpolation to estimate values and generate continuous surfaces based on spatial autocorrelation.

F) Spatial Autocorrelation

1. Spatial Autocorrelation Analysis: Calculate spatial autocorrelation statistics (e.g., Moran's I) to measure spatial patterns and identify clustering.

G) Network Analysis

1. Network Analysis: Utilize network analysis tools to find the shortest route, calculate travel distances, and solve routing problems.

H) Generating TIN and DEM

1. Triangulated Irregular Network (TIN) Generation: Create a TIN model from point data to represent continuous surfaces.
2. Digital Elevation Model (DEM) Generation: Generate a DEM from elevation data and perform surface analysis (e.g., slope, aspect).

DSE 1-2 Geo-instrumentation and Surveying

Load/week:04 **Credits:04**

Marks: 60 **Internal:40**

Course Objectives:

1. To familiarize basic principles of surveying, study of various types surveys,
2. To study various features and uses of maps and topo-sheets.
3. Students can learn different survey instruments likes; theodolite, dumpy level, total station etc.
4. To understand field sampling techniques**.**

Course outcome:

1. Help student to interpret plans and maps to set out works.
2. Can easily work in civil engineering project.
3. Can locate the coordinates of a given station using relevant technology

Unit No.	**Title and chapter**	**Contact hrs**	**Weightage marks**	**Credits**
1	Basic Principles : Definition, objective and fundamental. Classification of Plane of surveying, concept of scale, Conventional Surveying and mapping (Chain survey, Plane Table survey, Surveying with Theodolite), Representative Factor (RF), Types of Map, Plan, Ranging, Chainage, Offsetting, concept of chainage. Concept of bearing, meridian and their types, construction and use of prismatic compass.	15 hrs	**15**	1
2	Types of bench Marks, uses of contour maps, study and use of topo-sheets. Study of Theodolite and uses, Surveying using total station – Construction, types, principle features, field equipment, method of use, introduction to various special functions available in a total station such as remote elevation measurements, remote distance measurements and co-ordinate stake out. Cartography: Map Projection, Types of Map projections (Conical, Polyconic, Cylindrical, Equal area or Lamberts cylindrical, Mercators, Zenithal, Gnomonic)	15 hrs	**15**	1
3	Sample - Definition, field samples (rock, soil, sediment, water), sampling methods. Sample preparation-laboratory sample. Selection and screening criterion (physical, optical, biological), Preparation of specimen for different geological studies, Types of specimen Thin Section Studies-Etching technique Staining techniques particularly for feldspars, carbonates, dolomite, paragonite and quartz Model analysis and techniques, Calibration of eyepiece micrometer, areas selection and point counting Polished Section Studies Reflectance (specular and diffusive) and reflectance spectrometry	15 hrs	**15**	1

4	Introduction to Unmanned Aerial Systems (UAS) and Drone Survey Principles and Functions of UAS: Understanding the principles and functions of Unmanned Aerial Systems (UAS) in surveying applications. UAV (Unmanned Aerial Vehicle): Introduction to UAV and its role in drone surveys for capturing aerial data. Drone Survey: Exploring the process of conducting a drone survey for acquiring high-resolution aerial imagery and elevation data. Differential GPS (dGPS) in Topographical Surveying : Principles and Functions of dGPS, Dual and Single Frequency DGPS and their applications in topographical surveying. RTK and Static Surveys in DGPS, Use of DGPS in Topographical Survey.	15 hrs	**15**	1

Books :

1. Surveying and Levelling ---- N. N. Basak, Tata Mc-Graw Hill
2. Surveying Vol. I & II ---- Dr.K. R. Arora
3. Surveying: Theory and Practice --- James M. Anderson, Edward M. Mikhail
4. Surveying theory and practices -- Devis R. E., Foot F. S.
5. Plane and Geodetic surveying for Engineers. Vol. I -- David Clark
6. Principles of Surveying. Vol. I by J.G.Olliver, J.Clendinning
7. Potts, P.J. A Handbook of Silicate Rock Analysis, Blackie, London, 1987.
8. Thompson, M. and Walsh, J.N. A Handbook of Inductively Coupled Plasma Spectrometry, Blackie, London, 1983.
9. Van Loon, J.C. Analytical Atomic Absorption Spectroscopy, Academic Press, London, 1960.

PRACTICAL GEOINSTRUMENTATION AND SURVEYING

1. Measurement of a magnetic bearing, local attraction and calculation of true bearings.
2. Plane Table traversing.
3. Study of Dumpy level & Theodolite
4. Measurement by Total station.
5. Preparation of thin section, polished section.
6. Preparation of doubly polished section for fluid inclusion study.
7. Modal analysis.

DSE 1-2 : INTRODUCTION TO GEOLOGY

Load/week:04 **Credits:04**

Marks: 60 **Internal:40**

Course objectives:

1) students can learn rock forming minerals and their physical properties. They also study various valuable mineral deposits.
2) The object of the study is to know the various types of rocks, their structures, classification and origin
3) Students are familiar to study various stresses formed within the earth and their associated features.
4) Students also study role of geology in civil engineering.

Course outcome:

1) The study of this paper strengthens knowledge of students of any discipline with respect to understanding the essentials of the structural dynamics of the earth. They will also understand the origin of solar system, geological features of river, ocean, wind as well as processes of weathering.

