Vidyasagar University

Post Graduate Syllabus

in

Remote Sensing & Geographic Information System

under Choice Based Credit System

(CBCS)

[w.e.f. : 2016-2017]

Syllabus
for
M. Sc. Course in Remote Sensing & Geographic Information System

---

REVISED IN MARCH 2016: TO BE EFFECTIVE FROM THE ACADEMIC SESSION 2016-2017

Department of Remote Sensing & GIS

Vidyasagar University,

West Medinipur, West Bengal

PIN – 721 102

DIVISION OF MARKS

Total Marks : 1200
SEM I Marks : 300
SEM II Marks : 300
SEM III Marks : 300
SEM IV Marks : 300

Theoretical Marks: 600 (SEM I: 200, SEM II: 200, SEM III: 200)

Practical Marks : 300 (SEM I: 100, SEM II: 100, SEM III: 100)
Dissertation : 200 marks (SEM IV)
Grand Viva : 100 marks (SEM IV)

STRUCTURE OF THE SYLLABUS (SEM-I)

Type	Name of Paper	Paper /Module No.		Subject	Marks	Credits	Exam Time
THEORETICAL	FUNDAMENTALS OF REMOTE SENSING	RSG 101	Gr. A	Fundamentals & Physics of Remote Sensing	20	4	2 hours
			Gr. B	Platforms and Sensors	20		
				Internal Assessment	10		
	FUNDAMENTALS OF GIS & DIGITAL CARTOGRAPHY	RSG 102	Gr. A	Fundamentals of Geographic Information System	20	4	2 hours
			Gr. B	Digital Cartography	20		
				Internal Assessment	10		
	PHOTOGRAMMETRY, SURVEYING AND GPS	RSG 103	Gr. A	Photogrammetry	20	4	2 hours
			Gr. B	Surveying and Global Positioning System	20		
				Internal Assessment	10		
	COMPUTER FUNDAMENTALS & PROGRAMMING	RSG 104	Gr. A	Computer Basics	20	4	2 hours
			Gr. B	Programming languages	20		
				Internal Assessment	10		
PRACTICAL		RSG 105		Image Interpretation	25	2	4 hours

		RSG 106	Fundamentals of GIS	25	2	4 hours
		RSG 107	Photogrammetry, Surveying and GPS	25	2	4 hours
		RSG 108	Computer Fundamentals & Programming	25	2	4 hours

STRUCTURE OF THE SYLLABUS (SEM-II)

Type	Name of Paper	Paper /Module No.		Subject	Marks	Credits	Exam Time
THEORETICAL	DIGITAL IMAGE PROCESSING AND INFORMATION EXTRACTION	**RSG 201**	**Gr. A**	Digital Image Processing	20	4	2 hours
			Gr. B	Information Extraction from Satellite Images	20		
				Internal Assessment	10		
	ADVANCED REMOTE SENSING	**RSG 202**	**Gr. A**	Thermal and Microwave Remote Sensing	20	4	2 hours
			Gr. B	Hyperspectral Remote Sensing and Lidar	20		
				Internal Assessment	10		
	ADVANCED GEOGRAPHIC INFORMATION SYSTEM	**RSG 203**	**Gr. A**	GIS Data Analysis	20	4	2 hours
			Gr. B	Geodesy	20		
				Internal Assessment	10		
	CBCS I: FUNDAMENTALS OF GEOSPATIAL TECHNOLOGY	**RSG 204**	**Gr. A**	Fundamentals of Remote Sensing & Photogrammetry	20	4	2 hours
			Gr. B	Fundamentals of Geographic Information System & Global Positioning System	20		
				Internal Assessment	10		
PRACTICAL		**RSG 205**		Digital Image Processing (DIP)	25	2	4 hours
		RSG 206		Advance Remote Sensing: Data Processing & Applications	25	2	4 hours

		RSG 207	Advance Geographic Information System	25	2	4 hours
		RSG 208	Geodesy and GPS	25	2	4 hours

