SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

(*Formerly University of Pune*)

One-Year Post Graduate Programme in Geography

Faculty of Science and Technology

Choice Based Credit System (CBCS)

Syllabi for

Advanced Course in Geospatial Technology

Department of Geography, Savitribai Phule Pune University

Syllabi as per the guidelines of National Education Policy 2020

To be implemented from Academic Year 2024-2025

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

Department of Geography

Syllabi as per NEP 2020 for Advanced Course in Geospatial Technology

Title of the Programme: Advanced Course in Geospatial Technology

Preamble:

National Education Policy 2020 lays particular emphasis on the development of creative potential of each individual. It is based on the principle that education must develop not only cognitive capacities - both the foundational capacities of literacy and numeracy and higher order cognitive capacities, such as critical thinking and problem solving - but also social, ethical, and emotional capacities and dispositions. On behalf of new education policy Savitribai Phule Pune University has decided to change the syllabi of various faculties from June 2023. Taking into consideration the rapid changes in science and technology and new approaches in Geographical Information System and Remote Sensing, the syllabus of Post Graduate Diploma in GIS and Remote Sensing programme under the Choice Based Credit System (CBCS) was prepared (w.e.f. 2023-2024). The model curriculum as developed by NEP 2020 is used as a guideline for the present syllabi. The syllabi focus on credits related to major core, major elective, research methodology, internship/On job training and research projects.

Aims and Objectives of the new curriculum:

1. To update the curriculum as per the NEP 2020.
2. To incorporate recent development in the field of GIS and Remote Sensing.
3. To enhance the quality and standards of knowledge of geospatial technology.
4. To provide a broad common framework, for exchange, mobility, free dialogue across the global GIS and Remote sensing Community.
5. To provide students with a comprehensive understanding of these two interconnected fields and equip them with the necessary knowledge and skills to apply remote sensing and GIS technologies in various applications.
6. To maximize the efficiency of decision making and planning using GIS and Remote Sensing.

7. To introduce students to spatial programming as a way to automate common GIS tasks as a way to increase accuracy and reduce drudgery.
8. To strive to strike a balance between proprietary and all-open-source technologies in GIS.
9. To enhance employability and entrepreneurship skill among the students in local and global market.
10. To develop research and innovative skill among the students blended with the use of geospatial technology.
11. Reinforce the theoretical knowledge, to work on real-world projects and gain practical experience in data collection, analysis, and interpretation.
12. Introduce students to the basics of programming languages commonly used in GIS, such as C, Python and their application in spatial data manipulation and analysis.

Program Outcomes:

By the end of the program the students will be able to:

1. explain relevant terms and concepts of GIS and Remote Sensing including definitions.
2. give better explanation about relevant principles, theories and models in Geoinformatics.
3. understand the basic principles and concepts of GIS, including spatial data representation, coordinate systems, map projections, and spatial analysis techniques.
4. handle GIS software packages such as ArcGIS, QGIS, or other relevant tools. They should gain hands-on experience with data input, data management, cartography, and geospatial analysis using these tools.
5. show clear knowledge and identify the importance of application of GIS and RS in various disciplines.
6. identify the importance of spatial scale and time scale.
7. learn methods for gathering and integrating various types of spatial data from different sources, such as GPS data, satellite imagery, and online data services.
8. identify real-world problems that can be addressed using GIS, formulating appropriate spatial questions, and applying GIS techniques to solve those problems.
9. identify the importance of the resemblances and variance between places, environments and people.

10. develop a spatial mindset, which involves thinking critically about spatial relationships, patterns, and processes in the real world.
11. interpret a variety of types of geographical data and sources and recognize their limitations.
12. demonstrate skill of analysis and synthesis of geographical information.
13. to understand the methods and theories of programming for GIS that will allow students to apply GIS knowledge and skills to everyday life.
14. gain an understanding of the ethical and legal implications of using GIS, including privacy concerns, data sharing, and intellectual property rights.

SAVITRIBAI PHULE PUNE UNIVERSITY
Syllabi as per NEP 2020 for Advanced Course in Geospatial Technology
(Level 6.0)
Department of Geography, Savitribai Phule Pune University
Advanced Course in Geospatial Technology (Semester I)

Level	Semester	Group	Course Code	Course Title	Credits		Total Credits
					T	P	
6.0	First Semester	**Major Core**	AGT 501	Basics of Remote Sensing and Photogrammetry	04	--	04
			AGT 502	Practicals in Spatial Data Analysis	--	04	04
			AGT 503	Introduction to Geographical Information System	02	--	02
			AGT 504	Applied Statistics - I	02	--	02
			AGT 505	Concepts and Methods in Data Sources Exploration	02	--	02
				Total credits related to Major Core	**10**	**04**	**14**
		Major Electives (Theory is mandatory, select any one of the following practical courses)	AGT 511	Business Communication and Soft Skills	--	02	02
			AGT 512	Cartography and Data Representation	--	02	02
			AGT 513	Basic Programming with Python	02	--	02
				Total credits related to Major Elective	**02**	**02**	**04**
		Research Methodology	AGT 521	Research Methodology	**04**	**--**	**04**
			Sem I Total Credits= (Major Core + Major Elective + RM)		**16**	**06**	**22**

Vertical Group (Semester – I)	**Credits for Theory**	**Credits for Practical**	**Total Credits**
Total Credits related to Major Core	10	04	**14**
Total Credits related to Major Electives	02	02	**04**
Research Methodology	04	--	**04**
Total Credits	**16**	**06**	**22**

Advanced Course in Geospatial Technology (Semester II)

Level	Semester	Group	Course Code	Course Title	Credits		Total Credits
					T	P	
6.0	Second Semester	**Major Core**	AGT 551	Digital Image Processing: Theory	02	--	02
			AGT 552	Digital Image Processing: Practicals	--	02	02
			AGT 553	Geospatial Analysis: Theory	02	--	02
			AGT 554	Geospatial Analysis: Practicals	--	02	02
			AGT 555	Database Management Systems	02	--	02
			AGT 556	Advance Surveying and fieldwork: Theory	02	--	02
			AGT 557	Project Management	02	--	02
				Total credits related to Major Core	**10**	**04**	**14**
		Major Electives (Theory is mandatory, select any one of the following practical courses)	AGT 561	Advanced programming with Python	--	02	02
			AGT 562	Applications of GIS and Remote Sensing	02	--	02
			AGT 563	Applied Statistics - II	--	02	02
			AGT 564	Advance Surveying and fieldwork: Practical	--	02	02
				Total credits related to Major Elective	**02**	**02**	**04**
		On Job Training	AGT 571	**On Job Training** (Students should complete on job training not less than 60 clock hours)			**04**
			Sem II Total Credits = (Major Core +Major Elective + OJT)				**22**

Vertical Group (Semester – II)	**Credits for Theory**	**Credits for Practical**	**Total Credits**
Total Credits related to Major Core	10	04	**14**
Total Credits related to Major Electives	02	02	**04**
On Job Training	--	04	**04**
Total Credits	**12**	**10**	**22**

Semester-I

Code: AGT 501 Fundamentals of Remote Sensing and Photogrammetry

No. of Credits: 04 **No. of Lectures: 60**

Course Objectives:

1. To introduce the basic principles of remote sensing.
2. To be familiar with Indian space missions and satellite sensor characteristics.
3. To know the different types of satellite data products and visual interpretation.
4. To provide basic exposure to radiometry and spectroscopy.
5. To understand underlying concepts of aerial photo and photogrammetry.

