Vidyasagar University
Midnapore-721102, West Bengal

The SYLLABUS for
POST-GRADUATE Programme
In

REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM (RS & GIS)

[w.e.f. 2025-26]

Brief history

Remote Sensing and GIS has been developed as a powerful technology for mapping and analyzing earth resources. Although it has been widely used as a mapping tool and well-known for its application in various fields of earth sciences, but it has emerged as a new subject with immense potentiality and opportunity in recent days. The Department of Remote Sensing and Geographical Information System was established in 2003 with the view to cater the increasing demand of qualified and skilled manpower in this rapid growing field. It is one of the first Remote Sensing & GIS departments in West Bengal to start the course of Remote Sensing and GIS at Post Graduate and Doctoral levels. The Alumni of this Department have occupied responsible positions in India and abroad. Our students have unique opportunity to undertake their dissertation collaboratively with renowned state and central government agencies and research institutes and they are encouraged to carry out innovative research during their project period. Several Remote Sensing and GIS related Research and Consultancy Projects have been undertaken by the faculty members of the Department.

Program Outcomes (POs)

The Master of Science (M.Sc.) degree is designed to produce postgraduate students who are highly skilled, knowledgeable, and responsive to the demands of their respective fields. The core program outcomes (POs) for M.Sc. graduates are as follows:

- Advanced Knowledge: Graduates gain an in-depth understanding of their specific field of study, including theoretical foundations, practical applications, and current trends.
- Research Skills: Students develop robust research skills, enabling them to formulate, design, and conduct scientific research. This includes proficiency in using modern research methodologies, critical analysis, and data interpretation.
- Technical Proficiency: They are trained in the use of advanced tools and technologies relevant to their discipline, enhancing their analytical and problem-solving capabilities.
- Communication Skills: M.Sc. graduates are equipped with the skills to effectively communicate complex information in a clear and concise manner, both in writing and verbally, to both specialist and non-specialist audiences.
- Ethical Practices: Students are instilled with a strong sense of ethical responsibility, ensuring that their professional activities are conducted with integrity and adhere to applicable standards and regulations.
- Professional Competence: Graduates demonstrate the ability to work independently and as part of a team, managing projects efficiently and making informed decisions that reflect expert knowledge and judgment.
- Innovation and Creativity: The program encourages innovation and critical thinking, enabling graduates to contribute novel solutions to problems in their fields.
- Lifelong Learning: Graduates are prepared to engage in continuous learning, adapting to changes and pursuing further educational opportunities to remain relevant in their professions.

These outcomes prepare graduates not only to excel in their immediate roles but also to contribute effectively to the advancement of their fields and to address broader societal challenges.

Programme Specific Outcomes

The Master of Science (M.Sc.) degree in Remote Sensing and Geographic Information Systems (GIS) equips students with a comprehensive skillset and knowledge base that prepares them for diverse professional roles and further research in the field. The specific program outcomes include:

- Technical Proficiency: Graduates will demonstrate advanced proficiency in the principles and applications of remote sensing and GIS. This includes competency in data acquisition, processing, analysis, and interpretation.
- Analytical Skills: Students will develop strong analytical skills, enabling them to tackle complex spatial problems using geospatial technologies. They learn to integrate multiple data sources and apply quantitative and qualitative analysis techniques.
- Problem-Solving Abilities: The curriculum fosters the ability to design and implement GIS projects and remote sensing campaigns that address real-world issues, emphasizing strategic problem-solving and decision-making skills.
- Research Capability: Graduates will be capable of conducting independent research, utilizing advanced tools and methodologies in remote sensing and GIS. This includes designing research proposals, managing projects, and synthesizing findings coherently.
- Technological Adaptability: Keeping pace with rapid technological advancements in the field, students will gain proficiency in the latest remote sensing software and GIS tools, ensuring they remain adaptable and industry-relevant.
- Communication Skills: Effective communication is pivotal, and graduates will be adept at presenting complex geospatial information to diverse audiences, including scientists, policymakers, and the general public.
- Professional Development: The program prepares students for a professional career in various sectors, including government, academia, private industry, and non-profit organizations, by inculcating a strong ethos of ethical practice and continuous professional development.
- Collaborative Experience: Through collaborative dissertations and projects with state and central government agencies, as well as renowned research institutes, students gain valuable teamwork and leadership experience.

These outcomes ensure that graduates not only enter the workforce as highly qualified GIS and remote sensing professionals but also contribute innovatively to their fields of expertise.

DIVISION OF MARKS

Total Marks : 1100

SEM I Marks : 275

SEM II Marks : 275

SEM III Marks : 275

SEM IV Marks : 275

Theoretical Marks : 525 (SEM I: 175, SEM II: 175, SEM III: 175)

Practical Marks : 300 (SEM I: 100, SEM II: 100, SEM III: 100)

Dissertation : 175 marks (SEM IV)

Grand Viva : 100 marks (SEM IV)

M.Sc. in RS & GIS

SEMESTER	COURSE CODE	COURSE TITLES	Full Marks	No of Lectures (hours)	CREDIT (Lecture – Tutorial – Practical) (L-T-P)
I	RSG 101	FUNDAMENTALS & PHYSICS OF REMOTE SENSING	25	20	2 (1-1-0)
	RSG 102	PLATFORMS AND SENSORS	25	20	2 (1-1-0)
	RSG 103	FUNDAMENTALS OF GEOGRAPHIC INFORMATION SYSTEM	25	20	2 (1-1-0)
	RSG 104	DIGITAL CARTOGRAPHY	25	20	2 (1-1-0)
	RSG 105	INDIAN KNOWLEDGE SYSTEM	25	20	2 (1-1-0)
	RSG 106	SURVEYING AND NAVIGATIONAL SATELLITE SYSTEM	25	20	2 (1-1-0)
	RSG 107	INTRODUCTION TO PYTHON PROGRAMMING FOR GEOSPATIAL ANALYSIS	25	20	2 (1-1-0)
		VIDYASAGAR: LIFE AND PHILOSOPHY	Compulsory Non-credit course		
	RSG 108	FUNDAMENTALS OF IMAGE PROCESSING & INTERPRETATION (Practical)	25	40	2 (0-0-2)
	RSG 109	FUNDAMENTALS OF GIS (Practical)	25	40	2 (0-0-2)
	RSG 110	COMPULSORY FIELD SURVEY (Practical)	25	40	2 (0-0-2)
	RSG 111	PYTHON PROGRAMMING (Practical)	25	40	2 (0-0-2)
	TOTAL		275	300	22
II	RSG 201	DIGITAL IMAGE PROCESSING	25	20	2 (1-1-0)
	RSG 202	INFORMATION EXTRACTION FROM SATELLITE IMAGES	25	20	2 (1-1-0)
	RSG 203	THERMAL AND MICROWAVE REMOTE SENSING	25	20	2 (1-1-0)
	RSG 204	MASSIVE OPEN ONLINE COURSES (MOOC)/SWAYAM	50	40	4 (2-2-0)
	RSG 205	HYPERSPECTRAL REMOTE SENSING AND LIDAR	25	20	2 (1-1-0)
	RSG 206	ADVANCED GIS & MODELING SPATIAL DATABASE	25	20	2 (1-1-0)
	RSG-207	DIGITAL IMAGE PROCESSING (Practical)	25	40	2 (1-1-0)
	RSG 208	ADVANCED REMOTE SENSING: DATA PROCESSING AND APPLICATION (Practical)	25	40	2 (0-0-2)
	RSG 209	ADVANCED GEOGRAPHIC INFORMATION SYSTEM (Practical)	25	40	2 (0-0-2)
	RSG 210	MODELING SPATIAL DATABASE AND ANALYSIS (Practical)	25	40	2 (0-0-2)
	TOTAL		275	300	22
III	RSG 301	APPLICATION OF GEO-INFORMATICS	25	20	2 (1-1-0)
	RSG 302	SPATIAL DATA SCIENCE AND SDSS	25	20	2 (1-1-0)
	RSG 303	FUNDAMENTAL OF RESEARCH AND GEOSPATIAL PROJECT MANAGEMENT	25	20	2 (1-1-0)
	RSG 304	MASSIVE OPEN ONLINE COURSES (MOOC)/SWAYAM	50	40	4 (2-2-0)

SEMESTER	COURSE CODE	COURSE TITLES	Full Marks	No of Lectures (hours)	CREDIT (Lecture – Tutorial - Practical) (L-T-P)
	SPECIAL PAPER: **The students have to select any one of the following subjects (A-J), as proposed by the department, likely to be offered as elective special papers.**				
	RSG305A	THEORETICAL CONSIDERATIONS OF GEO-INFORMATICS IN COASTAL MANAGEMENT	25	20	2 (1-1-0)
	RSG306A	POTENTIAL APPLICATION AREAS OF RS/GIS IN COASTAL MANAGEMENT	25	20	2 (1-1-0)
	RSG305B	GEO-INFORMATICS IN WATERSHED MANAGEMENT	25	20	2 (1-1-0)
	RSG306B	REMOTE SENSING IN WATER RESOURCE EVALUATION	25	20	2 (1-1-0)
	RSG305C	FUNDAMENTALS OF EARTH SYSTEM	25	20	2 (1-1-0)
	RSG306C	APPLICATION OF GEO-INFORMATICS IN EARTH SCIENCE	25	20	2 (1-1-0)
	RSG305D	FUNDAMENTAL CONCEPTS OF HAZARDS AND DISASTERS	25	20	2 (1-1-0)
	RSG306D	APPLICATION OF GEO-INFORMATICS IN HAZARDS AND DISASTERS MANAGEMENT	25	20	2 (1-1-0)
	RSG305E	FUNDAMENTAL CONCEPTS OF SOIL AND AGRICULTURAL SCIENCE	25	20	2 (1-1-0)
	RSG306E	APPLICATION OF GEO-INFORMATICS IN SOIL AND AGRICULTURE	25	20	2 (1-1-0)
	RSG305F	GEO-INFORMATICS IN URBAN, RURAL DEVELOPMENT & REGIONAL PLANNING A THEORETICAL CONSIDERATIONS	25	20	2 (1-1-0)
	RSG306F	POTENTIAL APPLICATION AREAS OF RS/GIS IN URBAN, RURAL DEVELOPMENT & REGIONAL PLANNING	25	20	2 (1-1-0)
	RSG305G	THEORETICAL CONSIDERATIONS IN EVIRONMENTAL SCIENCE AND MANAGEMENT	25	20	2 (1-1-0)
	RSG306G	APPLICATION OF REMOTE SENSING AND GIS IN EVIRONMENTAL SCIENCE AND MANAGEMENT	25	20	2 (1-1-0)
	RSG305H	GEO-INFORMATICS IN RESOURCE MANAGEMENT	25	20	2 (1-1-0)
	RSG306H	APPLICATION OF REMOTESENSING AND GIS IN RESOURCE MANAGEMENT	25	20	2 (1-1-0)
	RSG305I	GEO-INFORMATICS IN TRANSPORT NETWORK ANALYSIS	25	20	2 (1-1-0)
	RSG306I	APPLICATION OF REMOTESENSING AND GIS IN TRANSPORTATION	25	20	2 (1-1-0)
	RSG305J	GEO-INFORMATICS IN UTILITY MANAGEMENT	25	20	2 (1-1-0)
	RSG306J	APPLICATION OF REMOTE SENSING AND GIS IN UTILITY MANAGEMENT	25	20	2 (1-1-0)
	RSG 307	APPLICATION OF GEO-INFORMATICS AND SPATIAL DECISSION SUPPORT SYSTEM (Practical)	25	40	2 (0-0-2)
	RSG 308	GENERATION OF CASE STUDIES & COMMUNITY ENGAGEMENT (COMPULSORY FIELD STUDY) (Practical)	25	40	2 (0-0-2)
	RSG 309	GEOSTATISTICS (Practical)	25	40	2 (0-0-2)
	RSG 310	PRACTICAL (based on selected Special Paper)	25	40	2 (0-0-2)
	TOTAL		275	300	22

IV	RSG 401	DISSERTATION EXAMINATION	100	120	8 (0-0-8)
	RSG 402	DISSERTATION-VIVA	75	60	6 (0-0-6)
	RSG 403	GRAND -VIVA	100	120	8 (0-0-8)
	TOTAL		275	300	22
	GRAND TOTAL		**1100**	**1200**	**88**

The total credit for the course is 88 and the total mark is 1100.

Distinctive features of course content:

- **Value-added course: RSG 105, 106, 107**
- **Employability / entrepreneurship/ skill development: RSG 101; 102; 103; 104; 105; 106; 107; 108; 301;** 302; 109; 110; 210; 211; 212; 309; 401; 402
- **Ethics, environment & sustainability: RSG 301; 303; 305C & 306C**
- **The new course introduced: RSG 206; 211; 302; 307**
- **Field Survey (academic excursion): RSG 111, 308**
- **Internship (optional): RSG 401**

Important Note:

- *The intake capacity of each special paper (SEM-III) will be decided by the Departmental Committee before commencement of SEM-III classes.*
- *First class 60 %, Second Class 50 %, No third class. Min marks for passing Theory 20, Practical 13.*
- *Field work & community engagement is compulsory for Students of semester – I and III*
- *Internal assessment will be based on seminar presentation, class tests, quiz and assignments.*
- *Students will get maximum 5 months to complete his/her dissertation work in semester-IV.*
- *Students may visit their field of study during dissertation work at their own expenses.*
- *Students may have to carry out Dissertation works in an outstation institution at their own expenses.*
- *Grand viva will be based on the overall understanding of the subject.*

SEM I PAPERS

SEM -I THEORY

RSG 101: Fundamentals & Physics of Remote Sensing:
Course Outcome:
After completion of this course, students will be able to:

- Students will learn the concept, scope, and operational process of remote sensing systems, along with their characteristics, advantages, and limitations.
- They will be able to interpret the principles of electromagnetic radiation (EMR) by relating wavelength, frequency, and energy, and analyze EMR spectrum, atmospheric windows, and spectral signatures for remote sensing applications.
- Students will acquire knowledge on application of radiation laws (Stefan–Boltzmann, Wien's, and Kirchhoff's) to differentiate between black body and real body radiation, and solve numerical problems related to radiant and kinetic temperatures.
- The concept on energy interactions within the atmosphere including scattering, absorption, transmission, and their impact on remote sensing data quality.
- They will be able to evaluate energy interactions with Earth's surface features by interpreting spectral reflectance curves and signatures of vegetation, soil, and water for resource monitoring and environmental studies.

RSG 101:

Full Marks: 25. Number of lectures to be delivered for each module is 20

Fundamentals & Physics of Remote Sensing:

i. *Concept and Scope of Remote Sensing:* Definitions, Process and Characteristics of Remote Sensing System, Advantages and limitations.
ii. *Concept of Electromagnetic Radiation (EMR):* Wavelength-frequency-energy relationship of EMR, EMR Spectrum and its properties, EMR wavelength regions and their applications, Atmospheric windows, Interaction of EMR with matter, Spectral signatures.
iii. *Fundamental laws governing the science*: Sources of Energy, Radiation laws: Stefan-Boltzmann law, Wien's law, Kirchhoff's law etc., Black body and Real body, Radiant temperature & Kinetic temperature ***(Numerical problems of all above)***
iv. *Energy Interaction in the atmosphere:* Scattering, absorption, transmission, atmospheric windows
v. *Energy Interactions with Earth Surface Features:* Spectral Reflectance Curve, Concept of signatures

Internal Assessment (5)

RSG 102: Platforms and Sensors:
Course Outcome:
After completion of this course, students will be able to:

- Describe sensor materials and scanning systems including framing, whiskbroom, push-broom, and side-looking scanners used in remote sensing.
- Differentiate types and characteristics of sensors (imaging vs. non-imaging, active vs. passive) and evaluate their resolution properties (spectral, spatial, radiometric and temporal), scale, and multi-band concepts including false colour composites.