STRUCTURE OF THE SYLLABUS (SEM-III)

Type	Name of Paper	Paper /Module No.		Subject	Marks	Credits	Exam Time
THEORETICAL	APPLICATION OF GEOINFORMATICS & SPATIAL DECISION SUPPORT SYSTEM	**RSG 301**	**Gr. A**	Application of Geo-informatics	20	4	2 hours
			Gr. B	Spatial decision support system	20		
				Internal Assessment	10		
	FUNDAMENTAL OF RESEARCH & GEOSTATISTICS	**RSG 302**	**Gr. A**	Fundamental of Research and Project Management	20	4	2 hours
			Gr. B	Geostatistics	20		
				Internal Assessment	10		
	ELECTIVE PAPER	**RSG 303**	**Gr. A**	*Elective Special paper*	20	4	2 hours
			Gr. B	*Elective Special paper*	20		
				Internal Assessment	10		
	CBCS II: ADVANCED REMOTE SENSING AND AREAS OF APPLICATIONS	**RSG 304**	**Gr. A**	Advanced Remote Sensing Techniques	20	4	2 hours
			Gr. B	Application of Geo-Informatics	20		
				Internal Assessment	10		
PRACTICAL		**RSG 305**		Application of Geo-Informatics and Spatial Decision Support System	25	2	4 hours
		RSG 306		Generation of Case Studies (Compulsory Field study)	25	2	4 hours
		RSG 307		Geostatistics	25	2	4 hours
		RSG 308		*Elective Special paper*	25	2	4 hours

STRUCTURE OF THE SYLLABUS (SEM-IV)

Type	Name of Paper	Paper /Module No.		Subject	Marks	Credit	Exam Time
THEORETICAL	DISSERTATION	RSG 401	Gr. A	Dissertation (Examination)	100	8	
			Gr. B	Dissertation (Viva)	100	8	
		RSG 402		Grand Viva	100	8	

The students have to select any one of the following subjects, likely to be offered as elective special papers:

1. Geoinformatics in Coastal Management
2. Geoinformatics in Watershed Management
3. Geoinformatics in Earth Sciences
4. Geoinformatics in Disaster Management
5. Geoinformatics in soil and Agriculture
6. Geoinformatics in Urban, Rural Development & Regional Planning
7. Geoinformatics in Environmental Science & Management
8. Geoinformatics in Resource Management
9. Geoinformatics in Transport Network Analysis
10. Geoinformatics in Utility Management

Important Note:

- **Total intake capacity of the Department (SEM-I) every year is 45 candidates at present.**
- **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.**
- **Internal assessment will be based on class attendance and class performance.**
- **Field work is compulsory for Students of semester - III**
- **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: (*Examination Time: 2 hours)*

FUNDAMENTALS OF REMOTE SENSING (50marks)

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

RSG-101

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 35

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-Boltzman 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
vi. Remote Sensing Scenario in Indian Context

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 35

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. Semisynchronous 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 (10)

RSG-102: (*Examination Time: 2 hours)*

FUNDAMENTALS OF GIS & DIGITAL CARTOGRAPHY (50 marks)

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

RSG-102

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30

Fundamentals of Geographic Information System:

i. *Basic Concepts*: definition of GIS, Components of GIS, Variables - points, lines, polygon, Functionality of GIS, Areas of GIS application, Advantage and Limitation of GIS
ii. *GIS Data:* Spatial and Attribute Data, Information Organization and Data Structures - Raster and Vector data structures, Data file and database
iii. *Creating GIS Database*: GIS Softwares, file organization and formats, Geo-database, Rectification, Digitization and Map Composition
iv. *GIS Data Input:* Nature and Source of data, Method of spatial data capture - Primary and Secondary, Attribute data capture digitization and scanning method, Techniques and procedure for digitizing, Errors of Digitization
v. *Data Editing:* Detecting and correcting errors, Re-projection, Transformation and Generalization, Edge matching and Rubber sheeting, Topology, Conversion from Other Digital Sources