Sr. No.	Topics	Lectures
1	Introduction to Remote Sensing: Concepts, Definition, Development, Overview of Remote Sensing System.	04
2	Physics of Remote Sensing: Electromagnetic radiation (EMR), Theories of EMR, Laws of Radiation, EM Spectrum, Sources of EMR	08
3	Interaction of EMR: Interaction between radiation and matter, Interaction with Earth's Atmosphere, Atmospheric Window, Reflection, Absorption, and Transmission.	06
4	Spectral Signature: Spectral Signatures for common features, e.g. Snow, Soil, Water and Vegetation.	04
5	Platform and Sensors: Platforms, Sensors, Orbits: Types of Platform, Types of Sensors- Active and Passive, Cameras and Satellite Orbits, Concept of Resolution, Satellite Imaging modes.	08
6	Fundamentals of Radiometry: Concept of solid angle, radiometric measurements, observation geometry in RS.	04
7	Data Products and RS data errors: Satellite Data Generation, Data reception, Type of data products and Aerial Photography Products, FCC and TCC images and their applications, radiometric, geometric and atmospheric errors.	06
8	Photogrammetry: Basic aerial Photography, Basic geometry of aerial photograph, central and orthographic projections, difference between map and aerial photograph, Types of aerial photographs.	04
9	Measurements: Scale and ground coverage of aerial photograph, Geometry of Aerial Photographs, Determination of Scale, Use of Parallax, height measurement.	04
10	Aerial Photo and Image Interpretation: Elements of visual interpretation for aerial photos and satellite imageries: Single, Vertical Stereo Pairs, Derived From PAN, LISS, Wifs, OCM Sensors. Study and Visual Interpretation of Satellite Images for Physical Features, Urban, Forest and Agricultural Uses.	06
11	Stereo Photogrammetry: Introduction, orientation of aerial photographs – inner, relative, absolute orientation, Collinearity and Coplanarity conditions, Concept of Rotation Matrix.	02

12	Digital Photogrammetry: Concept and Techniques of Digital Photogrammetry, Data Generation and Research Application of Cartosat-1 Data, Lidar-altimeter.	03
13	Field Work/Study Tour: Identification of Features in the Field Using Aerial Photographs and Satellite Images	01

Course Outcomes:

On completion of this course, the student shall be able to

1. understand the basic principles of remote Sensing and Photogrammetry.
2. obtain knowledge of the sensor characteristics of various RS Systems
3. acquire knowledge of different missions & their utility
4. understand functioning, data acquisition and orbit operations of missions.

Suggested Readings:

1. Campbell, J. (2002): Introduction to Remote Sensing, Taylor & Francis, London
2. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall, New Jersey
3. Joseph, G. (2004): Fundamentals of Remote Sensing, Universities Press, Hyderabad, India
4. Lillesand, T. M., Kiefer, R. W. and Chipman, J. W. (2008): Remote Sensing and Image Interpretation, John Wiley & Sons, New Delhi
5. Sabins, F. F. (1996): Remote Sensing: Principles and interpretation, W.H. Freeman and Company, San Francisco

Code: AGT 502 Practicals in Spatial Data Processing

No. of Credits: 04 **No. of Practicals: 30**

Course Objectives:

1. To develop an understanding of the basic skills necessary to work with Geographic Information Systems (GIS) using ESRI's ArcGIS software.
2. To learn about GIS data types.
3. To learn spatial data visualization techniques, cartography, aerial photos, and stereo pairs in 3D.
4. To learn geoprocessing tools and Spatial query and data extraction.

Sr. No.	Topics	Practicals
1	Overview of GIS software: ArcGIS Desktop, Arc Pro, Arc catalogue, Arc tool Box.	02
2	Attribute Data: Creation of Schema, Tables, Data Definition, Data Input, Data Updating, Queries on Tables, Simple-Complex Query with two or more tables using SQL; Queries in Arc GIS and QGIS.	04
3	Spatial Data: Generation of Vector Layers (Point, Line, Polygon) Compute geometry - line and area measurements, convert coordinates between reference systems, Topology creation and editing in Arc GIS and QGIS.	06
4	Geodatabase: Feature Dataset, Feature Classes, Import of Data, Spatial Data Formats, Shape/Coverage Files, and Layers in Arc GIS and QGIS.	02
5	Georeferencing: Image georeferencing, Coordinate Systems, Datum Conversions, Map Projections, Types, Image to Image georeferencing, vector to raster georeferencing in Arc GIS and QGIS.	04
6.	Study of Satellite imagery: Visual Interpretation in different bands, study with B/W images, B/W IR, Color IR mages, TCC, FCC in Arc GIS and QGIS.	04
7	Spatial Processes: Spatial Joins with Tabular data, Clip Raster to Polygon, Extract values of raster from a point shape file, Clip vectors, Distance Computations on feature data, Editing Data: Selecting Features, Simple Editing Functions, Creating New Features, Modifying, Schema Changes, Spatial Analysis: Query by Attribute and Location in Arc GIS and QGIS.	06
8	Map Composition in ArcGIS and QGIS	02

Course Outcomes:

On completion of this course, the student shall be able to

1. understand basic spatial analysis techniques: georeferencing, spatial statistics.
2. create datasets in GIS using ESRI ArcGIS Software.
3. identify key concepts related to GIS/Remote Sensing and explore how to apply them to solve real-world problems.
4. identify required data sources, design data preparation and advanced techniques in order to achieve a geospatial solution.

Note: a) For 4 credits 4 hours practical twice a week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

- Bailey, T. C., & Gatrell, A. C. (1995). *Interactive spatial data analysis* (Vol. 413, No. 8). Essex: Longman Scientific & Technical.
- Bao, J., Tsui, Y. (2005): Fundamentals of Global Positioning System Receivers, John Wiley Sons, Inc., Hoboken.
- Environmental Systems Research Institute, Inc. (1998): Understanding GIS: The ARC/INFO Method, ESRI Press, Redland
- Fotheringham, S., & Rogerson, P. (Eds.). (2013). *Spatial analysis and GIS*. Crc Press.
- Longley, P. (2003). *Advanced spatial analysis: the CASA book of GIS*. ESRI, Inc.