- Analyze remote sensing platforms and satellite orbits (ground, airborne, space borne) and explain orbital characteristics such as coverage, passes, pointing accuracy, and types of orbits (geostationary, sun synchronous, shuttle, Molniya, quasi-zenith).
- Apply orbital mechanics and satellite basics by using Kepler's laws to calculate orbital parameters (major axis, eccentricity, velocity, period, escape velocity) and understand payloads and launch vehicle systems.
- Evaluate space imaging satellite systems and their applications by studying multispectral, hyperspectral, radar, and lidar sensors, along with specifications of popular satellites (IRS, Landsat, SPOT, IKONOS, Cartosat, QuickBird, OrbView, GeoEye, Pléiades).

RSG 102:

Full Marks: 25. Number of lectures to be delivered for each module is 20

Platforms and Sensors:

i. *Introduction:* Sensor materials, Sensor System - Framing and Scanning System, Whiskbroom scanners, Push-broom scanners, Side Looking scanner

ii. *Types and Characteristics of Sensor:* Imaging and non-imaging sensors, Active and passive sensors, Resolution of Sensors - *Spectral*, Spatial, Radiometric & Temporal, Scale, Mapping unit, multi-band concepts and False Colour Composites

iii. *Remote Sensor Platforms and Satellite Orbits:* Ground, Airborne and Space borne Platforms, Orbital Characteristics – Coverage, Passes, Pointing Accuracy, Geostationary, sun synchronous, shuttle orbit. Semi synchronous orbit (Molniya orbit) and Quasi-zenith satellite orbit

iv. *Satellite Basics:* Kepler's laws, Major-Semimajor axis & Eccentricity, Velocity, Period (Numerical problems), Historical development, Launch Vehicle, Escape Velocity Payload.

v. *Space Imaging Satellites:* Early history of space imaging; Multispectral and Hyperspectral sensors, Radar, Lidar; Specification of some popular satellites – IRS, Landsat and SPOT series; High resolution satellites – IKONOS, Cartosat, Quickbird, OrbView, GeoEye, Pléiades, WorldView; Other latest earth resource satellites.

Internal Assessment (5)

RSG 103: Fundamentals of Geographic Information System:
Course Outcome:
After completion of this course, students will be able to:

- Fundamental Understanding of GIS Concepts: Students will understand the basic concept of Geographic Information Systems (GIS) and identify its key components, applications, advantages, and limitations.
- Differentiate Data Types: Students will be able to distinguish between spatial and attribute data, and analog vs. digital formats, understanding the importance of spatial elements.
- Explain Data Structures: Students will be able to explain the differences between raster and vector data structures, along with their advantages and disadvantages in various applications.
- Manage GIS Data: Students will develop skills to create GIS databases, understand file organization, implement data rectification, and utilize data input methods like digitizing and geocoding.
- Identify Modern Trends: Students will be able to identify and discuss current trends in GIS technology, discussing 3D GIS, Web GIS, and Mobile GIS, and their implications

for spatial analysis and mapping.

RSG 103:

Full Marks: 25. Number of lectures to be delivered for each module is 20

Fundamentals of Geographic Information System:

i. *Basic Concepts:* definition of GIS, Components of GIS, Areas of GIS application, Advantage and Limitation of GIS
ii. *GIS Data:* Spatial and Attribute Data, Analog vs. Digital data, Spatial/Graphical elements of GIS
iii. *Information Organization and Data Structures:* Raster and Vector data structures, advantages and disadvantages
iv. Nature and Source of data in GIS: Spatial and Attribute data capture and linking
v. *Creating GIS Database:* GIS Software, file organization and formats, Rectification; Methods of Data Input: Keyboard entry, Manual digitizing, Semi-automatic digitizing, Automatic digitizing, Geocoding, Map Composition
vi. *Data Editing:* Detecting and correcting errors, Re-projection, Transformation and Generalization, Edge matching and Rubber sheeting, Topology
vii. *Modern Trends in GIS:* 3D GIS, Web GIS and Mobile GIS

Internal Assessment (5)

RSG 104: Digital Cartography

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

- Comprehend Digital Cartography: Students will be able to articulate the concept of digital cartography and evaluate its advantages and disadvantages compared to traditional mapping practices.
- Concepts and Classifications of Map: Students will be able to identify various map types, understand map scales, and learn about coordinate systems and projections, including LCC and UTM.
- Measure Geographic Variables: Students will understand nominal, ordinal, interval, and ratio scales to measure geographic variables, enhancing mapping and analytical skills.
- Differentiate Data Type: Students will be able to distinguish between qualitative and quantitative data, discrete and continuous data, and understand absolute and derived data in digital cartography.
- Implement Digital Mapping Techniques: Students will develop skills in cartographic design and apply visual variables (shape, color, pattern) to create dot maps, choroplethic maps, and isarithmic mapping, developing effective map-making capabilities.

RSG 104:

Full Marks: 25. Number of lectures to be delivered for each module is 20

Digital Cartography:

i. *GIS and Digital Cartography*: Concept of Digital Cartography, Advantages and Disadvantages of Digital Cartography
ii. *Concept of Map:* Defining Map, Classification of maps, Map Scales, Coordinate System and Projections, Lambert Conformal Conic (LCC) and Universal Transverse Mercator (UTM) projection
iii. *Measurement of Geographic Variables:* Nominal, Ordinal, Interval and Ratio Scales

iv. *Types of data*: Qualitative vs. Quantitative data, Discrete vs. Continuous data, Absolute vs. Derived data

v. *Digital Mapping:* Cartographic Design, Concept of Visual Variables (Shape, Size, Orientation, Hue, Value, Chroma, Pattern), RGB colour model, Symbols, Map Lettering, Map Compilation, Map Generalization (Classification, Simplification, Exaggeration, Symbolization, Induction)

vi. Mapping Statistical Surface: Dot map, Choroplethic and Isarithmic Mapping, Dasymetric Mapping, Multivariate and Dynamic Mapping

Internal Assessment (5)

RSG 105: INDIAN KNOWLEDGE SYSTEM
Course Outcome:

RSG 105: INDIAN KNOWLEDGE SYSTEM

Full Marks: 25 Number of lectures to be delivered for each module is 20.

Internal Assessment (5)

RSG 106: Surveying and Navigational Satellite System:
Course Outcome:
After completion of this course, students will be able to:

- Recognize the importance of field surveys and ground truth data collection for validating and enhancing the accuracy of remotely sensed data.
- Students will be able to apply conventional field survey techniques such as plane and geodetic surveying (traversing, triangulation, levelling), topographic and cadastral mapping, and operate modern instruments like Total Station.
- They will be able to explain the fundamentals of Global Navigational Satellite Systems (GNSS), including GPS, NAVSTAR, GLONASS, and IRNSS, and analyze their space, control, and user segments.
- Differentiate GPS positioning techniques (absolute vs differential), and evaluate GPS surveying methods, DGPS data processing, and factors influencing positional accuracy.
- Select and operate reference station equipment including GPS receivers, antennas, and radio communication systems for high-accuracy geospatial data acquisition.

RSG 106:

Full Marks: 25 Number of lectures to be delivered for each module is 20.

Surveying and Navigational Satellite System:

i. *Validation of Data:* Importance of Field Survey, Collection of Ground Truth.

ii. The Planet Earth, Geoids, Concept of Spherical Geometry and Geodesy, Reference Spheroid and Mean Sea Level. Introduction to different spheroid / ellipsoid systems with special reference to Everest and WGS-84 - Geometric Constants.

iii. *Introduction to conventional field survey techniques:* Plane and Geodetic Surveying (Traversing, Triangulation and Levelling), Topographic, Cadastral; Total Station

iv. *Global Navigational Satellite System:* Introduction, Satellite constellation, GPS signals and data, Geopositioning-Basic Concepts. GPS, NAVSTAR, GLONASS, Indian Regional Navigational Satellite System (IRNSS), Control Segment, Space Segments, User Segment, GPS Positioning Types- Absolute Positioning, Differential positioning

v. *GPS Surveying Methods and Accuracy:* Methods: PPK, RTK, Positioning Modes, Factors Affecting signal error & GPS Accuracy.
vi. *Reference Station:* Selection of Reference Station, CORS & NTRIP, Reference Station Equipment: GPS receiver, GPS antenna, Radio Antenna.

Internal Assessment (5)

RSG 107

Introduction to Python Programming for Geospatial Analysis:

Course Outcome:

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

- Understand Python Basics: Students will learn the fundamentals of Python, including setting up the programming environment, understanding syntax, data types, and data structures.
- Utilize Control Structures: Students will be able to implement control structures by using conditional statements and loops to facilitate decision-making and iteration in their programming tasks.
- Master Functions and Modules: Students will learn call functions, work with modules and packages, and import libraries, gaining familiarity with libraries specifically for remote sensing and GIS applications.
- File Handling Skills: Students will develop skills in reading from and writing to files, manage different file formats, and handle exceptions to ensure robust programming practices.
- Apply Programming Concepts: Students will be able to integrate the acquired skills to solve practical problems in remote sensing and GIS, enhancing their programming and analytical capabilities.

RSG 107:

Introduction to Python Programming for Geospatial Analysis:

Full Marks: 25. Number of lectures to be delivered for each module is 20

Introduction to Python Programming:

i. Introduction to Python programming, syntax and data types, Data structures.
ii. Control Structures, Conditional statements, Loops.
iii. Defining and calling functions, Modules and packages, Importing and using libraries, Introduction to Libraries for Remote Sensing and GIS.
iv. Reading and writing files, Summarization, visualization and basic descriptive statistical analysis from data.

Internal Assessment (5)

SEM -I PRACTICAL

RSG 108 (Practical)

FUNDAMENTALS OF IMAGE PROCESSING & INTERPRETATION (25 marks)

Full Marks: 25. At least even number of periods to be assigned (preferably in batches).Examination Time: 2hours. Pattern of setting questions: 20 marks compulsory questions are to be set. 5 marks are to be allocated for Evaluation of Practical Notebook and Viva-voce. Right hand side parentheses indicate lecture / demonstration hours.

Course Outcome:

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

- Perform file import, export, and format conversion for handling remote sensing and GIS datasets across different platforms.
- Create and interpret False Colour Composites (FCCs) for visual identification of land features and resource mapping.
- They will be able to apply image registration, geocoding, and map projections to align satellite images with geographic coordinate systems and generate regions of interest (ROIs).
- Students will have efficiency in image subsetting, clipping, and mosaicking of aerial photographs and satellite imagery for area-specific analysis.
- Analyze image statistics and histograms, and generate spectral signature curves for feature identification and classification in digital image processing.

i. Familiarization with hard copy and soft copy images, Introduction to different GIS and RS software, Concept of bands and channels, True colour, false colour and standard false colour composite, Physical and cultural features identification from imageries, Ground based observation equipment -Radiometer, Spectrophotometer, Use of spectro-radiometer for ground truth.

ii.

Topic to be covered	
File export import/ translation, Conversion of file formats	**Available Software's**
False colour composite and visual identification	
Image registration / Geo coding, Projection, Creating Region of Interest	
File sub setting /clipping Mosaic Air photo and Images	
Feature identification and signature curve generation	
Image Statistics, Histogram	

(20)

Practical Notebook and Viva Voce (5)

RSG 109 (Practical)

FUNDAMENTALS OF GIS (25 marks)

Full Marks: 25. At least even number of periods to be assigned (preferably in batches).Examination Time: 2hours. Pattern of setting questions: 20 marks compulsory questions are to be set. 5 marks are to be allocated for Evaluation of Practical Notebook and Viva-voce. Right hand side parentheses indicate lecture / demonstration hours.

Course Outcome:

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

- Geo-Database Creation: Students will learn to create and manage geo-databases, including importing, exporting, and subsetting data effectively for spatial analysis.
- Geo-Referencing and Projections: Students will understand geo-referencing techniques and the process of changing projections to ensure accurate spatial representation of geographic data.
- Digitization Techniques: Students will acquire skills in digitizing geographic features by creating points, lines, and polygons to build accurate and detailed spatial datasets.
- Attribute Table Management: Students will manage attribute tables effectively, applying techniques for thematic mapping to visualize and analyze spatial relationships within the data.
- Map Composition Skills: Students will engage in map composition and representation, learning best practices for designing informative and visually appealing maps for various audiences.

Topic to be covered	
Creating Geo-Database: Import, Export, subset	
Managing Geo-Database, Geo-referencing & Changing Projection	
Digitization: Point, Line, Polygon	**Available Software's**
Managing attribute table and thematic mapping	
Map composition and representation	

(20)

Practical Notebook and Viva Voce (5)

RSG 110 (Practical)
COMPULSORY FIELD SURVEY

Course Outcome:

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

- **Prepare base maps** from Survey of India Toposheets and delineate various topographical features for geospatial analysis.
- **Operate GPS receivers** by performing initial settings, creating codes and attribute tables, and collecting point, line, and area data using different datum's.
- **Process and manage GPS data** including area calculation, post-processing, attribute table creation, and data export using GPS Pro software.
- **Integrate GPS data with GIS platforms** to generate spatial outputs and enhance mapping applications.
- **Conduct field validation of satellite imagery** to verify remotely sensed data and improve classification accuracy.

RSG 110 (Practical)
COMPULSORY FIELD SURVEY (25 marks)

Full Marks: 25. Compulsory field survey

Field survey and field report preparation (compulsory) using following methods

i. Preparation of Base map from Survey of India Toposheets, Use of India topographical sheets for delineation of different features.

ii. Introduction to a GPS and initial setting, creating codes and attribute table for GPS receiver, Point Data collection using GPS with different datum, Line data collection using GPS and measurements, GPS data collection for area calculation, Post processing of the GPS data, Creating attribute table in GPS software and Export functions, GPS and GIS integrations output preparation (20)

iii. Field validation of satellite imagery. (5)

iv. Viva voce and Report presentation

RSG 111 (Practical)
PROGRAMMING IN PYTHON (25 marks)

Full Marks: 25. At least even number of periods to be assigned (preferably in batches). Examination Time: 2 hours. Pattern of setting questions: 20 marks compulsory questions are to be set. 5 marks are to be allocated for Evaluation of Practical Notebook and Viva-voce. Right hand side parentheses indicate lecture / demonstration hours.

Course Outcome:

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

- Demonstrate foundational Python proficiency by writing scripts using basic syntax, data types, operators, and control structures.
- Apply Python data structures such as lists, tuples, and dictionaries, and utilize libraries like NumPy and Pandas for efficient data management and statistical analysis.
- Create data visualizations using Matplotlib to generate plots, graphs, and charts for interpreting datasets.
- Analyze relationships between variables using correlation techniques and apply

statistical methods to support data-driven decision-making.

- Develop modular and reusable Python code to solve real-world problems through structured programming and automation of data analysis tasks.

RSG 111 (Practical)
PYTHON PROGRAMMING (25 marks)

i. Setting up the environment, Basic syntax and data types, Variables and operators, Simple input and output operations.
ii. Data Structures: Working with lists, tuples, - Slicing and indexing List comprehensions.
iii. Conditional Logic and Loops: Writing scripts with if, elif, and else, implementing for and while loops, Combining loops with conditional statements.
iv. Functions and Modules: Defining and calling user-defined functions- Importing and using standard and external libraries, Introduction to NumPy and Pandas.
v. Reading from and writing to text files (.txt), Working with CSV files using Pandas, File export import.
vi. Descriptive Statistics: Summarizing data using Pandas (.describe(), etc.), Calculating mean, median, mode, and standard deviation. Creating various plots using Matplotlib.