Unit No.	**Title and chapter**	**Contact hrs**	**Weightage marks**	**Credits**
1	Definition, physical properties of minerals, brief introduction to rock forming minerals (silica, feldspar, amphibole, mica, garnet, pyroxene). Brief study of Gold, Iron, Copper, Manganese, Lead & Zinc, Bauxite, Coal and Petroleum	15 hrs	15	1
2	Definition – Rocks, their general classification into igneous, sedimentary and metamorphic – Forms and Structures of igneous rocks – Textures – Classification of igneous rocks – An outline of classification of sedimentary rocks – Textures and Structures of sedimentary rocks – Definition – agents and kinds of metamorphism – Zones , Grades Textures and Structures of metamorphic rocks.	15 hrs	15	1
3	Introduction to Structural geology : Topographic maps – Geologic maps- Outcrops and their trends with Reference to slope and topography – Clinometers compass and its uses – Brief Study of Folds – Faults – Unconformities – Joints	15 hrs	15	1
4	Role of engineering geology in civil construction and mining industry – Various stages of engineering geological investigation for civil engineering projects – Engineering properties of rocks – Brief study of Geological consideration of Dams and Reservoirs – Tunnels	15 hrs	15	1

Reference Books:

1. Introduction to geology, Sohni Sharma, Sharma, Dixit
2. Introduction to geology, Santosh Ray
3. Engineering Geology, Davis
4. Engineering Geology, Parbeen Singh
5. Structural geology, M.P.Billings
6. Foundation of Structural geology,R.G.Park

PRACTICAL INTRODUCTION TO GEOLOGY

1	Identification and description of Megascopic minerals (rock forming, Industrial and Ore)
2	Study of structural maps – surface inclined.
3	Identification and description of Megascopic rocks.
4	Study of common rocks with reference to their utility in engineering projects.
5	Preparation and interpretation of hydrogeological maps.

DSE 1-2 : INTRODUCTION TO CARTOGRAPHY

Load/week:04 **Credits:04**

Marks: 60 **Internal:40**

Course objective

1. The course gives emphasis on the art, science, and technologies of cartography and Photogrammetry.
2. It develops the user's ability to understand how maps are created traditionally and digitally. Representation and communicate spatial phenomena and their relationships through photogrammetric perspective which emphasis on skills like making of map, map reading signs and symbols etc..

Course Learning Outcome

After successful completion of a course in student will be able

1. Students will understand different types of projections and datum used in various locations. Proficiency and conceptual understanding in using Manual and computer techniques to carry out thematic maps and special purpose maps.
2. Remote sensing, image processing and analysis through a series of laboratory exercises and report
3. Be able to demonstrate proficiency in quantitative reasoning and analytical skills

Unit No.	**Title and chapter**	**Contact hrs**	**Weightage**	**Credits**
1	Definition, principles, nature, scope and History of cartography, , Scale- definition, types & importance,	15 hrs	15	1
2	The Earth: its shape and size; Concept of datum- vertical and horizontal, Basics of geodesy, Co-ordinate systems- geographical, projected and grid system; Curvature of the Earth and its effect on surveying	15 hrs	15	1
3	Choice and classification of map projections; 1) Stereographic Polar Zenithal projection. 2) Orthographic Polar Zenithal Projection. 3)Bonne's Conical Projection.4) Conical Equal Area Projection with one standard Parallel 5)Simple Cylindrical Projection. 6) Cylindrical Equal Area Projection,	15 hrs	15	1
4	Map- definition, types and significance, Cartographic methods and techniques for preparation of maps and diagrams; General maps: types and applications; Thematic maps: types and applications, Slope analysis, Trigonometrical surveying; Calculation of height & distance	15 hrs	15	1

Reference Books:

1. Hofmann-Wellenhof, B.,and Moritz, H. (4006):Physical Geodesy (2nd d.),springer, 460pp.
2. Kimerling, J.,Buckley, A.R., Muehrcke, P.C., and Muehrcke, J.O. (4011):Map Use: Reading, Analysis, Interpretation (7th Ed.), ESRI Press, 640pp.
3. Misra, R.P.,and Ramesh, A. (1999): Fundamentals of Cartography,Concept Publishing, New Delhi.
4. Nathanson, J.A.,Lanzafama, M., and Kissam, P. (4010): Surveying Fundamentals and Practices (6th Ed.),Prentice Hall, 360pp.
5. Robinson, A.H.,Morrison, J.L., Muehrcke, P.C., Kimerling, A.J., and Guptill, S.C. (1995): Elements of Cartography (6th Ed.),Wiley, New York, 688pp.

6. Singh, R.L.,and Singh, R.P.B.(1993): Elements of Practical Geography,Kalyani Publishers, New Delhi, India.
7. Slocum, T.A.,McMaster, R.B., Kessler, F.C., and Howard, H.H. (4008): Thematic Cartography and Geovisualization (3rd Ed.),Prentice Hall, 576pp.
8. Dent, B., Torguson, J., and Hodler, T. (4008):Cartography: Thematic Map Design (6th Ed.),McGrawHill, 368pp.

PRACTICAL INTRODUCTION TO CARTOGRAPHY

1	Map Scale	Types and Conversion
2	Map Projection	Types: source of light, developable surface, global properties
3	Representation of statistical data	One dimensional, Two dimensional, Three dimensional,
4	Topographical Map	Numbering, latitude-longitude, Sign and Symbols, color system, interpretation, use of total station for mapping.

ON JOB TRAINING (04)

Course objectives:

1. OJT helps students how to learn and apply skills in a real work environment. OJT also provide and train students in handling the tools and techniques used in industries.
2. OJT can be tailored to the specific needs of the organization and the individual employee.
3. Knowledge retention: OJT helps employees retain knowledge, even if they leave the company.
4. Updating skills: OJT can be used to update existing employees' skills when new technologies or processes are introduced.

Course outcome:

Students earned about application of theoretical knowledge to real-world situations through field projects, internships, community engagement and On job Training for gaining practical experience and problem-solving skills.