Code: AGT 503 **Fundamentals of GIS**

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To understand the core concepts of Geographic Information Systems.
2. To get acquainted with popular GIS software and their functionalities.
3. To learn about various data models (vector and raster), data types, and data structures used in GIS.
4. To learn about spatial analysis methods, including spatial query, buffering, overlay, interpolation, and network analysis.
5. To understand how to apply these techniques to solve spatial problems.

Sr. No.	Topics	Lectures
1	Introduction to GIS: Definitions, Evolution, Components and Objectives	03
2	Overview of GIS Software Packages	02
3	Spatial Data: Concepts of Space and Time, Layers Coverage, Spatial Data Models, Representation of Geographic Features in Vector, Raster Data Models, Concept of Arc, Node, Vertices and Topology	05
4	Object Oriented Models: Advantages and Disadvantages, Computer Representation for Storing Spatial Data: Block Code, Run-Length Encoding, Chain Coding, Quadtree, Issues Governing Choice of Models	05
5	Non-Spatial Data: Advantages of Data Base Management System. Conceptual Implementation Models, Hierarchical, Network, and Relational Models	05
6	Relational Database Management System: Components, Concept, Database Schema, Tables and Relationships, Database Design Normalization (1NF, 2NF, 3NF Forms) Data Definition Manipulation using SQL, SQL-Query Processing, Operations on Tables, Integrity Constraints, Database Security, Role of Database Administrator (DBA), Metadata	05
7	Spatial Data Input: Digitization, Error Identification, Errors: Types, Sources, Correction; Editing and Topology Building	05

Course Outcomes:

On completion of this course, the student shall be able to

1. equip with a comprehensive understanding of GIS theory
2. understand data concepts and spatial analysis techniques, preparing them to apply GIS knowledge effectively in a wide range of applications and pursue more advanced GIS studies or professional opportunities.

Suggested Readings:

1. Chang, K. T. (2008): Introduction to Geographic Information Systems, Avenue of the Americas, McGraw-Hill, New York
2. Demers, M. N. (2000): Fundamentals of Geographic Information

Systems, John Wiley and Sons, New Delhi
3. Korte, G. B. (2001): The GIS Book, Onward Press, Bangalore
4. Lo, C. P., Yeung, A. W. (2002): Concepts Techniques of Geographical Information Systems, Prentice-Hall of India, New Delhi
5. Longley, P. A., Goodchild, M. F., Maguire, D. J., Rhind, D. W. (2002): Geographical Information Systems and Science, John Wiley & Sons, Chichester

Code: AGT 504	**Applied Statistics – I**	
No. of Credits: 02		**No. of lectures: 30**

Course Objectives:

1. To learn the theoretical part of statistical techniques.
2. To learn the advantages and application of different statistical techniques for analysis.
3. To study comparison and conclusions of data.
4. To learn about the concepts related to geographical data and its types.

Sr. No.	Topics	Lectures
1	Geographic Data: Sources, Types, Discrete and Continuous Series, Scales of Measurements	04
2	Organization of Data: Graphical representation of frequency distribution: Histogram, frequency curve, ogive curve.	05
3	Measures of Central Tendency: Athematic mean, median and mode; Measures of Dispersion: Absolute and relative measures	08
5	Correlation and Regression: Concept of Bivariate correlation Regression: Bivariate linear and exponential	08
6	Matrix algebra: Matrix operations, types of matrices	05

Course Outcomes:

On completion of this course, the student shall be able to

1. understand the analysis of data and conclude it.
2. understand the distribution of spatial data, how things are changing over time, and planning, designing, collecting data, analyzing, drawing meaningful interpretations and reporting of the research findings.

Suggested Readings:

1. Ebdon, D. (1977): Statistics in Geography, Basil Blackwell, Oxford
2. Frank, H. and Althoen, S.C. (1994): Statistics: Concepts Applications, Cambridge University Press,Cambridge.
3. Gregory, S. (1978): Statistical Methods for Geographers, Longman, London
4. Hammond, R. and McCullagh, P. (1991): Quantitative Techniques in Geography, Clarendon Press, Oxford
5. Rogerson, P. A. (2010): Statistical Methods for Geography, Sage Publications, London

Code: AGT 505 Concepts and Methods in Data Sources Exploration

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. How it is allowing interoperability for general people.
2. Learning data quality assurance and security.
3. Knowledge of available resources and tools for educating people.

Sr. No.	Topic	Practical
1	Types of Data sources: Opensource, freely available, Paid Advantages, and Limitations of overall data sources available on the web.	04
2	Demonstration of various geospatial data portals and hands-on training on data downloading techniques.	10
3	Recent trends and applications of various data portals. Data Exploration using Governmental data portals, and national-international/Global data portals.	06
4	Data download using data portals, command prompts, widgets, program codes, etc., Downloading Climate data from the Internet into ArcGIS	04
5	Lab assignment	06

Course Outcomes:

On completion of this course, the student shall be able to

1. Data integration and accessibility.
2. Will study Metadata management.
3. Gain knowledge of scalability and collaboration.

Reference Material

https://bhuvan.nrsc.gov.in/home/index.php
https://www.surveyofindia.gov.in/
https://www.usgs.gov/
https://www.earthdata.nasa.gov/
https://www.diva-gis.org/
https://www.esri.com/en-us/arcgis/about-arcgis/overview
https://bhoonidhi.nrsc.gov.in/
https://sedac.ciesin.columbia.edu/data/collection/spatialecon

Code: AGT 511 Business Communication and Soft Skills

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To introduce the concept of Business Communication.
2. To learn communication and interaction with clients.
3. To learn how to write emails, cover letters, and resume
4. To develop professionalism and time management.

Sr. No.	Topics	Practicals
1	Introduction to Business Communication, Communication Process, 7Cs of Effective Communications and Writing Skills	02
2	Etiquette and Interview: Body Language Introduction, Body Language, Advantages of Knowing Body Language, Importance of Body Language in General, Body Language Examples and What They Show, Sending the Right Messages with Your Body Language	03
3	Personality development: Characteristics, Factors, Roles of Personality - An overview, Approaches to Studying Personality, Characteristics of Personality, Factors of Personality, Roles of Personality in Organizational Behavior	02
4	Professionalism (Dressing and Grooming) Introduction, Professionalism (Dressing and Grooming) : An explanation, The Importance of Professionalism in Business, Corporate Dressing and Personal Grooming, Corporate Dressing for Success at Workplace, Personal Grooming	03
5	Interview Preparation and Curriculum Vitae / Resume Writing: Types of Interview, the purpose of the interview, Dos and Don'ts in CV/Resume Writing	03
6	Group Discussion and Time Management	02

Course Outcomes:

On completion of this course, the student shall be able to

1. understand all aspects of handling geographical information, also it provides a simple platform to understand most of the geographical phenomena and the occurrence of these phenomena.
2. perform map making and understand how to apply patterns and colors when representing features on a map.