(20)

Practical Notebook and Viva Voce (5)

SEM II PAPERS

SEM -II THEORY

RSG 201: Digital Image Processing:

Course Outcome:

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

- Explain the fundamentals of digital images including definition, data sources, data loading, image restoration, and geometric transformations like reduction and magnification.
- They will be able to identify and correct errors in remotely sensed imagery through rectification, registration, resampling, and radiometric corrections.
- They will gather knowledge on contrast manipulation techniques such as gray-level thresholding, level slicing, and linear/non-linear contrast stretching for image enhancement.
- Students will be able to implement spatial and texture-based manipulations including spatial filtering, edge enhancement, gradient operations, and Fourier analysis to extract meaningful image features.
- Students will be able to perform multi-image manipulations and statistical evaluations such as band ratioing, differencing, PCA/CCA, vegetation indices, image fusion, and quality assessment using univariate and multivariate statistics.

RSG 201:

Full Marks: 25. Number of lectures to be delivered for each module is 20

Digital Image Processing:

i. *Introduction:* Definition of digital image, Source of Data, Data loading, Image Restoration, Image Reduction and Magnification
ii. *Image Pre-processing:* Sources of Error in image data, Image Rectification and Registration, Resampling Techniques, Radiometric corrections
iii. *Contrast Manipulation*: Gray Level Thresholding, Level Slicing; Contrast Stretching – Linear and Non-linear
iv. *Spatial Texture Manipulation:* Spatial filtering – Linear, High Boost, Directional and Gradient Filters; Edge Enhancement and Fourier Analysis
v. *Multi-image Manipulation:* Band Ratioing and Differencing, Principal and Canonical Components, Vegetation Components, Image Fusion; Initial Statistics Extraction: Univariate& Multivariate Image Statistics, Band Correlation, Statistical Evaluation of Image Quality Parameters

Internal Assessment (5)

RSG 202: Information Extraction from Satellite Images:

Course Outcome:

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

- Calibrate the data by collecting field information, interpreting spectral signatures, and preparing training and verification datasets.
- They will be able to differentiate thematic image classification approaches including

spectral, spatial, and temporal pattern recognition, and evaluate the strengths and limitations of parametric and non-parametric classifiers.

- They will have knowledge to apply unsupervised classification algorithms such as ISODATA and K-means to automatically categorize remotely sensed data.
- Students will be able to implement supervised classification methods including Minimum Distance, Parallelepiped, Maximum Likelihood, and Mahalanobis Distance classifiers for land cover mapping.
- Students will be able to utilize advanced classification techniques and assess accuracy using hybrid methods, ANN, SVM, decision trees, fuzzy classifiers, OBIA, and perform accuracy evaluation through error matrices, Kappa statistics, and change detection analysis.

RSG 202: Information Extraction from Satellite Images:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Information Extraction from Satellite Images:

i. *Ground Truthing:* Ground Truth Collection for Image Classification, Spectral Signature, Data Calibration, Interpretation of target Properties, Training, Verification.
ii. *Thematic Image Classification:* Spectral Pattern Recognition, Spatial Pattern Recognition, Temporal Pattern Recognition, Parametric and Non-Parametric classifiers, Hard and Soft Classification System, Advantage and Disadvantages of Different Classifiers
iii. *Unsupervised Classification:* Isodata, K-mean
iv. *Supervised Classification System:* Minimum Distance to Mean, Parallelepiped, Maximum Likelihood, Mahalanobis Distance
v. *Advanced Classification Techniques:* Hybrid Classification, ANN, Spectral Mixture Analysis, Fuzzy Classifiers, Spectral Angle Mapper, Decision Tree, Support Vector Machine, Object Based Classification. *Accuracy Assessment:* Reference Data, Sampling techniques, Error of Commission and Omission, Error Matrix, Kappa Statistics and Change Detection Analysis

Internal Assessment (5)

RSG 203: Thermal and Microwave Remote Sensing:

Course Outcome:

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

- Explain the principles of thermal remote sensing by applying physical radiation laws, understanding blackbody radiation, emissivity, and thermal infrared atmospheric windows, and analyzing terrain–thermal interactions.
- Students will be able to interpret thermal remote sensing imageries including detectors, radiometers, scanners, and apply geometric and radiometric calibration for thermal data analysis.
- Students will be able to describe the fundamentals of microwave remote sensing and compare active and passive microwave systems with their advantages and applications.
- The will acquire knowledge on microwave interactions with Earth's surface including attenuation, surface and volume scattering, vegetation and water response, and evaluate the role of antennas, platforms, and environmental factors.
- Students will be able to apply radar remote sensing techniques by understanding polarization, spatial resolution, image geometry, relief displacement, shadows, speckle effect, and advanced systems like SLAR, SAR, and differential interferometry for Earth observation applications.

RSG 203:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Thermal and Microwave Remote Sensing:

i. *Thermal Remote Sensing:* Basic Principles, Physical Laws, Blackbodies and Emissivity, Thermal Infrared Radiation Properties, Thermal Infrared Atmospheric Windows, Interaction of Thermal Radiation with Terrain Elements
ii. *Thermal Data Processing:* Thermal Energy Detectors, Thermal Radiometers, Thermal Scanners, Interpreting Thermal Scanner imaginary, Geometric Characteristics of Thermal Scanner Imaginary, Geometric and Radiometric Calibration of Thermal data, Applications
iii. *Microwave Remote Sensing:* Basic Principles, Microwave Remote Sensing and its advantages, Active and Passive Microwave Systems
iv. Attenuation of Microwave, Surface Scattering, Volume Scattering, Types of Antenna, Platforms and sensors, RADAR Environmental Considerations: Surface Roughness Characteristics, Electrical Characteristics, Vegetation and Water response to Microwave energy
v. Radar Operation, Polarization, Spatial Resolution, Radar Image Geometry, Relief Displacement, Shadows and Speckle effect, Side Looking Airborne Radar (SLAR) Operation, Synthetic Aperture Radar (SAR), Differential Interferometry, Applications

Internal Assessment (5)

RSG 204: MOOC/SWAYAM

Full Marks: 50

RSG 205

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Hyperspectral Remote Sensing and LIDAR:

Course Outcome:

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

- Comprehend Hyperspectral Remote Sensing: Understand the principles, advantages, disadvantages, and differences between hyperspectral and multispectral systems, including sensor specifications.
- Learn Data Processing Techniques: Acquire skills in atmospheric corrections, bad band and line removal, and information extraction methods like endmember collection and image classification.
- Explore Applications in Various Fields: Investigate practical applications of hyperspectral data in agriculture, water management, soil analysis, and mining to derive valuable insights.
- Understand LIDAR Technology: Grasp the fundamental principles of LIDAR, including laser scanning systems, types of returns, and post-processing for accuracy enhancement.
- Analyze LIDAR Applications: Examine LIDAR applications in vegetation monitoring and urban infrastructure, recognizing its significant impact on environmental analysis and urban planning.

RSG 205:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Hyperspectral Remote Sensing and LIDAR:

i. *Hyperspectral Remote Sensing:* Basic Concept, Advantages and Disadvantages, Multispectral vs. Hyperspectral Remote Sensing, Basic principles of Spectroscopy, Hyperspectral sensors

and platforms, Sensor specifications

ii. *Hyperspectral Data Processing and Information Extraction:* Atmospheric Corrections-Empirical and Physics based Approaches, Bad band and Bad line removal; Information extraction: Endmember collection, Minimum Noise Fraction, Pixel Purity Index, N-D visualizer, ground truthing through Spectro-radiometer, Image Classification techniques

iii. *Application of Hyperspectral Data:* Application in Agriculture, Water, Soil and Mining

iv. *LIDAR:* Basic Principles and advantages, Laser and Scanning System, Laser Location, LIDAR Antenna Attitude, Types of LIDAR returns, LIDAR post processing of multiple returns, Accuracy of LIDAR measurements, The Laser Vegetation Imaging Sensor

v. *Applications of LIDAR Data:* Areas of Applications with special reference to Vegetation and Urban Infrastructure

Internal Assessment (5)

RSG 206: Advanced GIS and Modeling Spatial Database

Course Outcome:

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

- Explain the role of databases in GIS by describing database models, geodatabase concepts, and selecting suitable GIS applications.
- The will be able to differentiate the types of geodatabases and describe their structure for effective storage and management of spatial and attribute data. Understand the fundamentals of geodatabases, including types like relational, hierarchical, and network models, as well as advanced data structures like Spaghetti, Topological models, and Quadtree.
- Students will gather knowledge on spatial analysis techniques including measurement, attribute and spatial queries, neighbourhood and connectivity analysis, and overlay operations.
- Students will be able to perform data manipulation and transformation in GIS using overlay, buffering, neighbourhood functions, interpolation, and other spatial analysis methods.
- They will be able to develop GIS-based models through flowcharting and map algebra operations, applying functional operators for spatial modeling and decision-making.

RSG 206:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Advanced GIS and Modeling Spatial Database

i. Role of databases in GIS, Methods of GIS analysis, Selection of GIS applications, Basics of the Geodatabase Model and concepts.

ii. Database Structure, Types of Geo-database used in GIS, Data Storage: Spaghetti Model, Topological Model, Quadtree, Data Organization: Chain Coding, Run-length Coding, Block Coding, Data Quality in GIS: Uncertainty in GIS data, Positional and Attribute Accuracy, Logical consistency, Completeness Lineage.

iii. Database Modelling: Hierarchical Model, Network Model, Relational Model. Spatial Analysis: Types of Spatial Analysis, Measurement in GIS, Query – Query by Attributes, Spatial Queries, Attribute Based Operation, Overlay and Geocoding.

iv. Data Manipulation Techniques, Overlay Operations and Buffering, Interpolation methods, Methods of Spatial analysis, Surface Modelling.

v. Map Algebra - Operators & Operations, Functional Operations.

Internal Assessment (5)

SEM -II PRACTICAL

RSG 207 (Practical)
DIGITAL IMAGE PROCESSING (25 marks)
Course Outcome:
After completion of this course, students will be able to:

- Apply geometric and atmospheric corrections to improve the positional and radiometric accuracy of satellite images.
- Students will be able to enhance and filter imagery using advanced image processing techniques for better visualization and feature extraction.
- Students will learn implementation of advanced classification algorithms for accurate land use/land cover mapping and resource assessment.
- Conduct accuracy assessment and ground truthing using spectroradiometer data, and evaluate classification reliability through statistical measures.
- Perform raster calculations and modeling by applying algorithms for spatial analysis, simulation, and predictive modeling in remote sensing applications.

RSG 207 (Practical)
DIGITAL IMAGE PROCESSING (25 marks)

Full Marks: 25.At least even number of periods to be assigned (preferably in batches).Examination Time: 2 hours. Pattern of setting questions: 20 marks compulsory questions are to be set. 5marks are to be allocated for Evaluation of Practical Notebook and Viva-voce. Right hand side parentheses indicate lecture / demonstration hours.

Topic to be covered	**Available Software's**
Geometric and Atmospheric Correction	
Image enhancement and filtering	
Advanced classification techniques	
Accuracy assessment, ground truthing with spectroradiometer	
Algorithm Liberation, Raster calculation, Modeling.	

(20)

Practical Notebook and Viva Voce (5)

RSG 208 (Practical)
ADVANCED REMOTE SENSING: DATA PROCESSING & APPLICATIONS (25 marks)

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

- Develop proficiency in atmospheric and radiometric correction, image enhancement, and filtering techniques for multispectral optical data, along with hyperspectral data processing, including bad band removal and the application of FLAASH models.
- Explain the collection and identification of endmembers, and perform advanced hyperspectral data analysis techniques such as Minimum Noise Fraction (MNF) transformation and Pixel Purity Index (PPI).
- Conduct various image classification methods—unsupervised, supervised, and advanced techniques—and evaluate classification accuracy using metrics like the contingency matrix and class separability measures.
- Understand and generate Stereo-SAR Digital Elevation Models (DEMs) and interpret

radar imagery through speckle suppression, interferogram generation, and texture analysis.

RSG 208 (Practical)

ADVANCED REMOTE SENSING: DATA PROCESSING & APPLICATIONS (25 marks)

Full Marks: 25.At least even number of periods to be assigned (preferably in batches).Examination Time: 2 hours. Pattern of setting questions: 20 marks compulsory questions are to be set. 5 marks are to be allocated for Evaluation of Practical Notebook and Viva-voce. Right hand side parentheses indicate lecture / demonstration hours.

Topic to be covered	
Atmospheric and Radiometric Correction, Image enhancement and filtering of multispectral optical data	**Available Software's**
Hyperspectral data processing, Bad band and bad line removal, FLAASH model, Endmember collection, MNF, PPI	
Image classification (Unsupervised, Supervised and advanced)	
Accuracy assessment, Class separability & contingency Matrix	
Stereo-SAR DEM generation, Rader image interpretation: Speckle suppression, Interferogram generation, Texture analysis, Texture& Object based classification.	

(20)

Practical Notebook and Viva-Voce (5)

RSG 209 (Practical)

ADVANCED GEOGRAPHIC INFORMATION SYSTEM

Course Outcome:

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

- Perform vector data management operations including export, editing, and handling attribute tables for geospatial datasets.
- Create thematic maps, charts, and diagrams by applying query operations in vector layers using SQL.
- Apply vector-based spatial analysis techniques such as network analysis, neighbourhood functions, buffering, and proximity analysis (Thiessen polygons).
- Use GIS software tools to carry out vector data processing and geospatial modeling tasks effectively.
- Conduct topographic and morphometric analysis by generating contours, isopleths, and deriving terrain-related information.

RSG 209 (Practical)

ADVANCED GEOGRAPHIC INFORMATION SYSTEM (25 marks)

Full Marks: 25.At least even number of periods to be assigned (preferably in batches).Examination Time: 2 hours. Pattern of setting questions: 20marks compulsory questions are to be set. 5 marks are to be allocated for Evaluation of Practical Notebook and Viva-voce. Right hand side parentheses indicate lecture / demonstration hours.

Topic to be covered	
Vector data Export, Vector Editing, Managing Attribute Table, Thematic Maps	
Charts and Diagrams generation Select and Query in vector layers, Use of SQL,	
Network, Neighbourhood, Buffer, Proximity [Thiessen polygon]	**Available Software's**
Topographic & Morphometric analysis: Contours & Isopleths generation.	

(20)

Practical Notebook and Viva Voce (5)

RSG 210 (Practical)

MODELING SPATIAL DATABASE AND ANALYSIS

Course Outcome:

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

- Perform image-to-image geo-referencing and create different types of geodatabases with proper topology building.
- Inspect and correct spatial database errors and apply data manipulation techniques to maintain data accuracy and consistency.
- Develop GIS-based terrain models such as Digital Elevation Model (DEM), Digital Terrain Model (DTM), and Triangulated Irregular Network (TIN) for topographic analysis.
- Apply vegetation, built-up, water, and terrain indices such as NDVI, NDBI, SAVI, NDWI, and TWI for environmental monitoring and resource assessment.
- Integrate geospatial data into GIS-based models to support environmental analysis, decision-making, and sustainable resource management.

RSG 210 (Practical)

MODELING SPATIAL DATABASE AND ANALYSIS (25 marks)

Full Marks: 25. At least even number of periods to be assigned (preferably in batches). Examination Time: 2 hours. Pattern of setting questions: 20marks compulsory questions are to be set. 5 marks are to be allocated for Evaluation of Practical Notebook and Viva-voce. Right hand side parentheses indicate lecture / demonstration hours.