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30

Digital Cartography:

i. *GIS and Digital Cartography*: Concept of Digital Cartography, Advantages and Disadvantages of Digital Cartography
ii. *Concept of Map Scales:* Defining Map, Projection Systems, Categories of maps, Map Scales
iii. *Measurement of Geographic Variables:* Nominal, Ordinal, Interval and Ratio Scales
iv. *Types of data*: Qualitative vs. Quantitative data, Discrete vs. Continuous data
v. *Digital Mapping:* Cartographic Design Issues, Concept of Visual Variables, Map Lettering, Map Compilation, Generalization
vi. Map Composition and Production, Multivariate and Dynamic Mapping

Internal Assessment (10)

RSG-103: (*Examination Time: 2 hours)*

PHOTOGRAMMETRY, SURVEYING AND GPS: (50marks)

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

RSG-103

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30

Photogrammetry:

i. *Introduction:* Historical Development and Fundamentals of aerial photography, Vertical and Oblique aerial photography, Classification of Aerial Film Cameras, Digital cameras Components of aerial Cameras, Camera Calibration, Photogrammetric Applications and Products

ii. Scale, Geometry and Ground Coverage of Aerial Photographs, Area calculation & Flight Planning.

iii. Binocular and Stereoscopic vision, Conditions for Stereovision, Photographic overlap Image Parallax, Height determination from stereo pairs - Parallax Equation, Ground Control.

iv. Co-ordinate Systems used in Photogrammetry, Relief distortion and Tilt distortions, Rectification, Ortho Rectification, Height determination from single photograph, Planimetric map compilation, Digital Elevation Model (DEM), Digital orthophotos.

v. *Principles of digital photogrammetry*: Hardware & software requirements, Image measurement, Orientation procedure, Epipolar geometry, Aerotriangulation, Block adjustment, Mosaics of DTM & ortho images.

Group B

Full Marks: 20 Number of lectures to be delivered for each module is 30.

Surveying and Global Positioning System:

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

ii. *Introduction to conventional field survey techniques:* Plane and Geodetic Surveying (Traversing, Triangulation and Levelling), Topographic, Cadastral, Engineering and Hydrographic surveys.

iii. *Surveying Instruments:* Principles of using Plane Table, Principles of Prismatic Compass, Theodolite traversing, Utility of Total Station

iv. *Global Positioning System:* Introduction, Satellite constellation, GPS signals and data, Geopositioning-Basic Concepts. 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-Static & Rapid Static, Kinematic-Real Time Kinematic Survey- DGPS-GPS Data Processing and Accuracy, Factors Affecting GPS Accuracy

vi. *Reference Station:* Selection of Reference Station, Reference Station Equipment: GPS receiver, GPS antenna. Radio and its types, Radio Antenna

vii. *Mobile Mapping and GPS Applications:* Mobile Mapping basic concepts and Applications , GPS Application in Surveying and Mapping

Internal Assessment (10)

RSG-104: (*Examination Time: 2 hours)*

COMPUTER FUNDAMENTALS AND PROGRAMMING (50marks)

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

RSG-104

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30

Computer Basics:

i. Introduction to Computers, Data representation, Conversion of data. Memory organization, Different secondary storage devices and Magnetic media devices.

ii. *Data Representation*: Representation of Characters in Computers, Representation of Integers, Representation of Fractions, Hexadecimal Representation of Numbers, Decimal to Binary Conversion, Error Detecting Codes.

iii. *Information Technology and Operating System:* Information Technology Infrastructure Hardware, software and Data related issues, Systems Application software, Enterprise software, Operating System Concepts, Structures, Files, Directories, Process and Memory management

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Programming Language:

i. *Introduction to Programming:* Basic concepts, program constructions – flowcharts, algorithms, pseudo codes, data structures – stacks, queues, linked lists etc., approaches to programming – top-down, bottom-up approach, divide & conquer, modular programming

ii. *C programming:* Preliminaries, Constants & Variables, Arithmetic Expressions, Input-Output statements, Control Statements, Do-Statements, C-Preprocessor, Do-While statement, if-else statement, Array, Pointer. Elementary Format Specifications, Logical Statements & Decision Tables, Function & Subroutines

iii. *Data Arrangement and access:* Basic of Data Arrangement and access, file Environment, Relational database system, DBMS (Oracle), Data Flow Diagrams Logical Data model, Data Warehouses, Meta Data and Global Databases, Spatial Databases available for natural resources and Terrain.