Suggested readings:

1. Jethwaney, J. (2010). Corporate Communications: Principles and Practices. *OUP Catalogue*.
2. Kaul & Asha, Effective Business Communication, PHI 2nd Edition, 2006.
3. Lesikar R.V & Flately M V, Basic Communication Skills for empowering the internet generation, Tata-McGraw Hill, 2009.
4. Kuczerawy, A. (2017). The Power of Positive Thinking. *J. Intell. Prop. Info. Tech. & Elec. Com. L.*, *8*, 226.
5. Parker, Y., & Brown, B. (2012). *The damn good resume guide: A crash course in resume writing*. Ten Speed Press.

Code: AGT 512 Cartography and Data Representation

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To learn the representation of the region on a short scale.
2. To understand and display/represent graphic information using a GIS system.
3. To learn easier data symbolization.
4. To learn different types and components of geographical maps.
5. To develop a map in a detailed manner easily and digitally.

Sr. No.	Topics	Practicals
1	Introduction to Cartography and Elements of Map Design	02
2	Map Projection and Coordinate System: Concepts, Types, and Uses	04
3	Scales of Measurement: Nominal, Ordinal, Interval, Ratio; Graphical Representation of Statistical Data: Two- and Three-dimensional diagrams	04
4	Map types: Thematic, Topographical, Cadastral; Interpretation of SOI Topographical Maps: Identification and Visualization of different Physical and Manmade Features	03
5	Digital Cartography and Digital Data Representation	02

Course Outcomes:

On completion of this course, the student shall be able to

1. understand all aspects of handling geographical information, also it provides a simple platform to understand most of the geographical phenomena and the occurrence of these phenomena.
2. perform map making and understand how to apply patterns and colors when representing features on a map.

Note: a) For 2 credits 2 hours practical twice a week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Gupta, K. K. Tyagi, (1992): Working with maps, Survey of India Publication, DST, New Delhi
2. Monkhouse, F. J., & Wilkinson, H. R. (1963). Maps and diagrams: their compilation and construction. Egmont Books Ltd
3. Ramamurthy, K. (1982): Map Interpretation, Rex Printers, Madras
4. Robinson, A. H., Morrison, J. L., Muehrcke, P. C., Kimerling, A. J. Guptill, S. C. (1995): Elements of Cartography, Wiley, New York
5. Singh, R. L. (1979): Elements of Practical Geography, Kalyani Publishers, New Delhi
6. Understanding Map Projection (2003-2004): GIS by ESRI, Redlands.

Code: AGT 513	**Basic Programming with Python**	
No. of Credits: 02		**No. of Practicals: 15**

Course Objectives:

1. To master the fundamentals of writing Python scripts.
2. To learn core Python scripting elements such as variables and flow control structures.
3. To understand the object-oriented program design and development.
4. To work with Python data types like integers, floats, strings, characters, and lists.
5. To understand basic flow control, including loops and conditionals.

Sr. No.	Topics	Practicals
1	Introduction to Python: Comparison of Python with other programming languages, the execution model of Python, Salient features of Python, Areas where Python is in use, Industries that are using Python	01
2	Installing Python, Learning the syntax and semantics of Python, Using the Python interpreter, Python Keywords, Identifiers, Comments, Expressions, Statements, Input and Output, Type Conversion, Debugging, executing a Script, Structuring with Indentation, Editors.	01
3	Data types and Variables: Naming convention of variables, Basic Input-Output Operations, Basic Operators	01
4	Control structures: Boolean Values, Conditional Execution, If/Else Statements, For/while Statements, Range () function, Break and continue statements, Else clauses on Loops, Pass statements, Operations and Assignment statements	01
5	Functions: Define Function Statements with Parameters, Return Values and Return Statements, The None Value, Keyword Arguments, and print (), Local and Global Scope, The Global Statement, Lamda function	02
6	Data structures: List Data Type, Working with Lists, Augmented Assignment Operators, Methods, Stack, operations on the stack (push and pop), Tuples, Set, Dictionaries, and Structuring Data	02
7	Strings and String Methods: Working with Strings, Useful String Methods	01
8	File Handling: Files and File Paths, os. path Module, File Reading/Writing Process, Introduction to files, types of files (Text file, Binary file, CSV, excel file), relative and absolute paths	01
9	Modules and Packages: Standard modules, Packages, Defining Classes, defining functions, Creating Modules and Packages, importing a module, Import the names, Executing modules as scripts	01
10	Data Visualization: Basic data visualization with Matplotlib, Line Charts, Bar Graphs, Histograms, Scatter Plots, 3D plots, Heat maps	02
11	Finding and Fixing Code Bugs: Error handling and fixing bugs	01

12	Object-oriented design: Object-Oriented Approach, Classes, Methods, Standard Objective Features, Exception Handling, and Working with Files	01

Course Outcomes:

On completion of this course, the student shall be able to

1. develop algorithmic solutions to simple computational problems.
2. demonstrate programs using simple Python statements and expressions.
3. Explain control flow and function concepts in Python for solving problems.
4. use Python data structures lists, tuples and dictionaries for representing compound data.
5. explain files, exceptions, modules and packages in Python for solving problems.

Suggested Readings:

1. Barry, P. (2016). *Head first Python: A brain-friendly guide*. " O'Reilly Media, Inc.".
2. Chun, W. (2001). *Core Python programming* (Vol. 1). Prentice Hall Professional.
3. Lutz, M. (2013). *Learning Python: Powerful object-oriented programming*. " O'Reilly Media, Inc.".
4. Phillips, D. (2010). *Python 3 object-oriented programming*. Packt Publishing Ltd.
5. Sweigart, A. (2019). *Automate the boring stuff with Python: practical programming for total beginners*. No Starch Press.

Code: AGT 521 **Research Methodology**

No. of Credits: 04 **No. of Lectures: 60**

Course Objectives:

1. To understand the fundamental principles of the research.
2. To differentiate between different types of research.
3. To evaluate research design.
4. To set or develop a hypothesis.
5. To select the appropriate data collection method.
6. To apply research methodology to real-world problems.