Topic to be covered	**Available Software's**
Creation of Different types of Geo-Data base, Topology building, Errors Inspections, Corrections of errors in spatial database, Data manipulation techniques.	
Fishnet Creation, Raster values Extraction.	
Model Building, GIS based models: DEM, DTM, TIN etc. Different environmental modelling: NDVI, NDBI, SAVI, NDWI, TWI etc.	
Network Model & Network Analysis	

(20)

Practical Notebook and Viva-Voce (5)

SEM III PAPERS

SEM -III THEORY

RSG 301:
Application of Geo-Informatics:
Course Outcome:
After completion of this course, students will be able to:

- Students will acquire skills to access, integrate, and analyze diverse geospatial data, enabling the creation of meaningful information layers for solving spatial problems and supporting decision-making.
- They will learn to interpret and apply geospatial techniques to map, analyze, and model natural hazards and disasters such as earthquakes, landslides, floods, droughts, forest fires, and cyclones for risk assessment and management
- Students will utilize remote sensing and GIS methods for agricultural, soil, water resource, and forest management, including habitat analysis, soil quality monitoring, and biomass estimation.
- They will understand application of geospatial techniques for analyzing surface and sub-surface water data, and implement hydrological modeling techniques for effective water resource management
- They will explore GIS and remote sensing tools to identify forest types, estimate canopy cover, tree height, biomass along with urban spatial analysis, focusing on urban growth, green spaces.

RSG 301:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Application of Geo-Informatics:

i. *Natural hazards and disasters:* Application of geospatial techniques in mapping and modeling Earthquake, Landslide, Flood, Drought, Forest fires, Cyclone
ii. *Agriculture and soils:* Crop inventory mapping, crop type identification, environmental factors for aquaculture development, mapping and monitoring soil quality
iii. *Water resources:* Surface and sub-surface water resource evaluation, different hydrological modeling for water resource management
iv. *Forestry:* Identification of forest type, canopy cover and height estimation, biomass estimation
v. *Urban studies:* Mapping built-up area and expansion, urban planning, urban green space dynamics, urban climate

Internal Assessment (5)

RSG 302:
Spatial Data Science and SDSS:
Course Outcome:
After completion of this course, students will be able to:

- The students will understand the fundamental concepts of Spatial Data Science,

including its application areas, key machine learning (ML) and deep learning (DL) techniques, and their role in predictive analysis, along with challenges faced in ML and DL applications.

- They will explore advanced trends in spatial data analytics, such as Geospatial Artificial Intelligence and the utilization of Big Data within GIS, recognizing their potential to enhance spatial analysis and decision-making.
- The students will be able to comprehend the principles and characteristics of Spatial Decision Support Systems (SDSS), including types of decision problems, decision-making phases, and integration of GIS within SDSS frameworks.
- They will learn multicriteria decision analysis (MCDA), including the use of criterion standardization, weighting via pairwise comparison, and decision rules such as the Simple Additive Weighting method.
- The students will be able to apply spatial decision-making tools and techniques to real-world problems, facilitating informed and effective spatially-enabled decisions.

RSG 302:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Spatial Data Science and SDSS:

i. *Introduction to Spatial Data Science:* Basic concept and application areas, Key Elements and types of Machine Learning (ML) techniques, predictive analysis through ML, Deep Learning (DL) methods and application areas, Challenges in ML and DL

ii. *Advanced Trends in Spatial Data Science:* Geospatial Artificial Intelligence, concept of Big Data, Potentialities of Big Data in GIS

iii. *GIS and Spatial Decision Support Systems:* Concept and characteristics of Spatial Decision Support Systems (SDSS), Types of Decision Problems, Phases of Decision-Making Process, Spatial Decision Support Systems (SDSS) and GIS, Elements and Structure of Multicriteria Decision Analysis (MCDA)

iv. *Analytic Hierarchy Process:* Standardization of Criterion Maps, Criterion Weighting through Pairwise Comparison method, Decision Rules-Simple Additive Weighting method

Internal Assessment (5)

RSG 303:

Fundamental of Research and Geospatial Project Management

Course Outcome:

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

- Identify and define research problems effectively and recognize the importance of literature review in formulating research objectives.
- Apply statistical inference techniques including hypothesis testing, model calibration, and validation in research studies.
- Design appropriate sampling strategies for spatial and temporal data collection by understanding steps, methods, and applications of sampling design.
- Implement project management principles by understanding its elements, techniques, and the role of project managers in geospatial and research projects.
- Adopt ethical practices in research by avoiding plagiarism, following research ethics guidelines, and addressing ethical challenges in the use of Artificial Intelligence (AI).

RSG 303:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Fundamental of Research and Geospatial Project Management

i. *Research Problem:* Identification and Techniques of defining a research problem, significance of literature review
ii. *Statistical Inference for Research:* Concepts and Procedure concerning testing of Hypothesis, Model Calibration and Validation
iii. *Sampling Design:* Steps in Sampling Design, Types of Sampling and their applications in research, Collection of Spatial and Temporal data.
iv. *Project Management* : Definition and elements of Project management, Techniques of Project Management, Roles and attributes for project manager
v. *Research Ethics*: Fundamental ethical practices in research, Types of Plagiarism, Research ethics and artificial intelligence (AI)

Internal Assessment (5)

RSG 304: (MOOC/SWAYAM)
Course Outcome:

RSG 304: (MOOC/SWAYAM)

Full Marks: 40

Internal Assessment (10)

RSG 305 & 306: (*EXAMINATION TIME: 2 HOURS)*

ELECTIVE SPECIAL PAPER THEORY: (The students have to select any one of the following subjects (A-J), as proposed by the department, likely to be offered as elective special papers)

Course Outcome: Students will be able to analyze various tasks to solve the problems in a specified domain.

RSG 305A: Geo-informatics in Coastal Management

RSG 306A: Potential Application areas of RS /GIS in Coastal Management

RSG 305B: Geo-informatics in Watershed Management

RSG 306B: Remote Sensing in Water resource Evaluation

RSG 305C: Fundamentals of Earth System Science

RSG 306C: Application of Geo-informatics in Earth System Science

RSG 305D: Fundamental Concepts of Hazards and Disasters

RSG 306D: Application of Geo-informatics in Hazards and Disasters Management

RSG 305E: Fundamental Concepts of Soil and Agricultural Science

RSG306E: Application of Geo-informatics in Soil and Agriculture

RSG 305F: Geo-Informatics in Urban, Rural Development & Regional Planning a Theoretical Considerations

RSG306F: Potential Application Areas of RS/GIS in Urban, Rural Development & Regional Planning

RSG305G: Theoretical Considerations in Environmental Science and Management

RSG306G: Application of Remote sensing and GIS in Environmental Science and Management

RSG305H: Geo-Informatics in Resource Management

RSG306H: Application of Remote Sensing and GIS in Resource Management

RSG305I: Geo-Informatics in Transport Network Analysis

RSG306I: Application of Remote Sensing and GIS in Transportation

RSG305J: Geoinformatics in Utility Management

RSG306J: Application of Remote Sensing and GIS in Utility Management

RSG 305A

Geo-informatics in Coastal Management

Course Outcome:

After completing this course, students will be able to:

- **Explain** the principles of coastal morphodynamics, including micro, macro, and biogenic forms, and classify coasts based on processes and sediment characteristics.
- **Analyze** coastal biogeography with reference to seaweeds, mangroves, dune vegetation, and corals, and **evaluate** the sources, impacts, and management of coastal pollution through integrated coastal management approaches.
- **Assess** natural coastal hazards such as sea level rise, erosion, sedimentation, and tropical cyclones, and **critically examine** the impacts of coastal engineering structures with strategies for sustainable management.
- **Apply** modern techniques (field, remote sensing, GIS, and modeling) to monitor changes in coastal processes and landforms.
- **Evaluate and design** sustainable management strategies for human utilization of coasts (navigation, mining, fishing, oil exploitation, reclamation, and tourism) while minimizing environmental impacts.

RSG 305A

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Theoretical Considerations of Geo-Informatics in Coastal Management

i. Coastal morpho dynamics: Micro, macro and biogenic forms. Systems of change in coasts: cyclical and progressive. Classification of coasts based on processes and sediment characteristics.

ii. Coastal biogeography with special reference to sea weeds, mangroves, dune vegetation and corals, Coastal pollution: Sources, impacts and management, Integrated Coastal Management: Concepts, techniques and applications.

iii. Natural coastal hazards and their management: Sea level rise, erosion, sedimentation and tropical cyclones, Coastal engineering and its impacts: Ports and harbours, measures for prevention of erosion and sedimentation.

iv. Techniques of monitoring changes in coastal processes and landforms.

v. Human utilisation of coasts, environmental impacts and management: Navigation, mining, fishing and fish-processing, off-shore oil exploitation, reclamation and tourism.

Internal Assessment (5)

RSG 306A

Potential Application areas of RS /GIS in Coastal Management

Course Outcome:

After completing this course, students will be able to:

- **Identify and evaluate** major environmental issues along the Indian coast and propose suitable management practices.
- **Apply** remote sensing techniques and tools for effective **Coastal Zone Management (CZM)**.

- **Monitor and analyze** surface waters in Coastal Regulatory Zones (CRZ) for regulatory and conservation purposes.
- **Assess** suspended minerals and chlorophyll concentration in coastal waters to understand ecological productivity and water quality.
- **Measure and interpret** Sea Surface Temperature (SST) using modern techniques to study climatic and oceanographic processes.

RSG 306A

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Potential Application areas of RS /GIS in Coastal Management

i. Indian coast: Major environmental issues, problems and their management
ii. Application of Remote Sensing with special reference to Coastal Zone Management
iii. Monitoring Surface waters in Coastal Regulatory Zone (CRZ)
iv. Study of Suspended mineral in water
v. Study of Chlorophyll in water
vi. Measurement of Sea Surface Temperature (SST)

Internal Assessment (5)

RSG 305B
Geo-Informatics in Watershed Management:

Course Outcome:

After completing this course, students will be able to:

- **Differentiate and analyze** the interactions between surface water and groundwater through hydrogeological interpretation and water deciphering techniques.
- **Conduct** quality inventory and monitoring, and **apply** parametric watershed modeling for assessing water quantity and hydrologic parameters.
- **Explain and perform** morphometric analysis to characterize watershed features and hydrological processes.
- **Apply** hydro-morphogeologic techniques to identify groundwater potential zones and locate aquifers in alluvial, sedimentary, and hard rock terrains.
- **Design and evaluate** watershed management strategies, incorporating soil and water conservation techniques for sustainable resource utilization.

RSG 305B

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Geo-Informatics in Watershed Management:

i. Surface water-ground water, water deciphering
ii. Quality inventory and monitoring, quantity assessment – Parametric watershed modeling – dimensional consideration of basic dynamics – evaluation of hydrologic parameters
iii. Concept of watershed, Morphometric Analysis
iv. Hydro-morphogeologic interpretation techniques for targeting ground water potential zones in alluvial, sedimentary and hard rock areas, location of aquifer
v. Watershed management, techniques of soil and water conservation.

Internal Assessment (5)

RSG 306B

Remote Sensing in Water resource Evaluation:

Course Outcome:

After completing this course, students will be able to:

- **Assess** drought and flood conditions through floodplain mapping, soil moisture analysis, water quality monitoring, and snow/cloud mapping using geospatial techniques.
- **Estimate** aquatic biodiversity, runoff, and soil loss to evaluate ecosystem health and watershed sustainability.
- **Select and justify** suitable sites for storage and diversion projects, including dam sites, tunnels, and canal alignments based on geomorphic and hydrologic criteria.
- **Analyze** real-world case studies to integrate theory with practical applications in water resource planning and management.

RSG 306B

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Remote Sensing in Water resource Evaluation:

i. Drought & flood Assessment, flood plain mapping, soil moisture, water quality, snow & cloud mapping.
ii. Estimation of Aquatic biodiversity, Runoff and soil loss estimation.
iii. Site location for storage and diversion projects, dam site selection, tunnel and canal alignment
iv. Case Studies.

Internal Assessment (5)

RSG 305C

Fundamentals of Earth System Science:

Course Outcome:

After completing this course, students will be able to:

- **Explain** the Earth System components (lithosphere, hydrosphere, atmosphere, biosphere) and **analyze** their interactions with tectonic processes, earthquakes, and volcanic activity.
- **Identify and classify** igneous, sedimentary, and metamorphic rocks along with their field and image-based characteristics.
- **Interpret** major rock structures (folds, faults, joints, lineaments) using field data and satellite imagery.
- **Apply** geomorphological concepts to analyze landform development, drainage patterns, and the role of geomorphic agents and processes.
- **Evaluate** satellite image characteristics of different landforms for geological and geomorphological mapping.

RSG 305C

Full Marks: 25. Number of lectures to be delivered for each module is 35.

Fundamentals of Earth System Science:

i. *The Earth System:* Concept of Earth System, lithosphere, biosphere, hydrosphere & atmosphere, plate tectonic theory and its relationship to earthquakes, and volcanic activity.
ii. *Rock Types:* igneous, sedimentary and metamorphic rocks, their characteristics, types and forms, delineation on satellite images.
iii. *Rock Structures:* Folds, faults, joints and lineaments, field characteristics, delineation on satellite images and analysis.
iv. *Geomorphology:* Fundamental concepts, geomorphic agents and processes, drainage patterns,

classification of landforms. Image characteristics of major landforms.

Internal Assessment (5)

RSG 306C

Application of Geo-informatics in Earth System Science:

Course Outcome:

After completing this course, students will be able to:

- **Interpret** visual and digital satellite imagery using elements of image interpretation and digital enhancement techniques for lithological and structural mapping.
- **Apply** digital terrain models in geo-technical engineering for the selection of dam sites, road alignments, and canal construction with environmental considerations.
- **Utilize** multivariate data modeling techniques in geosciences for disaster management, including landslide hazard zonation.
- **Integrate** Rock Information Systems and GIS-based multivariate analysis for mineral targeting and resource exploration.

RSG 306C

Full Marks: 25. Number of lectures to be delivered for each module is 35.

Application of Geo-informatics in Earth System Science:

i. *Visual/ Digital Satellite Image Interpretation:* Elements of image interpretation, Digital image enhancement techniques for lithological discrimination. Application of Remote Sensing in Geological Mapping (both Lithological and Structural)
ii. Geo-technical Engineering & Environmental Management, Digital terrain models for selection of dam site, road, and canal construction.
iii. *Multivariate data modelling:* Concept and application in geosciences: Disaster Management, Landslide hazard zonation
iv. *Mineral targeting:* Rock Information System, GIS based multivariate analysis in mineral targeting.

Internal Assessment (5)

RSG 305D:

Fundamental Concepts of Hazards and Disasters:

Course Outcome:

After completing this course, students will be able to:

- **Differentiate** types of hazards and disasters (natural and human-induced), and **analyze** their spatial distribution and zonation.
- **Evaluate** the historical perspective and socio-economic impacts of disasters in India with reference to national losses.
- **Explain and assess** the principles of disaster management and the roles of government, NGOs, and community participation within India's organizational framework.
- **Apply** geoinformatics tools and techniques for disaster monitoring, mitigation, and management.

RSG 305D:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Fundamental Concepts of Hazards and Disasters:

i. *Introduction:* Types of hazards and disasters, characterization, zonation of hazards, natural and human induced disasters.
ii. Disaster and National losses, historical perspective of disasters in India.

iii. *Disaster Management:* Fundamental concept of Disaster Management, government, NGOs and peoples participation disaster management. Existing organization structure for managing disasters in India.
iv. Geoinformatics in disaster mitigation.