Internal Assessment (10)

SEM -I PRACTICAL

RSG-105 (Practical)
IMAGE 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.

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 equipments -Radiometer, Spectrophotometer, Use of spectrometer for ground truth.

ii. Determination of orbital period of a satellite, its velocity and distance from the earth's centre.

(20)

Practical Notebook and Viva Voce (5)

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	

RSG-106 (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.

Topic to be covered	
Visualization Tools Blend, Swipe, Flicker, Conversion: Raster ↔ Vector ↔ ASCII and others	**Available Software's**
Managing Geo-database, Geo-referencing & Changing Projection	
Digitization: Point, Line, Polygon	
Managing attribute table and thematic mapping	
Map composition and representation	

(20)

Practical Notebook and Viva Voce (5)

RSG-107 (Practical)
PHOTOGRAMMETRY AND SURVEYING (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.

i. Scale measurement of aerial photographs, Distance and area measurement of themes, Aerial-photo Interpretation for Terrain Evaluation and thematic mapping, Object height measurements by Parallax bar, Aerial photo mosaicking, Stereo plotting with photogrammetric Instruments, Aerial triangulation and photo control.

ii. Ortho rectification of Air photos [orthobase] Stereo analysis & Anaglyph generation (10)

iii. Calculation of distance & area on plane surface, spherical surface and ellipsoidal surface. Coordinate transformation.

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

v. Plane table survey for cadastral and large scale Mapping, Theodolite traverse and triangulation, Spirit Leveling, use of Dumpy level, Prismatic Compass, and preparation of a road map (10)

Practical Notebook and Viva Voce (5)

RSG-108 (Practical)

COMPUTER FUNDAMENTALS & PROGRAMMING (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.

i. Operating System: Windows XP, MSDOS Commands, Windows 7

ii. Office Application: Microsoft PowerPoint

iii. Web Designing: CSS tags and JAVA script

iv. Image Management: Scanning, Image format, Export and Import

v. C Programming Language: Basics, Statements, Loop, Array, String, Pointer

vi. DBMS: Database Generation, Database Management, Quarry in Oracle (20)

Practical Notebook and Viva Voce (5)

SEM II PAPERS

SEM -II THEORY

RSG-201: (*Examination Time: 2 hours)*

DIGITAL IMAGE PROCESSING & INFORMATION EXTRACTION (50marks)

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

RSG-201

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30

Digital Image Processing:

i. *Introduction:* Definition of digital image, Source of Data, Data Formats, Hardware and Software Consideration for Digital Image Processing, 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

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

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

vi. *Accuracy Assessment:* Reference Data, Sampling techniques, Error of Commission and Omission, Error Matrix, Kappa Statistics and Change Detection Analysis

Internal Assessment (10)

RSG-202: (*Examination Time: 2 hours)*

ADVANCED REMOTE SENSING (50marks)

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

RSG-202

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

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, Radar Operation, Polarization, Spatial Resolution, Radar Image Geometry, Relief Displacement, Shadows and Speckle effect, Side Looking Radar System (SLAR) Operation, Synthetic Aperture Radar (SAR), Radar Interferometry

iv. *RADAR Environmental Considerations:* Surface Roughness Characteristics, Electrical Characteristics, Vegetation and Water response to Microwave energy

v. Microwave Remote Sensing and its advantages, Active and Passive Microwave Systems, Attenuation of Microwave, Surface Scattering, Volume Scattering, Types of Antenna, Platforms and sensors, Applications