Sr. No.	Topics	Lectures
1.	Methods of Geospatial Studies, Research: Definition, Types, Classification, Literature Review, Case Studies	10
2.	Methods of Explanation: Inductive, Deductive, Empiricism, Positivism, Hempel	04
3.	Hypothesis, Theories, Laws, and Models	04
4.	Research Question, Objectives, Significance of Research, Research Design	06
5.	Data Collection: Types, Methods, Tools and Techniques	05
6.	Recent Trends in RS and GIS Research	04
7.	Ethics in Scientific Research and Plagiarism	04
8.	Scientific Journals: Impact Factor, Citation,	03
9.	Introduction to useful online platforms: Mendeley, Google Scholar, ResearchGate, Shodhganga	04
10.	Research Proposal	04
11.	Presentation of Research Findings: Report Writing, Presentation and Formatting	04
12.	Citations, References, Bibliography and various referencing styles	04
13.	Evaluation of Research: Criteria of evaluation	04

Course Outcomes:

On completion of this course, the student shall be able

1. equip with the foundation skills and competencies needed to embark on their research journey successfully.
2. master research methodology.
3. to conduct meaningful research in their academic and professional endeavors.

Suggested Readings:

1. Gomez, B. and Jones, J. P. III (2010): Research Methods in Geography: A Critical Introduction, John Wiley and Sons
2. Goudie, A. (Ed) (2004): Encyclopedia of Geomorphology, Routledge, London

3. Gregory, D., Johnston, R., Pratt, G., Watts, M. and Whatmore, S. (2009): The Dictionary of Human Geography, Wiley-Blackwell, Singapore
4. Montello, D. and Sutton, P. (2013): An Introduction to Scientific Research Methods in Geography and Environmental Studies, SAGE Publications
5. Warf, B. (Ed) (2006): Encyclopedia of Human Geography, SAGE Publications, London

Semester-II

Code: AGT 551 **Digital Image Processing: Theory**

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To learn the interpretation of remote sensing images,
2. To understand numerous image processing and analysis techniques
3. To understand methods or algorithms to use is determined by the objectives of each specific requirement.
4. To learn the creation of new themed maps by combining multiple data layers in a computer.

Sr. No.	Topics	Lectures
1	Introduction to Digital Image Processing: Digital images, Types Sources of Errors, Atmospheric, Radiometric and Geometric; Image Rectification: Geometric Correction, Radiometric, Correction, Noise Removal	10
2	Image Enhancement Techniques: Contrast Enhancement, Linear, Non-Linear, Spatial Filtering, Edge Enhancement, Band Ratio and Band Combination	07
3	Digital Image Classification: Classification Scheme, Supervised Classification, Training Sites Selection, Classifier types, Unsupervised Classification, Accuracy Assessment	10
4	Object-oriented classification, Object-oriented vs. pixel-based classification, Algorithms for classification	03

Course Outcomes:

On completion of this course, the student shall be able to

1. extract additional information from geographical data that might not be obvious simply by looking at a map.
2. understand how efficiently they can encode, save, retrieve, overlay, correlate, alter, analyze, query, and display geographical data. Digital image processing and visual inspection are crucial components, and the results of these methods also help to gather data from the images.

Suggested Readings:

1. Cha, B., Dattaa, D., Majumdar (2001): Digital Image Processing Analysis, Prentice-Hall of India, NewDelhi
2. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall,NewJersey
3. Lillesand, T. M., Kiefer, R. W.Chipman, J. W.(2008): Remote Sensing and Image Interpretation, JohnWiley & Sons, New Delhi
4. Nag, P. Kudrat, M. (1998): Digital Remote Sensing, Concept Publishing Company, New Delhi
5. Richards, J. A, Jia,X.(1999):Remote Sensing and Digital Image Processing, Springer, Verlag Berlin

Code: AGT 552 **Digital Image Processing: Practicals**

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To learn the interpretation of remote sensing images,
2. To understand numerous image processing and analysis techniques
3. To understand methods or algorithms to use is determined by the objectives of each specific requirement.
4. To learn the creation of new themed maps by combining multiple data layers in a computer.

Sr. No.	Topics	Lectures
1	Introduction to ERDAS	1
2	Familiarization with Image Processing Systems: Loading of Image Data, Identification of Objects on Visual Display, Study of Histograms and Layer Information	2
3	Image Enhancement Techniques: Contrast Enhancement, Linear, Non-Linear, Spatial Filtering, Edge Enhancement, Band Ratio and Band Combination	2
4	Image Registration: Registration of Bases Map/ Topomap, Image to Map, Image to Image	2
5	Image Classification: Supervised, Unsupervised and Use of Different Algorithms, Change Detection	3
6	Accuracy Analysis: Producer, User Accuracy, Overall and Mapping Accuracy, Kappa Coefficient	2
7	Vector Layers: Generation of Vector Layer, Editing, and Area and Perimeter Estimation; Map Composition	3

Course Outcomes:

On completion of this course, the student shall be able

1. extract additional information from geographical data that might not be obvious simply by looking at a map.
2. understand how efficiently they can encode, save, retrieve, overlay, correlate, alter, analyze, query, and display geographical data. Digital image processing,
3. visual inspection is a crucial component, and the results of these methods also help to gather data from the images.

Note: a) For 2 credits 2 hours practical twice a week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Cha, B., Dattaa, D., Majumdar (2001): Digital Image Processing Analysis, Prentice-Hall of India, NewDelhi
2. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall,NewJersey
3. Lillesand, T. M., Kiefer, R. W.Chipman, J. W.(2008): Remote Sensing and Image Interpretation, JohnWiley & Sons, New Delhi
4. Nag, P. Kudrat, M. (1998): Digital Remote Sensing, Concept Publishing Company, New Delhi
5. Richards, J. A, Jia,X.(1999): Remote Sensing and Digital Image Processing, Springer, Verlag Berlin

Code: AGT 553 **Geospatial Analysis: Theory**

No. of Credits:02 **No. of Lectures: 30**

Course Objectives

1. To learn spatial data visualization techniques and cartography.
2. To learn geo-processing tools.
3. To learn about GIS and decision-making.
4. To learn about surface analysis.
5. To learn about 3D modelling and analysis.