Internal Assessment (5)

RSG 306D:

Application of Geo-informatics in Hazards and Disasters Management:

Course Outcome:

After completing this course, students will be able to:

- **Explain and analyze** different geological hazards such as landslides, earthquakes, mining hazards, volcanic, groundwater, and glacial hazards.
- **Evaluate** the causes and impacts of hydro-meteorological hazards including floods, dam bursts, cloud bursts, cyclones, coastal hazards, and droughts.
- **Assess** environmental hazards such as deforestation, forest fires, soil degradation, desertification, and pollution (air, water, and soil).
- **Apply** geospatial techniques for hazard monitoring, zonation mapping, and early warning systems to support disaster preparedness and mitigation.

RSG 306D:

Full Marks: 25. Number of lectures to be delivered for each module is 35.

Application of Geo-informatics in Hazards and Disasters Management:

i. *Geological Hazards:* Landslide, Earthquake, Mining hazards (subsidence, flooding etc.), Volcanic hazards, Groundwater hazards, Glacial hazards
ii. *Hydro meteorological Hazards:* Flash floods, River floods, Dam burst, Cloud burst, Cyclones, Coastal hazards and Drought
iii. *Environmental hazards:* Forest hazards (Deforestation, Degradation and Forest fire), Land, soil degradation, desertification and Pollution (Water, air and soil)
iv. *Geospatial Applications:* Monitoring and hazard zonation mapping, early warning of natural hazard

Internal Assessment (5)

RSG 305E:

Fundamental Concepts of Soil and Agricultural Science:

Course Outcome:

After completing this course, students will be able to:

- **Explain** crop yield parameters and spectral properties of crops, and **apply** remote sensing for crop identification and acreage estimation.
- **Utilize** vegetation indices and digital analysis techniques for production forecasting, monitoring crop conditions, and assessing agricultural case studies.
- **Describe and implement** soil survey methods, soil classification, and land evaluation approaches.
- **Apply** remote sensing techniques for mapping saline and alkaline soils and for sustainable agricultural land management.

RSG 305E:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Fundamental Concepts of Soil and Agricultural Science:

i. Crops, Introduction – Yield parameters- spectral properties of crops- identification of crops

and acreage estimation

ii. Vegetation indices production forecasting through digital analysis monitoring and condition assessment – case studies.

iii. Soils, Introduction –Soil Survey methods- soil Classification – land Evaluation- Saline, alkaline soils- mapping using RS data

Internal Assessment (5)

RSG 306E:

Application of Geo-informatics in Soil and Agriculture:

Course Outcome:

After completing this course, students will be able to:

- **Identify and analyze** soil problems such as erosion, sedimentation, and degradation, and **evaluate** soil conservation measures using case studies.
- **Detect and assess** crop damage caused by pests, diseases, droughts, floods, waterlogging, and salinity through geospatial and field techniques.
- **Apply** integrated survey methods with a watershed approach for sustainable agriculture, forestry, and resource management.
- **Utilize** GIS tools for preparing action plans in watershed management and agro-climatic modeling.
- **Evaluate** recent developments and case studies in integrated land and water resource planning for sustainable development.

RSG 306E:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Application of Geo-informatics in Soil and Agriculture:

i. Problems soil identification and mapping – Soil sedimentation and erosion- Soil conservation case studies.

ii. Damage assessment, Detection of pest and diseases- damages due to droughts and floods – water-logging and salinity- stress detection.

iii. Integrated surveys, Integrated surveys for sustainable development – watershed approach – Agriculture and forest development,

iv. GIS for drawing out action plans- case studies and recent development in Agro- climatic modelling –watershed planning.

Internal Assessment (5)

RSG 305F:

Geo-Informatics in Urban, Rural Development & Regional Planning a Theoretical Considerations:

Course Outcome:

After completing this course, students will be able to:

- **Define and explain** key concepts of urbanization, urbanism, and the growth of urban settlements, with an emphasis on their processes and bases.
- **Analyze** the historical trajectory of urbanization in India and **evaluate** metropolitan development patterns with special reference to West Bengal.
- **Assess** major urban environmental problems and propose strategies for sustainable urban management.
- **Explain and compare** theoretical frameworks of rural development and rural economies under different production systems in developed and developing contexts.
- **Apply and evaluate** growth pole theories and examine regional environmental issues within the broader framework of development geography.

RSG 305F:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Geo-Informatics in Urban, Rural Development & Regional Planning a Theoretical Considerations:

i. Concepts and definitions: urban, urbanization and urbanism,
ii. Origin & growth of urban settlements; bases & process of urbanisation
iii. Urbanization in India: a historical perspective
iv. Features of metropolitan development (with special reference to India), Urban Environmental Problems in West Bengal
v. Theoretical framework of rural development and geographical perspective: Rural economy under different production systems – experiences of developed and developing world with examples.
vi. Growth Pole theories and the developing world, Regional Environmental Issues.

Internal Assessment (5)

RSG 306F

Potential Application Areas of RS/GIS in Urban, Rural Development & Regional Planning:
Course Outcome:
After completing this course, students will be able to:

- **Analyze** the causes, distribution, and spatial patterns of rural settlements, including nodal service centres, market centres, and the rural–urban continuum.
- **Apply** remote sensing techniques for studying urban landscapes and their spatial dynamics.
- **Evaluate** demographic and infrastructural aspects such as population estimates, housing quality, site suitability, traffic, and parking through geospatial approaches.
- **Conduct** change detection studies to monitor urban and rural transformations using remote sensing.
- **Utilize** remote sensing applications in biological systems to assess environmental and ecological conditions.

RSG 306F

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Potential Application Areas of RS/GIS in Urban, Rural Development & Regional Planning:

i. Analysis of rural settlement: Cause and effect associations, distribution of rural settlement with special reference to size and spacing; Rural service centres – Nodal settlement of market centres and growth centres – Studies on rural urban continuum.
ii. Brief introduction of Remote Sensing applications on Urban landscape
iii. Population estimates, housing quality studies, site selection processes, traffic and parking studies,
iv. Urban & rural change detection studies, Remote sensing applications in Biological systems.

Internal Assessment (5)

RSG 305G:

Theoretical Considerations in Environmental Science and Management:
Course Outcome:
After completing this course, students will be able to:

- **Explain and analyze** the relationship between water and the environment, and **apply** remote sensing for monitoring water quality, pollution sources, runoff, snow cover, and flood prediction.
- **Assess** soil-related problems such as erosion, salinity, degradation, and flood damage

using Remote Sensing and GIS.

- **Identify and evaluate** the impacts of insects and diseases on soils and crops through geospatial analysis.
- **Examine** urban and rural environmental issues including industrial pollution, chemical effluents, land reclamation, solid waste disposal, and mining pollution.
- **Apply** geospatial tools for environmental monitoring, impact assessment, and sustainable resource management.

RSG 305G:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Theoretical Considerations in Environmental Science and Management:

i. Water and the environment, R.S. of fluorescence- water quality- water pollution- pollution sources- water runoff, Remote Sensing and Water quality management –snow surface cover- flood prediction

ii. Soils and land forms- insects and disease- soil erosion- salinity- flood damage- soil limitation –soil degradation using Remote Sensing and GIS.

iii. Urban environment, General consideration rural structure- urban areas- Impact of industrial pollution- chemical effluents, land reclamation- disposal of solid waste- mining pollution

Internal Assessment (5)

RSG 306G:

Course Outcome:

Application of Remote sensing and GIS in Environmental Science and Management:
After completing this course, students will be able to:

- **Explain and apply** ecological concepts in relation to spectral reflectance of vegetation for stress monitoring, forest conservation, wildlife studies, and non-point source pollution assessment using GIS.
- **Utilize** various environmental monitoring sensors (optical, radar, thermal) for studying the marine environment, including oil slick mapping, chlorophyll detection, fisheries resource assessment, and coastal processes.
- **Apply** remote sensing techniques for air pollution monitoring, weather forecasting, and climatological studies with emphasis on emissivity characteristics and case-based applications.
- **Measure and analyze** atmospheric parameters such as temperature, composition, wind flows, and circulation patterns using meteorological satellite data.
- **Evaluate** the applications of geospatial techniques in environmental conservation, marine studies, and global climate monitoring for sustainable resource management.

RSG 306G:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Application of Remote sensing and GIS in Environmental Science and Management:

i. Ecology and ecosystem, Conservation and resource management – spectral reflectance from vegetated surface- Stress monitoring- forest conservation- wild life studies- GIS for monitoring non print source pollution.

ii. Marine environment, Sensors for environmental monitoring sensors – visible and outside visible wave length – absorption spectrometers – selection of ground truth sites- sea truth observations –Radar techniques for sensing ocean surfaces- thermal measurements – application of sensing, mapping oil slicks – Chlorophyll detection- Fisheries resources- Coastal marine studies- determination of temperature and sea state.

iii. Air pollution and global climatology, R.S. technique for Air quality monitoring- case studies- weather forecasting and climatology- emissivity characteristics.

iv. Measurement of atmospheric temperature- composition- constituent distribution and concentration- composition- constituent distribution and concentration- wind flows and air Circulation- Hurricane tracking – meteorological satellite systems.

Internal Assessment (5)

RSG 305H:

Geo-Informatics in Resource Management:

Course Outcome:

After completing this course, students will be able to:

- **Differentiate** natural and cultural resources, and **classify** them into renewable and non-renewable categories.
- **Apply** remote sensing–based land use/land cover mapping techniques for resource monitoring and sustainable management.
- **Analyze** strategies for conservation of natural resources within the framework of sustainable development.
- **Interpret** soil and mineral resource characteristics using geospatial approaches.
- **Assess** the impacts of soil degradation and surface mining on land resources through remote sensing applications.

RSG 305H:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Geo-Informatics in Resource Management:

i. Resources classification systems, natural and cultural resources, renewable and non-renewable resources.

ii. Resource Conservation: Remote sensing based Land use- Land cover mapping for resource monitoring and management Sustainable development of natural resources.

iii. Land Resources: Introduction to soil, mineral resources, remote sensing in mapping soil degradation, impact of surface mining on land resources.

Internal Assessment (5)

RSG 306H:

Application of Remote Sensing and GIS in Resource Management:

Course Outcome:

After completing this course, students will be able to:

- **Apply** remote sensing techniques for assessment of agricultural, forest, and wildlife resources, and **analyze** issues in forest density, type mapping, and management.
- **Evaluate** surface and sub-surface water resources, water mining, and pollution problems using geospatial tools for sustainable water resource management.
- **Explain and assess** conventional (coal, oil, nuclear) and non-conventional energy resources, and **utilize** GIS for energy resource management and planning.
- **Implement** geoinformatics-based models such as forest fire modeling, wildlife habitat assessment, soil erosion, and land resource prioritization.
- **Integrate** remote sensing and GIS approaches for comprehensive natural resource monitoring, conservation, and sustainable management.

RSG 306H:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Application of Remote Sensing and GIS in Resource Management:

i. Bio-Resources: Remote sensing application in agriculture, forest resources and wildlife habitat assessment. Mapping of forest density and type, issues in forest management.
ii. Water Resources: Remote sensing application in surface and sub-surface water resources evaluation, water mining and pollution, issues in water resources management.
iii. Energy Resources: Coal, oil and nuclear energy, non-conventional energy resources, future potential and requirement of energy resources. GIS in energy resources management.
iv. Geoinformatics Models in Resource Management: Forest Fire Modeling, Wild Life Habitat Assessment Modeling, Soil Erosion Modeling, Land Resources Development Prioritization Modeling.

Internal Assessment (5)

RSG 305I

Geo-Informatics in Transport Network Analysis:

Course Outcome:

After completing this course, students will be able to:

- **Explain** the fundamentals of transportation planning, including behavioral aspects and public transportation operations and technology.
- **Analyze** different mass transportation systems through traffic studies, capacity evaluation, and transportation economics and finance.
- **Evaluate** issues of traffic safety and control in urban and regional transportation planning.
- **Apply** concepts of network analysis and network models to solve problems in utilities, transportation, and multi-modal freight systems.
- **Utilize** GIS-based network models for transportation planning, decision-making, and optimization.

RSG 305I

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Geo-Informatics in Transport Network Analysis:

i. Introduction to Transportation Planning, Behavioral Issues in Transportation Studies, Public Transportation Operations and Technology
ii. Transportation Systems: Mass Transportation Systems, Traffic Studies and Capacity, Transportation Economics and Finance, Traffic Safety and Control
iii. Network Analysis and Transportation: Concept of networks and Network models, Network analysis, Important applications, utilities and transportation, using network model in GIS, Multi-modal Freight Transportation Systems Analysis

Internal Assessment (5)

RSG 306I:

Application of Remote Sensing and GIS in Transportation:

Course Outcome:

After completing this course, students will be able to:

- **Apply and evaluate** transportation models, simulation techniques, and discrete choice modeling for travel demand forecasting.
- **Analyze** urban transportation networks and **design** transportation facilities using intelligent transportation system (ITS) approaches.
- **Demonstrate** principles of geometric design for efficient and safe transportation systems.

- **Plan and assess** large-scale transportation projects including airports, ports, and urban transport systems.
- **Examine and critique** real-world applications and case studies in transportation modeling and planning.

RSG 306I:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Application of Remote Sensing and GIS in Transportation:

i. Transportation Modelling: Transportation Models, Simulation Analysis , Discrete Choice Modeling for Travel Demand Forecasting
ii. Intelligent Transportation Systems: Urban Transportation Networks , Geometric Design of Transportation Facilities, Transportation Design
iii. Planning and Execution: Airport Design and Planning , Port Design and Planning , Urban Transport planning
iv. Applications and case studies

Internal Assessment (5)

RSG 305J:

Geoinformatics in Utility Management:

Course Outcome:

After completing this course, students will be able to:

- **Describe** essential services and utilities, and **develop** spatial databases through geospatial data acquisition and integration.
- **Apply** techniques of spatial data manipulation, query processing, and visualization for geospatial analysis.
- **Design and manage** geospatial systems and projects, ensuring efficient data handling and application development.
- **Utilize** GIS for solving real-world problems related to public utilities such as electricity, gas, water supply, and sewerage.
- **Evaluate** the role of geospatial technologies in planning, managing, and optimizing urban and regional utility services.

RSG 305J:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Geoinformatics in Utility Management:

i. Utility, Description of all essential services and utilities, Database development and Data Acquisition, Acquiring and integrating geospatial data, Spatial Data Bases
ii. Spatial Data Manipulation and Analysis, Geospatial system analysis and design, Geospatial technology project , management ,Query Processor and Visualization
iii. Applications and Problem solving with GIS Electricity, Gas, Water supply, Sewerage system

Internal Assessment (5)

RSG 306J:

Application of Remote Sensing and GIS in Utility Management:

Course Outcome:

After completing this course, students will be able to:

- **Analyze** urban and regional issues related to solid waste disposal, telecommunication, public health, safety, and crime using geospatial tools.
- **Apply** modeling techniques in utility applications to support infrastructure planning

and management.

- **Evaluate** infrastructure aims and objectives in the context of sustainable development.
- **Interpret and assess** environmental laws and regulations governing infrastructure utilities.
- **Examine** real-world case studies to understand modern infrastructure tools and their applications.

RSG 306J:

Full Marks: 25. Number of lectures to be delivered for each module is 20.

Application of Remote Sensing and GIS in Utility Management:

i. Solid waste disposal, Telecommunication, Public health and safety, Crime analysis
ii. Modelling in utility applications**,** Infrastructure aims and objectives, Environmental law and regulations governing infrastructure utilities, Modern infrastructure tools
iii. Case study

Internal Assessment (5)

SEM -III PRACTICAL

RSG 307 (Practical)

APPLICATION OF GEO-INFORMATICS AND SPATIAL DECISION SUPPORT SYSTEM

Course Outcome:

- Students will analyze terrain morphometry and perform hydro-geomorphological interpretations from satellite imagery for groundwater exploration and management.
- They will estimate runoff and soil erosion using empirical models, supporting sustainable land and water resource planning.
- Learners will utilize Digital Terrain Models (DTMs) for site selection in dam, road, and canal construction, and conduct Cut & Fill analysis using DEM data.
- The course covers generating criterion maps and applying linear transformation methods to standardize and prepare data for spatial decision-making.
- Students will learn to assign weights through ranking, rating, pairwise comparison, and trade-off analysis, culminating in site suitability assessments using the Simple Additive Weighting method within Spatial Decision Support Systems.

RSG 307 (Practical)

APPLICATION OF GEO-INFORMATICS AND SPATIAL DECISION SUPPORT SYSTEM (25 marks)

Full Marks: 25. At least even number of periods to be assigned (preferably in batches).Examination Time: 2 hours. Pattern of setting questions: 20marks compulsory questions are to be set. 5 marks are to be allocated for Evaluation of Practical Notebook and Viva-voce. Right hand side parentheses indicate lecture / demonstration hours.

i. Morphometric analysis of terrain, satellite image-based hydro-geomorphological interpretation for ground water targeting.
ii. Runoff & Soil Loss estimation based on empirical models.
iii. Digital terrain models for selection of dam site, road, and canal construction, Cut & Fill analysis using DEM
iv. Generating Criterion Maps, Linear Transformation Methods for Standardization of Criterion Maps
v. Estimation of Weights: Ranking, Rating, Pairwise Comparison and Trade-off analysis method; Decision Rules-Simple Additive Weighting method
vi. Application of Spatial Decision Support System in Site Suitability Analysis

(20)

Practical Notebook Viva-voce (5)

RSG 308 (Practical)

GENERATION OF CASE STUDIES & COMMUNITY ENGAGEMENT (COMPULSORY FIELD STUDY)

Course Outcome:

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

- **Generate pre-field thematic maps** using multi-seasonal remote sensing imagery for planning field investigations.
- **Conduct ground truthing and systematic field data collection** to validate remotely sensed outputs.
- **Integrate post-field data with pre-field analyses** to enhance the reliability of geospatial

interpretations.

- **Prepare professional field reports** by synthesizing data, maps, and analysis results in a structured format.
- **Demonstrate communication and analytical skills** through viva-voce presentations based on fieldwork outcomes.

RSG 308 (Practical)

GENERATION OF CASE STUDIES & COMMUNITY ENGAGEMENT (COMPULSARY FIELD STUDY) (25 marks)

Full Marks: 25. At least even number of periods to be assigned (preferably in batches).Examination Time: 2 hours. Pattern of setting questions: 20marks compulsory questions are to be set. 5 marks are to be allocated for Evaluation of Practical Notebook and Viva-voce. Right hand side parentheses indicate lecture / demonstration hours.

i. Generation of pre-field theme maps using multi-seasonal image of an area – ground truthing and field data collection -- Validation of the output based on post field data
ii. Output generation – finalization of Field Report and Viva-Voce

(25)

RSG 309 (Practical)

GEOSTATISTICS (25 marks)

Course Outcome:

- Students will gain proficiency in statistical software, performing time series analysis, creating charts and scatter plots with regression lines, and applying bi-variate and multiple correlation techniques.
- They will understand and conduct significance testing, calculate mean centers of populations, and interpret Z-scores for spatial data analysis.
- Learners will learn to perform Principal Component Analysis (PCA) for data reduction and feature extraction in multivariate spatial datasets.
- The course covers geostatistical interpolation methods such as Inverse Distance Weighting (IDW) and Kriging, implemented through GIS software for spatial prediction.
- Students will extract image statistics and perform regression analysis using R programming, integrating statistical insights into remote sensing and GIS workflows.

RSG 309 (Practical)

GEOSTATISTICS (25 marks)

Full Marks: 25. At least even number of periods to be assigned (preferably in batches).Examination Time: 2 hours. Pattern of setting questions: 20marks compulsory questions are to be set. 5 marks are to be allocated for Evaluation of Practical Notebook and Viva-voce. Right hand side parentheses indicate lecture / demonstration hours.

iii. Introduction of Statistical Software: Time series, Charts, Scatter plot with regression line, Variance, Bi-variate and Multiple Correlation, Linear regression & Residual mapping, RMSE, Significance test, Mean Centre of Population, Z-Score
iv. Principal Component analysis
v. Role of Interpolation, Methods of Interpolation – Global and Local Deterministic Methods,
vi. Density Estimation, Inverse Distance Interpolation and Krigging.
vii. Extraction of image statistics and regression analysis using R studio.

(20)

Practical Notebook and Viva-Voce (5)

RSG 310 (Practical)

BASED ON ELECTIVE SPECIAL PAPER THEORY: (The students have to select any one of the following subjects (A-J), as proposed by the department, likely to be offered as elective special papers)

Full Marks: 25. At least even number of periods to be assigned (preferably in batches).Examination Time: 2 hours. Pattern of setting questions: 20marks compulsory questions are to be set. 5 marks are to be allocated for Evaluation of Practical Notebook and Viva-voce. Right hand side parentheses indicate lecture / demonstration hours.

Generation of Case Studies

Based on primary or secondary data case studies to be generated on respective themes, Validation of the output based on post field data, Output generation – finalization (20)

Practical Notebook and Viva-Voce (5)

SEM IV

RSG 401, RSG 402 & RSG 403: (275 marks)

RSG 401 DISSERTATION EXAMINATION (100)

Course Outcome:

- Students will develop the ability to identify and define a focused research problem within the geospatial domain.
- They will acquire skills to formulate research objectives and identify appropriate geospatial methodologies to address the problem.
- Learners will design and implement a geospatial research approach, utilizing GIS and remote sensing tools for data analysis and solution development.
- They will critically evaluate and interpret geospatial data results, drawing actionable insights for real-world applications.
- Students will effectively present and document their research findings, demonstrating the capacity to develop practical geospatial solutions for assigned problems.

Dissertation consisting of relevance of the problem to be studied and its aims and objectives, Methodology adopted to study such problem

Chapter Scheme:

- Problem Definition
- Objective
- Review of Literature
- Database and Methodology
- Result and Discussion

RSG 402: DISSERTATION VIVA (75)

Course Outcome:

- Students will develop the ability to identify and define specific, manageable research problems within the geospatial domain.
- They will formulate clear objectives and select appropriate geospatial tools and techniques to address their research questions.
- Learners will design and execute a research methodology, applying GIS, remote sensing, and spatial analysis methods to develop effective solutions.
- They will critically analyze their findings, interpret results, and derive practical, data-driven insights.
- Students will effectively communicate their research through well-structured PowerPoint presentations and viva voce examinations, demonstrating their understanding and problem-solving skills.

Presentation:

On satisfactory completion of the taught component of the course, students will normally proceed to the M.Sc. Research dissertation which must be completed by the end of fourth semester. This should be a substantial piece of research work, which both reinforces the skills learned in the taught component of the course and provides a genuine opportunity to undertake valuable research. Each student is required to defend his / her thesis through a presentation in front of an external expert and faculty and students.

RSG 403 GRAND-VIVA (100)

Course Outcome:

- Students will demonstrate a comprehensive understanding of the core concepts and principles of the subject during the grand viva.
- They will effectively articulate their knowledge, research work, and applications related to the course in front of external and internal examiners.
- Learners will showcase their ability to synthesize key topics, answering questions confidently and accurately.
- They will demonstrate critical thinking and problem-solving skills through discussion and clarification of their coursework and research.
- Students will exhibit professionalism, communication skills, and confidence in presenting and defending their work before examiners.

Grand Viva:

The grand viva will assess the student's comprehensive understanding of the entire subject, encompassing core concepts, methodologies, and applications. It will require the student to confidently articulate their knowledge, answer questions clearly, and demonstrate critical thinking skills. The evaluation will be conducted in front of both external and internal examiners, who will scrutinize the student's grasp of the course material, research work (if applicable), and ability to respond to diverse queries, ensuring a thorough assessment of their competency.

LIST OF REFERENCES:

RSG 101: FUNDAMENTALS OF REMOTE SENSING

TEXT BOOKS:

1. Jensen, J.R., 2000. Remote sensing of the environment: An earth resource perspective, Prentice Hall, Upper saddle river, NJ,
2. Joseph, George, (2003), Fundamental of Remote Sensing, University Press (India) Pvt. Ltd, Orient Longman Pte. Ltd., Hyd
3. erabad, India
4. Lillesand, T.M. and Kieffer, R.W., 2003. Remote Sensing and Image Interpretation, 5th Edition., Wiley, New York
5. Panda, B. C., 2008. Remote Sensing: Principles and Applications, Viva Books Private Limited, India

REFERENCE BOOKS:

1. Avery, T.E., and G.L.Berlin, Fundamental of remote sensing and airphoto interpretation,5thed, Macmillan, New York,1992
2. Barrett,E.C., and L.F.Curtis, Introduction to environmental remote sensing, 3rded, Chapman and Hall, New York,1992
3. Campbell J.B. (2002) Introduction to Remote Sensing, 3rd ed., The Guilford Press.
4. Canada Center for Remote Sensing, Remote Sensing Tutorial
5. Cracknelll, A.P., and L.W.B.Hayes, Introduction to remote sensing, Taylor and Francis, Washington, DC,1991
6. Curran, P.J. (1980) Mulltispectral remote sensing of vegetation amount, Progress in Physical Geography, 4:315
7. Curran, P.J. (1988) Principles of Remote Sensing, ELBS Edn. Longman Group UK Ltd.
8. Guha, P.K. (2003) Remote Sensing for the Beginner, Affiliated East-West Press Pvt. Ltd., New Delhi
9. Jensen J.R. (2005) Digital Image Processing: A Remote Sensing Perspective, 3rd ed., Prentice Hall.
10. Jensen J.R. (2007) Remote Sensing of the Environment: An Earth Resource Perspective, 2nd ed., Prentice Hall.
11. John, R. J., Introductory Digital Image Processing – A Remote Sensing Perspective, Prentice Hall Series
12. Muralikrishna V., Geographical Information Systems and Remote Sensing Applications, Allied Publishers Private Limited.
13. Nag P. and Kudrat M., Digital Remote Sensing, New Delhi, Concept Publishing.
14. Reeves, Robert G., "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA
15. Richards J.A. and Jia X. (2006) Remote Sensing Digital Image Analysis: An Introduction, 4th ed., Springer

RSG 102: FUNDAMENTALS OF GIS &DIGITAL CARTOGRAPHY

TEXT BOOKS:

1. Anson, R.W. &Ormeling, F.J. (1993), Basic Cartography, Vol. 1, 2nd ed., Elsevier Applied Science Publishers, London.
2. Burrough, Peter A. and Rachael McDonnell, 1998, 'Principles of Geographical Information Systems' Oxford University Press, New York.
3. C.P.Lo and Albert K.W.Yeung 2005 "Concepts and Techniques of Geographic Information Systems" Prentice Hall of India,New Delhi.
4. Chakraborty and Sahoo, 2008, Fundamentals of Geographic Information Systems, Viva Books Private Limited, India
5. Magwire, D. J., Goodchild, M.F. and Rhind, D. M. Ed. 1991, 'Geographical Information Systems: Principles and Applications', Longman Group, U.K.
6. Robinson A.H. & Morrison J.L, (1995) Elements of Cartography, John Wiley & Sons

REFERENCE BOOKS:

1. Chaisman, N. 1992: Exploring Geographical Information Systems, John Wiley and Sons Inc., New York: 198p.
2. Chrisman, N.R. (1997) Exploring Geographic Information Systems. John Wiley andSons.
3. DeMers, M.N.,Fundamentals of geographic information system, Wiley, New York, 1997
4. ESRI (2004) ESRI Cartography: Capabilities and Trends, Redlands, CA, White Paper.
5. Foresman,T.W.(ed)History of GIS, Prentice-Hall, Upper saddle river, NJ,1998
6. Harvey, F. 2008, A Primer of GIS: Fundamental Geographic and Cartographic Concepts, The Guilford Press, New York.
7. Humhold.W.E., 1991. An introduction to urban geographic information system, Oxford University press, New York
8. Ian Masser& Michael Blakemore., 1991, Handling Geographical Information: Methodology and Potential Applications, Ed.
9. Imus D. and Dunlavey P. (2002) Back to the Drawing Board: Cartography vs the Digital Workflow, MT, Hood, Oregon.
10. Kang-tsung Chang 2002, 'Introduction to Geographic Information Systems' Tata McGraw Hill, New Delhi.
11. Keates, J.S. (1973): Cartographic Design and production, London, Longman
12. MacEachren A.M. (1994) Some Truth with Maps: A Primer on Symbolization and Design, University Park: The Pennsylvania State University.
13. Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (eds.) (1991) Geographical Information Systems: Principles and Applications. Avon, Longman Scientific and Technical.
14. Martin, D. (1991) Geographical Information Systems and their Socioeconomic Applications. London, Routledge.
15. Menno-Jan Kraak&FerojanOrmeling, 2003, Cartography – Visualisation of Geospatial data, 2ndEdn, , Pearson Education Ltd.
16. Mishra, R.P. and. A. Ramesh, Fundamentals of Cartography , Concept Publishing House, New Delhi – 110059
17. Monkhouse F.J. and Wilkinson, H.R. 1971. : Maps and Diagrams: Their Compilation and Construction, B.I. Publications Private Limited, New Delhi: 527p.
18. Muralikrishna V., Geographical Information Systems and Remote Sensing Applications, Allied Publishers Private Limited.
19. Peterson, M.P. (1995) "Interactive and Animated Cartography" Upper Sadde River, NJ: Prentice Hall.

20. Peuquet, D.J. and Marble, D.F. (eds.) (1990) Introductory Readings in Geographic Information Systems. London, Taylor and Francis.
21. Ramesh, P. A. (2000): Fundamentals of Cartography, Concept Publishing Co., New Delhi.
22. Rampal, K.K. (1993): Mapping and Compilation, Concept Publishing Co.,New Delhi.
23. Slocum T. (2003) Thematic Cartography and Geographic Visualization, Upper Saddle River, New Jersey: Prentice Hall.
24. Wilford J.N. (2000) The Mapmakers, Vintage Books.

RSG 103: PHOTOGRAMMETRY, SURVEYING AND GPS

TEXT BOOKS:

1. Hussain, S.K. and Nagaraj, M.S. 1992 :Text Book of Surveying, S. Chand & Co. Ltd., New Delhi:
2. Joseph, George, (2003), Fundamental of Remote Sensing, University Press (India) Pvt. Ltd, Orient Longman Pte. Ltd., Hyderabad, India
3. Kanetkar, T.P. and Kulkatni, S. V. 1.988: Surveying and Levelling, Part I, Pune VidyarthiGrihaPrakashan, Pune: 608p.
4. Lillesand, T.M. and Kieffer, R.W., 2003. Remote Sensing and Image Interpretation, 5th Edition., Wiley, New York
5. Panda, B. C., 2008. Remote Sensing: Principles and Applications, Viva Books Private Limited, India
6. Terry-Karen Steede, 2002, Integrating GIS and the Global Positioning System, ESRI Press
7. Wolf P.R. (1983) Elements of Photgrammetry, McGraw-Hill, NY.