Sr. No.	Topics	Lectures
1	Introduction to Spatial Analysis: Significance of Spatial Analysis, Overview of Tools for Analysis	03
2	Vector Analysis, Overlay Operations, Single Layer, Operations, Multilayer Operation	03
3	Raster Analysis: Map Algebra, Grid Based Operations, Cost Surface Analysis, and Proximity Analysis	04
4	Spatial Network and Location Analysis: Concepts, Evaluation of Network Complexity Using Alpha-Gamma Indices, C-Matrices for Evaluating Connectivity of the Network, Network Data Model, Path Analysis, Types of Network Analysis, Optimum Cyclic Path, Vehicle, Routing, Path Determination and Cost-Path Analysis	05
5	Point Pattern Analysis: Methods for Evaluating Point Pattern, Clustered. Geocoding and Reverse geocoding.	05
6	Surface and Grid Analysis, Creating 3D data, Mapping, Animation	04
7	Spatial Modeling: Role of Spatial Model, Explanative, Predictive and Normative Models, Correlation-Regression Analysis in Model Building, Handling Complex Spatial Query and case Studies	04
8	Big Data and Geospatial Analysis: Types and Challenges	02

Course Outcomes:

On completion of this course, the student shall be able to

1. apply a range of geospatial analysis techniques using remote sensing and GIS tools toward solving quantitative problems in one or more core disciplinary areas such as geography, ecology, environmental sciences, bio-geosciences, urban planning, natural resources management etc.
2. quantitatively analyze data to evaluate scientific hypotheses and arguments in remote sensing and geographic information science.

Suggested Readings:

1. Booth, B., Shaner, J., MacDonald, A., Sanchez, P. Pfaff, R. (2004): ArcGIS, Geodatabase Workbook, Redlands
2. Environmental Systems Research Institute, Inc. (1998): Understanding GIS: The Arc/Info Method, ESRI Press, Redlands.
3. ESRI (2003): Introduction to ArcGIS- I, Course Lectures, GIS Education Solutions
4. Makrewski, J. (1999): GIS Multi-criteria Analysis, John Wiley and Sons, New York
5. Melania, H. M., Rhonda, P., Minami, M., Hatakeyama, A. M. (2004): ArcGIS, Using ArcMap, ESRI Press, Redlands

Code: AGT 554	**Geospatial Analysis: Practical**	
No. of Credits:02		**No. of Practical: 15**

Course Objectives

1. To learn spatial data visualization techniques and cartography.
2. To learn geo-processing tools.
3. To learn about GIS and decision-making.
4. To learn about surface analysis.
5. To learn about 3D modelling and analysis.

Sr. No.	Topics	Lectures
1	Editing Data: Selecting Features, Simple Editing Functions, Creating New Features, Modifying, Schema Changes	3
2	Spatial and Non-Spatial Data: Spatial: Linking Features Attributes, Ways to View Data, Metadata Non-Spatial: Understanding Tables, Field Types, Table Manipulations, Table Relationship, Joins, Relates, Creation of Graphs and Reports	3
3	Spatial Analysis: Query by Attribute and Location, Identifying Spatial and Non-Spatial Data, Geoprocessing Wizard, Spatial Analysis Functions, Multi Criteria Analysis using Boolean Logic	3
4	Network Analysis: Network Utility, Creating Network Model, Shortest Path, Geocoding	2
5	Surface and Grid Analysis: DEM, DSM and DTM, Creating 3D data, Animation	3
6	Presenting Data: Map Design, Map Composition	1

Course Outcomes:

On completion of this course, the student shall be able to

1. apply a range of geospatial analysis techniques using remote sensing and GIS tools toward solving quantitative problems in one or more core disciplinary areas such as geography, ecology, environmental sciences, bio-geosciences, urban planning, natural resources management, etc.
2. quantitatively analyze data to evaluate scientific hypotheses and arguments in remote sensing and geographic information science.

Note: a) For 2 credits 2 hours practical twice a week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Mitchell, A. (1999): The ESRI guide to GIS analysis, Redlands
2. Zeiler, M. (1999): The ESRI guide to Geodatabase design, Redlands
3. ESRI (2003): Introduction to ArcGIS- I, Course Lectures,GIS Education Solutions
4. Booth, B., Shaner, J., MacDonald, A., Sanchez, P. Pfaff, R. (2004): ArcGIS,Geodatabase Workbook, Redlands
5. Melania, H. M., Rhonda, P., Minami, M., Hatakeyama, A. M. (2004): ArcGIS, Using ArcMap, ESRI Press, Redlands
6. Environmental Systems Research Institute, Inc. (1998): Understanding GIS: The Arc/Info Method, ESRI Press, Redland.

Code: AGT 555 Database Management Systems

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To present an introduction to database management systems.
2. To organize, maintain and retrieve - efficiently, and effectively - information from a DBMS.
3. To understand the relational database design principles.
4. To master the basics of SQL and construct queries using SQL.

No.	Topics	Lectures
1	Database concepts: introduction to database concepts and its need, relational databases, database architecture, Database Security.	03
2	Data Models: The importance of data models, Basic building blocks, The evolution of data models, and degrees of data abstraction; DBMS, RDBMS, Advantages and Disadvantages of DBMS	05
3	Database Design and ER-Diagram: overview, ER-Model, ER-Diagrams, ERD Issues, weak entity sets, Codd's rules, Relational Schemas, Introduction to UML; Relational database model: Logical view of data, keys, and integrity rules, Relational Database design and Normalization (1NF, 2NF, 3NF, BCNF)	05
5	Constraints and Views: Types of constraints, Concept of Backup Recovery, Concepts of views	04
7	Manipulating Dataset using SQL Statement: Basic Select Statement, Selecting Specific Column, Using Arithmetic Expressions, Defining Column Alias, using Where Clause	03
8	Restricting & Sorting Data: using Comparison Condition (=, <=, >=); Using Logical Operator: AND, OR, NOT, using BETWEEN, LIKE Conditions, Rule of Precedence, using Order by Clause	04
9	SQL Function: Sub-Query, Nested queries Concept of Function, Types, Group Functions, Use of Group by, Having Clause, Types of Joins	03
10	Spatial database systems and application: Exploring Spatial Geometry Organizing spatial data – spatial data relationships and functionalities– Application program and user Interfaces, Overview of NoSQL for spatial data handling	03

Course Outcomes:

On completion of this course, the student shall be able to

1. describe the fundamental elements of relational database management systems.
2. explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.
3. design ER models to represent simple database application scenarios.
4. extract data from the database using SQL.
5. understand the basic concept of spatial databases.

Suggested readings:

1. Connolly, T. M., & Begg, C. E. (2005). *Database systems: a practical approach to design, implementation, and management*. Pearson Education.

2. Deshpande, P. S. (2008): SQL & PL/SQL for Oracle 10g, Blackbook, Dreamtech Press, New Delhi
3. Ramakrishnan, R., Gehrke, J., & Gehrke, J. (2003). *Database management systems* (Vol. 3). New York: McGraw-Hill.
4. Silberschatz, A., Korth, H. F., & Sudarshan, S. (2011). Database system concepts.
5. Ullman, J. D. (1983). *Principles of database systems*. Galgotia publications.