REFERENCE BOOKS:

1. Alvi, Z. 1995: Statistical Geography: Methods and Applications, Rawat Pub. New Delhi: 194p.
2. American society of photogrammetry (ASP), Manual of remote sensing, second edition, ASP, Falls church,VA,1983
3. Burnside C.D. (1985) Mapping from Aerial Photography, 2nd Ed, Collins.
4. Campbell J.B. (2002) Introduction to Remote Sensing, 3rd ed., The Guilford Press.
5. Digital Photogrammetry, Michel Kasse and Yves Egles, Taylor & Francis, 2001.
6. Digital Photogrammetry, Theory and Application, Eilifried Linder, Springer, 2003.
7. Elements of Photogrammetry with Applications in GIS (3rd Ed.) by Wolf P. and DeWitt B., McGraw-Hill, 2000.
8. Elfic, M.H., Fryer, J.G. Brinkner, R.C. and Wolf, P.R. 1994: Elementary Surveying, 8th edition, Harper Collins Publishers, London: 510 p.
9. Floyd F.S. ( ) Remote Sensing: Principles and Interpretation New York, WH Freeman and Company.
10. Global Navigation Satellite Systems: Insights into GPS, GLONASS, Galileo, Compass and Others by BasudebBhatta, CRC Press.
11. GNSS – Global Navigation Satellite Systems, GPS, GLONASS, Galileo, and more by Hofmann-Wellenhof, Bernhard, Lichtenegger, Herbert, Wasle, Elmar, SPRINGER.
12. GPS: Theory, Algorithms and Applications by GuochangXu, Artech House, 2009.
13. Introduction to GPS: The Global Positioning System, by Ahmed El-Rabbany, ARTECH House.
14. Introduction to Modern Photogrammetry by Edward M.Mikhail, JananS.Bethel& Chris McGlone, Wiley & Sons Inc,2000.

15. Kellaway, G.P. 1979: Map Projections, 1st Indian edition, B.I. Publication, Delhi.
16. Kochher, C.L. 1993 : A Text Book of Surveying, S.K. Katariya& Sons, Delhi:
17. Leicka. A.: GPS Satellite Surveying, John Wiley & Sons, use. New York
18. Lillesand, T.M. and Kieffer, R.W., 2003. Remote Sensing and Image Interpretation, 5th Edition., Wiley, New York
19. Menno-Jan Kraak&FerojanOrmeling, 2003, Cartography – Visualisation of Geospatial data, 2ndEdn, , Pearson Education Ltd.
20. Mishra, R.P. and. A. Ramesh, Fundamentals of Cartography , Concept Publishing House, New Delhi – 110059
21. Moffitt F.H. (1980) Photogrammetry, 3rd Ed, Harper & Row, NY.
22. N.K.Agrawal Essentials of GPS, Spatial Network Pvt Ltd 2004
23. Paul J.C. ( ) Principles of Remote Sensing UK, ELBS.
24. Photogrammetry: Geometry from Images and Laser Scans by Kraus, Karl, de Gruyter Publishers.
25. Principles of GNSS, Inertial, and Multi-sensor Integrated Navigation Systems by Paul D. Groves, ARTECH House.
26. Punmia, B.C, Surveying (vol I, and II), Standard book House, Nayasarak, New Delhi
27. Robinson, A.H., Sale, R.D., Morrison, J. 1984 : Elements of Cartography, Wiley, New York:
28. Roy, P. 1988 : An Analytical Study of Map Projections, Volume 1, Kolkata:
29. Saha, Pijushkanti& P. Basu, 2004, Advanced Practical Geography – A Laboratory Manual Books & Allied (P) Ltd.
30. Sarkar, A. 1997 : Practical Geography: A Systematic Approach, Orient Longman Ltd., Hyderabad:
31. Sheffield, C. (1983) Man on Earth, Sidgwick and Jackson, London
32. Shepherd, F.A. 1983 : Engineering Surveying, Edward Arnold, London:
33. Singh, N. Surveying, Tata McGraw-Hill Publishing Company Ltd., New Delhi:
34. Singh, R.L &Dutt. P.K, "Elements of Practical geography", Students Friends Allahabad
35. Singh, R.L. and Singh, R.P.B. 1991: Elements of Practical Geography, Kalyani Pub. New Delhi: 421p.
36. Steers, J.A. 1965 : An Introduction to Map Projections, 14th ion, University of London Press, London:
37. Terry-Karen Steede, 2002, Integrating GIS and the Global Positioning System, ESRI Press
38. Understanding GPS: Principles and Applications by Elliott D.Kaplan, Artech House, 2005.
39. Venkatramaiah, C. 1996: A Textbook of Surveying, Universities Press / Orient Longman Ltd., Hyderabad: 76p.
40. Walford, P., 1995: Geographical Data Analysis, John Wiley and Sons Inc., New York: 446p.
41. www.trimble.com/index.htm
42. Zorn H.C. (1980) Introductory Course in Photogrammetry, 6th Ed. ITC, Netherlands.

RSG 104: COMPUTER FUNDAMENTALS & PROGRAMMING

TEXT BOOKS:

1. E Balaguruswamy " Programming in ANSI C " TMH 2nd Edition 2000
2. EvangelosPetroutsos "Mastering Visual Basic 6.0" , BPB Publications, Edition 1998
3. MohmmedAzam"Programming with VB 6.0 ",Vikash Publishing House Pvt. Ltd.
4. Rajaraman Y., "Fundamentals of Computers", Prentice Hall of India, New Delhi, 1999.

REFERENCE BOOKS:

1. Mano, M., Digital Logic and Computer Design
2. Pal, S.K. 1999: Statistics for Geoscientists, Concept publishing Company, New Delhi: 423p.
3. Peter Norton and Michael Groh, "Guide to Visual Basic 6", Techmedia, SAMS, Seventh Edition
4. R G Dromey, "How to solve it by Computer", PHI, Edition 1999
5. Scott Warner, "Teach Yourself Visual Basic 6.0", TMH, 1999.
6. Walford, P., 1995: Geographical Data Analysis, John Wiley and Sons Inc., New York: 446p.
7. YashwantKanetkar, "Let us C", BPB Publications, 2001

RSG 201: DIGITAL IMAGE PROCESSING AND INFORMATION EXTRACTION

TEXT BOOKS:

1. Jensen J.R. (2005) Digital Image Processing: A Remote Sensing Perspective, 3rd ed., Prentice Hall.
2. Jensen J.R. (2007) Remote Sensing of the Environment: An Earth Resource Perspective, 2nd ed., Prentice Hall.
3. Joseph, George, (2003), Fundamental of Remote Sensing, University Press (India) Pvt. Ltd, Orient Longman Pte. Ltd., Hyderabad, India
4. Lillesand, T.M. and Kieffer, R.W., 2003. Remote Sensing and Image Interpretation, 5th Edition., Wiley, New York
5. Panda, B. C., 2008. Remote Sensing: Principles and Applications, Viva Books Private Limited, India

REFERENCE BOOKS:

1. Campbell J.B. (2002) Introduction to Remote Sensing, 3rd ed., The Guilford Press.
2. Campbell, James B., Introductory Remote Sensing: Principles and Concepts, Routledge.
3. Castleman, K.R. (1979) Digital Image Processing. Prentice Hall Inc, New Jersey.
4. Cracknelll, A.P., and L.W.B.Hayes, Introduction to remote sensing, Taylor and Francis, Washington, DC,1991
5. Curran, P.J. (1980) Mulltispectral remote sensing of vegetation amount, Progress in Physical Geography, 4:315
6. Curran, P.J. (1988) Principles of Remote Sensing, ELBS Edn. Longman Group UK Ltd.
7. Gibson, P.J., Introduction to Remote Sensing, 2nd ed., Taylor & Francis, London.
8. John R.J. (2000). Introductory Digital Image Processing: Remote Sensing Perspective, New Jerysey, Prentice Hall.
9. Nag P. and Kudrat M. Digital Remote sensing New Delhi: Concept Publishing.
10. Rafael C.G. and Woods R.E. (1992) Digital Image Processing.
11. Rencz, Andrew N. (Ed), Remote Sensing for the Earth Sciences: Manual of Remote Sensing, 3rd ed., John Wiley & Sons, Inc., New York.
12. Sabins, Floyd F., Remote Sensing: Principles and Interpretation, H. Freeman and C., New York.
13. Umbaugh S.E (2005) Computer Imaging: Digital Image Analysis and Processing.
14. William K.P. (1978) Digital Image Processing.

RSG 202: ADVANCED REMOTE SENSING

TEXT BOOKS:

1. Jensen J.R. (2005) Digital Image Processing: A Remote Sensing Perspective, 3rd ed., Prentice Hall.
2. Jensen J.R. (2007) Remote Sensing of the Environment: An Earth Resource Perspective, 2nd ed., Prentice Hall.
3. Joseph, George, (2003), Fundamental of Remote Sensing, University Press (India) Pvt. Ltd, Orient Longman Pte. Ltd., Hyderabad, India
4. Lillesand, T.M. and Kieffer, R.W., 2003. Remote Sensing and Image Interpretation, 5th Edition., Wiley, New York
5. Panda, B. C., 2008. Remote Sensing: Principles and Applications, Viva Books Private Limited, India

REFERENCE BOOKS:

1. Campbell J.B. (2002) Introduction to Remote Sensing, 3rd ed., The Guilford Press.
2. Cracknell A.P. (ed) Remote Sensing in Meteorology, Oceanography and Hydrology, Chichester, Ellis Horwood Limited.
3. Digital Elevation Model Technologies and Applications: The DEM Users Manual,
4. Ghassem A. Theory and Applications of Optical Remote Sensing, New York, John Wiley and Sons.
5. Hyperspectral Data Exploitation: Theory and Applications by Chein-I Chang,Wiley& Sons Ltd.
6. Hyperspectral Remote Sensing of Tropical and Subtropical Forests by Margaret Kalacska and G. Arturo Sanchez‐Azofeifa., CRC Press.
7. Hyperspectral Remote Sensing: Principles and Applications by Marcus Borengasser, William S. Hungate, and Russell Watkins, CRC Press.
8. Imaging Radar (Manual of Remote Sensing, Volume 2) by Henderson F.M. and Lewis A.J. (3rd Ed.), Wiley, 1998.
9. Imaging with Synthetic Aperture Radar by Didier Massonnet, Jean-Claude Souyris, CRC Press, 2008.
10. Introduction to Microwave Remote Sensing by Iain H. Woodhouse, CRC, 2004.
11. Maune, D. F. and Bethesda, M.D. (2nd Ed.), American Society for Photogrammetry and Remote Sensing. 2007.
12. Microwave Remote Sensing: Active and Passive, from Theory Applications by Ulaby F.T., Moore R.K. and Fung A.K., Artech House Publishers, 1986.
13. Polarimetric Radar Imaging. From Basics to Applications by Lee, J.-S. andPottier, E., CRC Press, 2009.
14. Skolnik and Merrill I. Introduction to Radar Systems, McGraw-Hill (1st ed., 1962; 2nd ed., 1980; 3rd ed., 2001).
15. Techniques and Applications of Hyperspectral Image Analysis by Hans F. Grahn and Paul Geladi, Wiley & Sons Ltd.
16. Topographic Laser Ranging and Scanning, Principles and Processing, Shan, J. and C. Toth, Taylor & Francis, 2008.
17. Understanding Synthetic Aperture Radar Images by Olivie, C. and Quegan, S. Scitech, 2004.

RSG-203: ADVANCED GEOGRAPHIC INFORMATION SYSTEM

TEXT BOOKS:

1. Burrough, Peter A. and Rachael McDonnell, 1998, 'Principles of Geographical Information Systems' Oxford University Press, New York.

2. C.P.Lo and Albert K.W.Yeung 2005 "Concepts and Techniques of Geographic Information Systems" Prentice Hall of India,New Delhi.
3. Chakraborty and Sahoo, 2008, Fundamentals of Geographic Information Systems, Viva Books Private Limited, India
4. Magwire, D. J., Goodchild, M.F. and Rhind, D. M. Ed. 1991, 'Geographical Information Systems: Principles and Applications', Longman Group, U.K.

REFERENCE BOOKS:

1. A. Silberschats, Henry F. Korth "Database System Concepts", 3rd Edition, TMH, 1998
2. Bonham Carter G.F (1994) GIS for Geoscientists: Modeling with GIS Pergamon Publications.
3. Chaisman, N. 1992: Exploring Geographical Information Systems, John Wiley and Sons Inc., New York: 198p.
4. Chrisman, N.R. (1997) Exploring Geographic Information Systems. John Wiley and Sons.
5. David J Maguire, Michael F Goodchaild and David W Rahind., 1991, Geographical Information System, Ed.
6. DeMers, M.N.,Fundamentals of geographic information system, Wiley, New York, 1997
7. Foresman,T.W.(ed)History of GIS, Prentice-Hall, Upper saddle river, NJ,1998
8. Goodchild, M.F. (1978) - Statistical Aspects of the Polygon Overlay Problems, in Harvard papers on GIS, Ed. G. Dulton, Vol. 6, Addison Wesley, Reading Press.
9. Humhold.W.E., 1991. An introduction to urban geographic information system, Oxford University press, New York
10. Huxhold, W.E. (1991) An Introduction to Urban Information Systems. New York, OUP.
11. Ian Masser& Michael Blakemore., 1991, Handling Geographical Information: Methodology and Potential Applications, Ed.
12. Kang-tsung Chang 2002, 'Introduction to Geographic Information Systems' Tata McGraw Hill, New Delhi.
13. Laurini, R. and Thompson, D. (1992) Fundamentals of Spatial Information Systems. London, Academy Press.
14. Mac Donald, A. 1999, Building a Geodatabase, Redlands CA: ESRI Press.
15. Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (eds.) (1991) Geographical Information Systems: Principles and Applications. Avon, Longman Scientific and Technical.
16. Martin, D. (1991) Geographical Information Systems and their Socioeconomic Applications. London, Routledge.
17. Mary Summer, Computers: Concepts and Uses, Prentice Hall, Englewood Cliffs. New Jersey.
18. Muralikrishna V., Geographical Information Systems and Remote Sensing Applications, Allied Publishers Private Limited.
19. Peuquet, D.J. and Marble, D.F. (eds.) (1990) Introductory Readings in Geographic Information Systems. London, Taylor and Francis.
20. Samet, H. 1990, The Design and Analysis of Spatial Data Structures, Addison–Wesley.
21. Sanghavi, Hitesh (1998) Oracle Miracles, Express computers methods, 1998.

RSG-204: CBCS I: FUNDAMENTALS OF GEOSPATIAL TECHNOLOGY

TEXT BOOKS:

1. Jensen, J.R., 2000. Remote sensing of the environment: An earth resource perspective, Prentice Hall, Upper saddle river, NJ,
2. Lillesand, T.M. and Kieffer, R.W., 2003. Remote Sensing and Image Interpretation, 5th Edition., Wiley, New York
3. Burrough, Peter A. and Rachael McDonnell, 1998, 'Principles of Geographical Information Systems' Oxford University Press, New York.
4. C.P.Lo and Albert K.W.Yeung 2005 "Concepts and Techniques of Geographic Information Systems" Prentice Hall of India,New Delhi.
5. Wolf P.R. (1983) Elements of Photgrammetry, McGraw-Hill, NY.
6. Hussain, S.K. and Nagaraj, M.S. 1992 :Text Book of Surveying, S. Chand & Co. Ltd., New Delhi:

REFERENCE BOOKS:

1. Panda, B. C., 2008. Remote Sensing: Principles and Applications, Viva Books Private Limited, India
2. Joseph, George, (2003), Fundamental of Remote Sensing, University Press (India) Pvt. Ltd, Orient Longman Pte. Ltd., Hyderabad, India
3. Chakraborty and Sahoo, 2008, Fundamentals of Geographic Information Systems, Viva Books Private Limited, India

RSG 301: APPLICATION OF GEOINFORMATICS & SPATIAL DECISION SUPPORT SYSTEMa

TEXT BOOKS:

1. An Introduction to Database Systems by C.J.Date, A. Kannan S. Swamynathan (8th Ed.), Pearson Education, 2009.
2. Database Management Systems by Raghu Ramakrishnan, Johannes Gehrke, McGraw-Hill, 2002.
3. Jenson J.R. 2000. Remote Sensing of the environment – An Earth Resource Perspective, Prentice Hall Inc.
4. Lillisand, T. M. and Keifer, R. W. 1994. Remote Sensing and Image interpretation', John Willey and Sons, New York, Third Edition
5. Malczewski, J. 1999 GIS and Multicriteria Decision Analysis, John Willey and Sons, New York

REFERENCE BOOKS:

1. An Introduction to Database Systems by C.J.Date, A. Kannan S. Swamynathan (8th Ed.), Pearson Education, 2009.
2. Bonczek, R.H., C.W. Holsapple, and A.B. Whinston, 1981. Foundations of Decision Support Systems, Academic Press, New York. Basic text on DSS.
3. Database Management Systems by Raghu Ramakrishnan, Johannes Gehrke, McGraw-Hill, 2002.
4. Fundamentals of Database Systems by Elmasri and Navathe, (6th Ed.), Addison-Wesley, 2011.
5. Geoffrion, A.M., 1983. "Can OR/MS evolve fast enough?" Interfaces 13:10. Source for six essential characteristics of DSS.