Code: AGT 556 Advance Surveying and Fieldwork: Theory

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To understand advanced surveying concepts.
2. To utilize modern surveying instruments.
3. To plan and execute field survey.
4. To analyze and process survey data.
5. To apply surveying in various domains.

Sr. No.	Topics	Lectures
1	Introduction to GPS: GPS Survey, Data Import, Processing and Mapping	2
2	Introduction to Differential GPS (DGPS): Principle and Function, Data Collection and Data Processing	3
3	Single and Dual Frequency DGPS, RTK, and Static Surveys in DGPS, Use of DGPS in Topographical Survey	6
4	Introduction to Total Station: Principle and Function	3
5	REM, RDM, Use of Total Station for data processing and analysis	6
6	Comparison of Total Station with DGPS in Topographical Surveying	5
7	Introduction to Unmanned Aerial Vehicle (UAV): Principles and Functions	3
8	Types of UAV, DGCA directions and rules	2

Course Outcomes:

On completion of this course, the student shall be able to

1. handle advanced survey instruments such as Total Station, DGPS, and UAVs.
2. conduct surveys and collect the required data.
3. analyze the data and produce the results.
4. Correlation and compare the data from various sources.
5. integrate remote sensing data, such as aerial and satellite imagery, LiDAR and other remote sensing technology into surveying projects for enhanced spatial information.

Suggested Readings:

1. Jeff, H. (1995): Differential GPS Explained, Trimble Navigation
2. Lawrence, L. and Alex, L. (2008): GPS Made Easy: Using Global Positioning Systems in the Outdoors, Rocky Mountain Books, Calgary
3. Mohinder, S. G., Lawrence, R. W. and Angus, P. A. (2001): Global Positioning Systems, Inertial Navigation and Integration, John Wiley and Sons Inc., New York
4. Satheesh, G., Sathikumar, R. and Madhu, N. (2007): Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education, Delhi
5. Stinespring, B. M. (2000): The Experimental Evaluation of a DGPS Based Navigational System for the ARIES AUV, Monterey, California: Naval Postgraduate School; Springfield.

Code: AGT 557 **Project Management**

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To understand the project's goals, deliverables, and constraints.
2. To understand work acceptance criteria.

Sr. No.	Topic	Lectures
1	Project scope and limitations, Availability of resources, and collecting requirements.	05
2	Project phases, timelines, and schedules. Project monitoring and control. Budget	05
3	Resource optimization and schedule analysis, Techniques for prioritizing requirements, Milestones, and understanding dependencies.	05
4	Product/ work quality checks, Risk analysis, and management, Cost estimation budget, and release planning.	05
5	Presentation of Research Findings: Progress Report, Report Writing, Formatting and Presentation	10

Course outcomes:

On completion of this course, the student shall be able to

1. Gain knowledge of expectations, delivering value, and ensuring client satisfaction.
2. Understand a comprehensive project plan that includes tasks, timelines, resource allocation, dependencies, and milestones.
3. Gain the project management knowledge and skills, necessary to manage an entire project

Suggested Readings:

1. Stanley E. Portny (2013). Project Management for Dummies. 4th ed. New Jersey: John Wiley & Sons, Inc. 408. ISBN-13: 978-1118497234
2. Project Management Institute (2021). A Guide to the Project Management Body of Knowledge: PMBOK® Guide. Seventh Edition. Pennsylvania: Project Management Institute, Inc. ISBN: 978-162825664
3. Newell, M., & Grashina, M. (2003). The project management question and answer book. Amacom.
4. Nokes, S. (2007). The definitive guide to project management. Pearson Education India.
5. Schwalbe, K. (2009). Introduction to project management. Boston: Course Technology Cengage Learning

Code: AGT 561 Advance Programming with Python

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To master the numeric data processing with Python scripts.
2. To learn geospatial data analysis using Python.
3. To learn to create API and web applications using Python.
4. To work with GUIs and web browsers with Python.

Sr. No.	Topics	Practicals
1	NumPy and SciPy: Introduction to NumPy, Creation of vectors and matrices, Matrix manipulation	02
2	Pandas: Introduction, Pandas data structures – Series and DataFrame, Data wrangling, loading a dataset into a DataFrame, Selecting Columns, Selecting Rows, Adding/ Deleting new data in a DataFrame, manipulation of tabular data	02
3	Data Visualization: Matplotlib and Seaborn	01
4	GeoPandas: Introduction, Installation, Vector data processing, reading/writing shapefile, plotting, clip, overlay, spatial join, choropleth maps, classification	02
5	Rasterio: Introduction, Installation, opening data, reading, saving, georeferenced and visualizing raster files, spatial indexing, creating data	02
6	Scikit-Learn: for machine learning, model fitting, predicting, cross-validation, for predictive data analysis, Tensor Flow, Pytorch	02
8	Web Scraping: Beautiful Soap, python web browser Module, Downloading Files from the Web with the requests Module, Saving downloaded Files to the Hard Drive, HTML	01
9	Introduction to Django framework: Component structure	01
10	Arcpy for ArcGIS Pro	02

Course Outcomes:

On completion of this course, the student shall be able to

1. understand the concept of numerical python, manipulate and extract data from pandas DataFrames.
2. write Python code according to standard style guidelines.
3. master basic processing of Raster and vector data in python.
4. understand the concept of Django and Arcpy for ArcGIS Pro.

Note: a) For 2 credits 2 hours practical twice a week.

b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Beazley, D., & Jones, B. K. (2013). *Python Cookbook: Recipes for Mastering Python 3*. " O'Reilly Media, Inc."
2. Kanetkar, Y. (2019). *Let Us Python*. BPB Publications
3. Lutz, M. (2010). *Programming Python: powerful object-oriented programming*. " O'Reilly Media, Inc."
4. McKinney, W. (2012). *Python for data analysis: Data wrangling with Pandas, NumPy, and IPython*. " O'Reilly Media, Inc".

Code: AGT 562 Applications of GIS and Remote Sensing

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To learn the applications of remote sensing data and GIS techniques in different fields.
2. To understand periodic updates in various fields.
3. To monitor the environment and human activities using RS and GIS techniques.

Sr. No.	Topics	Lectures
1	Geosciences: Landform Analysis, Drainage Basin Morphometry, Slope Mapping, Integrated Approach for Landslide Hazard Zonation Models and Mapping	5
2	Water Resources: Watershed Hydrology, Physical Processes in Watershed, Hydrological Modeling	5
3	Forest: Image Processing for Forest, Vegetation Classification Mapping, Forest Inventory, Forest Management	5
4	Fundamental of Climatology: Meteorological Satellites, Forecasting of Natural Calamities, Climate change detection	5
5	Agriculture and Soils: Spectral Characteristics of Crop, Crop Inventory, Crop Yield Modeling, Soil Mapping, Crop Water Management, Agro-Ecological Zoning	5
6	Biodiversity: Assessment of Biodiversity Hotspots, Wildlife Habitat Suitability Analysis, Species Inventory	5

Course Outcomes:

On completion of this course, the student shall be able to

1. understand how remote sensing data and GIS techniques are efficient to find and analyze real world problem in the different fields and it will help for decision making to minimize problem and for their management.
2. understand Satellite imaging helps detect environmental and structural changes in various sites.

Suggested Readings:

1. Deekshatulu, B. L. (1990): Description and useofLand use/Landcover, NRSA, Hyedrabad
2. Harris, J. E. (1990): Earthwatch – The Climate from space, Ellishorwood Ltd., Midsower Norton
3. Lal, D. S. (1998): Climatology, Chaitanya Publishing House, Allahabad
4. SPRS Technical Commission VII (2002): Symposium on Resource Environmental Monitoring, ISRS Annual Convention, IIRS, Dehradun
5. Roy, P.S., Dwivedi, R. S. (2010): Remote Sensing Application www.nrsc.gov.in/Learning- Center, E Book. html

Code: AGT 563 Applied Statistics – II

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To understand GIS and geo-statistical techniques, tools and approaches for spatial analysis.
2. To enhance the knowledge about the distribution of spatial data.
3. To learn how to make predictions to better understand the available information.

Sr. No.	Topics	Practicals
1	Geographical Data and Multivariate Analysis	01
2	Trend Surface Analysis: Computation of Linear Trend and Ideas of Quadratic and Cubic Surfaces	04
3	Principal component analysis (PCA), Factor Analysis	03
4	Introduction to R software: Exploratory data analysis, Probability, and statistical operations, Regression, and least squares using R	04
5	Geostatistics: Point data interpolation techniques including kriging methods - Simple kriging, Ordinary kriging, Universal kriging	03

Course Outcomes:

On completion of this course, the student shall be able to

1. understand the geostatistical methods and their application in different GIS domain, spatial trends in the data, or whether the features form spatial patterns.
2. analyze and predict the values associated with spatial or spatio-temporal phenomena.
3. enhance their knowledge about recent trends in geostatistics and it will offer convenient management in the related field.

Note: a) For 2 credits 2 hours practical twice a week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Acevedo, M. F. (2012). *Data Analysis and Statistics for Geography, Environmental Science and Engineering.* London: CRC Press.
2. Hammond, R. and McCullagh, P. (1991): Quantitative Techniques in Geography, Clarendon Press, Oxford
3. Johnston, R. J. (1978). *Multivariate Statistics in Geography*. London: Longman.
4. Rogerson, P. A. (2010). *Statistical Methods for Geography,* London: Sage Publications

Code: AGT 564 Advanced Surveying and Fieldwork: Practicals

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To understand advanced surveying concepts.
2. To utilize modern surveying instruments.
3. To plan and execute field survey.
4. To analyze and process survey data.
5. To apply surveying in various domains.

Sr. No.	Topics	Practicals
1	GPS: GPS Survey, Data Import, Processing and Mapping	03
2	Introduction to Total Station: REM, RDM, Use of Total Station for data collection, processing, and analysis	04
3	Introduction to Differential GPS (DGPS): DGPS setting of Instruments at base and rover, DGPS Survey and Data Processing	04
4	Introduction to Unmanned Aerial Vehicle (UAV): Drone Survey, Data Collection, Data processing	04

Course Outcomes:

On completion of this course, the student shall be able to

1. handle advanced survey instruments such as Total Station, DGPS, UAV.
2. conduct survey and collect the required data.
3. analyze the data and produce the results.
4. corelate and compare the data from various sources.
5. integrate remote sensing data, such as aerial and satellite imagery, LiDAR and other remote sensing technology into surveying projects for enhanced spatial information.

Note: a) For 2 credits, 2 hours practical twice a week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Jeff, H. (1995): Differential GPS Explained, Trimble Navigation
2. Lawrence, L. and Alex, L. (2008): GPS Made Easy: Using Global Positioning Systems in the Outdoors, Rocky Mountain Books, Calgary
3. Mohinder, S. G., Lawrence, R. W. and Angus, P. A. (2001): Global Positioning Systems, Inertial Navigation and Integration, John Wiley and Sons Inc., New York
4. Satheesh, G., Sathikumar, R. and Madhu, N. (2007): Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education, Delhi
5. Stinespring, B. M. (2000): The Experimental Evaluation of a DGPS Based Navigational System for the ARIES AUV, Monterey, California: Naval Postgraduate School; Springfield.

Code: AGT 571 **On Job Training**

No. of Credits: 04

On Job Training (OJT) in the RS and GIS field aims to provide necessary knowledge and practical skills to excel in their RS and GIS roles. The objectives of OJT in RS and GIS are as follows.

1. To understand spatial data management and perform spatial analysis.
2. To interpret remote sensing imagery.
3. To apply RS and GIS in real world problems.
4. To enhance problem solving skills.
5. To foster collaboration and communication.
6. To emphasize data ethics and privacy.
7. To embrace emerging technology.

By considering on these objectives, OJT in the RS and GIS field equips employees with the necessary skills and knowledge to contribute effectively to geospatial projects, making them valuable assets in the organization's geospatial endeavors.

Guidelines

1. For on Job Training, the students will be attached with various institutions and employing establishments, which have laboratory/workshop, other related facilities and where adequate supervision by qualified personnel will be available.
2. A student is expected to spend not less than 60 working hours on On-Job Training and related activities.
3. On Job Training will be carried out in summer vacation after the students complete their second semester examinations.
4. Students need to provide the confirmation letter from the organization or the institute where they have joined for On Job Training.
5. Continuous evaluation of the students' performance in the On-Job Training will be carried out with the assistance of the personnel of training institutions/employing establishments where this training will be imparted.
6. The proof of completion of On Job Training (work experience certificate and field report) should be submitted during examination to the parent institution, duly issued and signed by the concerned training authority.

Course Outcomes:

On completion of this course, the student shall be able to

1. apply the principles of RS and GIS in real-world projects.
2. solve problems and enhance their critical thinking skills.
3. effectively communicate and collaborate with corporate industries.
4. adapt to emerging RS and GIS technology.
5. embrace different pathways of learning, including experiential learning.
6. understand the social, economic and administrative considerations that influence the working environment of different organizations.
7. learn new strategies like time management, multi-tasking and new skills.
8. get an opportunity to meet new people and learn networking skills.