6. House, W.C. (ed.), 1983. Decision Support Systems, Petrocelli, New York. Basic DSS text.
7. P.S. Roy (2000). Natural Disaster and their mitigation. Published by Indian Institute of Remote Sensing (IIRS), 2000.
8. Schultz , G. A. and Engman, E. T. 2000. Remote Sensing in Hydrology and Water Management, Springer-Verlag, Berlin, Germany.
9. Spatial Technologies for Natural Hazard Management. Proceedings of ISRS National Symposium, Nov. 21-22, 2000, IIT, Kharagpur.
10. Sprague, R.H., 1980. "A framework for the development of decision support systems," Management Information Sciences Quarterly 4:1-26. Source for DSS development model.
11. Sprague, R.H., and Carlson, E.D., 1982. Building Effective Decision Support Systems, Prentice-Hall, Englewood Cliffs NJ. Basic DSS text.

RSG 302: FUNDAMENTAL OF RESEARCH & GEOSTATISTICS

TEXT BOOKS:

1. Kothari, C. R., 1985. Research Methodology: Methods and Techniques, New Age International Pvt. Ltd.
2. Mishra, R. C. and Soota, T., 2005, Modern Project Management, New Age International Ltd.
3. Murthy, C., 2009, Research Methodology, Vrinda Publications Ltd.
4. W.E. Huxold& A.G. LerinsonsAronoft.S.(1989) Managing Geographic Information Projects.
5. Alvi, Z. 1995: Statistical Geography: Methods and Applications, Rawat Pub. New Delhi
6. Burrough, P.A. and McDonnel, R.A., 2007, Principles of Geographical Information Systems, 3e, Oxford University Press, New York.
7. Chiles, J.P. (1999). Geo-statistics: Modelling spatial uncertainty, Wiley Interscience Publ.
8. Isaaks, E.H. and Srivastava, R.M., 1989, Applied Geostatistics, Oxford University Press, New York, 561pp.
9. Longley, P. and Batty, M. (eds.), 1996, Spatial Analysis: Modelling in a GIS Environment, Geoinformation International, Cambridge, 392pp.
10. Pal, S.K. 1999 : Statistics for Geoscientists, Concept publishing Company, New Delhi
11. Sharma, D.D. (2002). Geo-statistics with application in Earth Sciences, Capital Publ.
12. Silk, J. 1979 : Statistical techniques in Geography, George Allen and Unwin, London
13. Walford, P.,1995: Geographical Data Analysis, John Wiley and Sons Inc., New York

REFERENCE BOOKS:

1. Ahuja, R., 2010. Research Methods, Rawat Publication.
2. Beer D. (1991) Writing and Speaking in the Technology Professions: A Practical Guide, Wiley-IEEE Press.
3. Bennet P. Lientz& Kathryn P. (1995) Project Management for the 21st Century, Academic Press, California
4. Berkun, Scott (2005). Art of Project Management. Cambridge, MA: O'Reilly Media.
5. Earickson, R,. and Harlin, J. (1994) Geographic Measurement & Quantitative Analysis, Macmillan, N.York
6. Kerzner, Harold (2003). Project Management: A Systems Approach to Planning, Scheduling, and Controlling, 8th Ed., Wiley.

7. Lewis, James (2002). Fundamentals of Project Management, 2nd ed., American Management Association.
8. Markel M. (1994) Writing in the Technical Fields: A Step-by-Step Guide for Engineers, Scientists and Technicians, publisher.
9. Markel M. (2009) Technical Communications, 9th Edition, Bedford/St Martin's.
10. Meredith, Jack R. and Mantel, Samuel J. (2002). Project Management: A Managerial Approach, 5th ed., Wiley. ISBN 0-471-07323-7.
11. Rossiter, D. G. 2003. *Introduction to the R Project for Statistical Computing for use at ITC*. Enschede (NL): International Institute for Geo-information Science & Earth Observation (ITC). URL: http://www.itc.nl/personal/rossiter/teach/R/RIntro_ITC.pdf
12. Rossiter, D. G. 2004. *Statistical methods for accuracy assesment of classified thematic maps*. Technical note, International Institute for Geo-information Science and Earth Observation (ITC). URL: http://www.itc.nl/personal/rossiter/teach/R/R_ac.pdf 158

    http://courses.washington.edu/hcde231/Readings.html

    http://www.writing.engr.psu.edu/

    http://owl.english.purdue.edu/owl/resource/629/01/

    http://www.writing.engr.psu.edu/exercises/

13. Das, N.G., 1997, Statistical Methods: Part I, M. Das and Company, Calcutta.
14. Das, N.G., 1997, Statistical Methods: Part II, M. Das and Company, Calcutta.
15. Geostatistics for Environmental Scientists by R. Webster and M.A. Oliver, (2nd Ed.) Wiley, 2007.
16. Gregory, S. (1978): Statistical Methods for Geographers, Longman
17. Hierarchical Modeling and Analysis for Spatial Data by Banerjee, Carlin and Gelfand, Chapman and Hall, 2004.
18. Interpolation of Spatial Data by Stein, Springer, 1999.
19. Khan, N., 2002, Quantitative Methods in Geographical Research, Concept Publishing Company, New Delhi.
20. Mehmood, A., 2002, Statistical Methods in Geographical Studies, Rajesh Publication, New Delhi.
21. Multivariate Geostatistics: An introduction with Applications by Hans Wakernagel, Springer, (3rd Ed.), 2003.
22. Murray R. Spiegel, (1981), Theory and Problems of Statistics , Schaum's Outline Series
23. Paul L. Meyer: Introductory Probability and Statistical Applications, Addison Wesley
24. Peterson, M.P. (1995) "Interactive and Animated Cartography" Upper Sadde River, NJ: Prentice Hall.
25. Saha, Pijushkanti& P. Basu, 2004, Advanced Practical Geography – A Laboratory Manual Books & Allied (P) Ltd.
26. Sarkar, A. 1997 : Practical Geography: A Systematic Approach, Orient Longman Ltd., Hyderabad:
27. Singh, R.L. and Singh, R.P.B. 1991: Elements of Practical Geography, Kalyani Pub. New Delhi: 421p.
28. Spatial statistics: geospatial Information Modeling and Thematic Mapping by Mohammed A Kalkhan, CRC Press, 2011.
29. Statistics for Spatial Data by Cressie, Wiley, 1993.
30. Walford N. (2011) Practical Statistics for Geographers and Earth Scientists, John Wiley & Sons, New Jersey, USA.

31. Williams R.B.G. (1984) Introduction to Statistics for Geographers and Earth Scientists, Macmillan, London.
32. Wrigley N. (1985) Categorical Data Analysis for Geographers and Environmental Scientists, Longman, Harlow.
33. Zhang C. (2007) Fundamentals of Environmental Sampling and Data Analysis, John Wiley & Sons, NJ, USA.

RSG 303 ELECTIVE PAPERS

GEOINFORMATICS IN COASTAL MANAGEMENT

1. Carter, R. W. G., 1989. Coastal Environments: An Introduction to Physical, Ecological and Cultural Systems of Coastlines, Academic Press Ltd.
2. Paul, A., 2002. Coastal Geomorphology and Environment, ACB Publications, Kolkata, 582p
3. Paul, A., 2005. Tsunami-an assessment of disasters, ACB Publications, Kolkata, 125p
4. Pethic, J., 1983. An Introduction to Coastal Geomorphology, Arnold Publishers
5. Woodrooffe, C., 2002. Coasts-form, process and evolution, Cambridge University Publications, 688p

GEOINFORMATICS IN EARTH SCIENCES

1. Drury, S.A. 1993. Image interpretation in geology, Chapman & Hall India.
2. Jenson, J.R. 2000. Remote Sensing of the environment – An Earth Resource Perspective, Prentice Hall Inc.
3. Lillisand, T. M. and Keifer, R. W. 1994. Remote Sensing and Image interpretation', John Willey and Sons, New York, Third Edition
4. Murk & Skinner. 1999. Geology Today- Understanding our planet, John Wiley and Sons Inc, New York
5. Pandey, S. N. 1987. Principal and applications of photogeology. New Delhi; Eastern Wiley.
6. Sabins, Floyd F. 1986. Remote Sensing: Principles and Interpretation, 2nd ed., Freeman, New York.
7. Thornbury, W. D. (I960): Principles of Geomorphology, John Wiley and Sons, New York

GEOINFORMATICS IN URBAN, RURAL DEVELOPMENT & REGIONAL PLANNING

1. Brench M.C., City Planning and Aerial Information, Harvard University, Cambridge, 1971

GEOINFORMATICS IN FOREST MANAGEMENT

2. Baretl, E.C. and Culis I.F. Introduction to Environmental Remote Sensing, Second edition, Chapman and Hall, New York, 1993.
3. Simmons, T.G. The Ecology of Natural Resources, Edword Arnold, London, 1974.

GEOINFORMATICS IN ENVIRONMENTAL SCIENCE & MANAGEMENT

1. Baretl, E.C. and Culis I.F. Introduction to Environmental Remote Sensing, Second edition, Chapman and Hall, New York, 1993.
2. Lintz, J.andSimonent,D.S. Remote Sensing of environment Addision Wesley, Rading mars, 1976.

GEOINFORMATICS IN TRANSPORT NETWORK ANALYSIS

1. Network Analysis in Geography. St Martin's Press Haggett P, Chorley R J
2. Spatial Processes: Models and Applications. Pion Cliff A D, Ord J K

GEOINFORMATICS IN WATER RESOURCES MANAGEMENT

1. Dutta, D., Sharma, J.R. and Adiga, S. (2002). Watershed characterization, development planning, and monitoring- Remote sensing approaches, Tech. Report, ISRO-NNRMS-TR-103-2002.
2. Manual of Remote Sensing, vol-II, Chapter on "Water Resources Assesment". American Society of Photogrammtery.
3. Murthy, J. V. S. 1994. Watershed Management in India. Wiley Eastern Ltd., New Delhi.
4. Schultz, G. A. and Engman, E. T. 2000. Remote Sensing in Hydrology and Water Management, Springer-Verlag, Berlin, Germany.
5. Schultz, G.A. &Engman, E.T., 2000. Remote Sensing in hydrology and water management, Springer-Verlang, Berlin, Germany.
6. Todd David Keith. 1980. Groundwater Hydrology, John Wiley & Sons, New York, Second Edition.

GEOINFORMATICS IN UTILITY MANAGEMENT

1. Escritt, L. B., Water Supply and Building Sanitation, 4th Ed., Mac Donald and Evans Limited, 1972
2. Hammer, Mark J., Water and wastewater Technology, 2nd Ed., John Willey and Sons Inc., 1986.
3. Harries K (1999) Mapping Crime: Principle and Practice. Washington, DC: Crime Mapping Research Center, Department of Justice
4. Hodder I, Orton C (1979) Spatial Analysis in Archaeology. Cambridge: Cambridge University Press

GEOINFORMATICS IN AGRICULTURE

1. GhassemAsrar, Theory and application of optical remote sensing. John Wiley & Sons, New York, 1989.
2. Space Applications Centre- Manual of procedure for Forest mapping and Damage Detection using satellite data, Report No. IRS-UP/SAC/FMDD/TN/16/90, 1990: pp-58.
3. Space Applications Centre –Status Report on Crop Acreage and Production Estimation, Report No. RSAM/SAC/CAPE/SR/ 25/90, October 1990, pp-253.
4. Steven, M.D. and Clark, J.A. Application of Remote Sensing in Agriculture, Butterworths, London, 1990.

GEOINFORMATICS IN RESOURCE MANAGEMENT

1. Lillisand, T. M. and Keifer, R. W. 1994. Remote Sensing and Image interpretation', John Willey and Sons, New York, Third Edition
2. Miller, R. W. and Donahue, R. L. (1990): Soils, Prentice-Hall of India

3. Robert G. Reeves: Manual of Remote Sensing Vol. II American Society of Photogrammetry and Remote Sensing, Falls Church.DonaldA Davidson: Soils and Land use Planning, Longman, London, 1998.
4. Robert W. Colwell. Monitoring of Earth Resources from Aircraft and Spacecraft, NASA, Washington DC.
5. Simmons, T.G. The Ecology of Natural Resources, Edword Arnold, London, 1974.

RSG 304: CBCS II: ADVANCED REMOTE SENSING AND AREAS OF APPLICATIONS

TEXT BOOKS:

1. Jensen J.R. (2005) Digital Image Processing: A Remote Sensing Perspective, 3rd ed., Prentice Hall.
2. Jensen J.R. (2007) Remote Sensing of the Environment: An Earth Resource Perspective, 2nd ed., Prentice Hall.
3. Joseph, George, (2003), Fundamental of Remote Sensing, University Press (India) Pvt. Ltd, Orient Longman Pte. Ltd., Hyderabad, India
4. Lillesand, T.M. and Kieffer, R.W., 2003. Remote Sensing and Image Interpretation, 5th Edition., Wiley, New York
5. Panda, B. C., 2008. Remote Sensing: Principles and Applications, Viva Books Private Limited, India

REFERENCE BOOKS:

1. Campbell J.B. (2002) Introduction to Remote Sensing, 3rd ed., The Guilford Press.
2. Cracknell A.P. (ed) Remote Sensing in Meteorology, Oceanography and Hydrology, Chichester, Ellis Horwood Limited.
3. Digital Elevation Model Technologies and Applications: The DEM Users Manual,
4. Ghassem A. Theory and Applications of Optical Remote Sensing, New York, John Wiley and Sons.
5. Hyperspectral Data Exploitation: Theory and Applications by Chein-I Chang,Wiley& Sons Ltd.
6. Hyperspectral Remote Sensing of Tropical and Subtropical Forests by Margaret Kalacska and G. Arturo Sanchez‐Azofeifa., CRC Press.
7. Hyperspectral Remote Sensing: Principles and Applications by Marcus Borengasser, William S. Hungate, and Russell Watkins, CRC Press.
8. Imaging Radar (Manual of Remote Sensing, Volume 2) by Henderson F.M. and Lewis A.J. (3rd Ed.), Wiley, 1998.
9. Imaging with Synthetic Aperture Radar by Didier Massonnet, Jean-Claude Souyris, CRC Press, 2008.
10. Introduction to Microwave Remote Sensing by Iain H. Woodhouse, CRC, 2004.