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Hyperspectral Remote Sensing and Lidar:

i. *Hyperspectral Remote Sensing:* Basic principles of Spectroscopy, Advantages, Hyperspectral sensors and platforms, Sensor specifications

ii. *Hyperspectral Data Processing:* Atmospheric Corrections, Bad band and bad line removal

iii. *Information extraction:* Endmember collection, Minimum Noise Fraction, Pixel Purity Index, N-D visualize, ground truthing through Spectro-radiometer, Image Classification techniques

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

v. *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, LIDAR types based on Platforms

vi. *LIDAR Applications:* LIDAR derived Vegetation and Urban Information, Applications in Vegetation, Urban and Coastal mapping

Internal Assessment (10)

RSG-203: (*Examination Time: 2 hours)*

ADVANCED GEOGRAPHIC INFORMATION SYSTEM (50marks)

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

RSG-203

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30

GIS Data Analysis:

i. *Data Storage:* Spaghetti Model, Topological Model, Quadtree
ii. *Database Modelling:* Hierarchical Model, Network Model, Relational Model
iii. *Spatial Database Management:* Concept of Spatial Database, Database Management System, Basic Concepts of Entity, Relationship and Primary Key, Database Structure
iv. *Data Organization:* Chain Coding, Run-length Coding, Block Coding
v. *Spatial Analysis:* Types of Spatial Analysis, Measurement in GIS, Query – Query by Attributes, Spatial Queries, Attribute Based Operation, Neighbourhood Analysis, Connectivity Analysis, Overlay and Coverage Rebuilding
vi. *Data Quality in GIS:* Uncertainty in GIS data, Positional and Attribute Accuracy
vii. *Web GIS, Mobile GIS*

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Geodesy:

i. The Planet Earth, Geoids, Concept of Spherical Geometry and Geodesy, Reference Spheroid and Mean Sea Level
ii. Introduction to different spheroid / ellipsoid systems with special reference to Everest and WGS-84 - Geometric Constants, Indian Geodetic Datum; Rectangular and Geographical Co-ordinate System - Conversion of latitudes and longitudes to linear distances, Co-ordinate Transformations, Geoidal parameters and their relationship.
iii. Dimensions of some well-known Spheroids, Definition and Determination of Geoid Undulation, Coordinate System used in Geodesy, Coordinate System used by Survey of India (φ, λ, H), Redefinition of Horizontal and Vertical Datum in India, Indian Mean Sea Level Datum;
iv. Satellite Geodesy: Early satellites, Interferometry, Doppler, Point Positioning, Translocation, Observational systems, New Satellite gravity missions,
v. Modern Views on determination of figure of the Earth: Gravimetric Methods, Astrogeodetic methods.

Internal Assessment (10)

RSG-204: (*Examination Time: 2 hours)*

CBCS- I: FUNDAMENTALS OF GEOSPATIAL TECHNOLOGY (50marks)

Full Marks: 50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B

RSG-204

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Fundamentals of Remote Sensing & Photogrammetry:

i. *Concept and Scope of Remote Sensing:* Definitions, Process and Characteristics of Remote Sensing System, Advantages and limitations. *Concept of Electromagnetic Radiation (EMR):*
ii. Sensor System - Framing and Scanning System, Whiskbroom scanners, Push-broom scanners, Platforms and Sensors, Concept of False Colour Composites. Orbits and Orbital Characteristics
iii. Fundamentals of aerial photography, Vertical and Oblique aerial photography, Classification of Aerial Cameras, Applications and Products, Scale, Geometry and Ground Coverage of Aerial Photographs, Area calculation & Flight Planning.
iv. Binocular and Stereoscopic vision, Parallax Equation, Relief distortion, Ortho Rectification, Height determination from single photograph,
v. Principles of digital photogrammetry

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Fundamentals of Geographic Information System & Global Positioning System:

i. *Basic Concepts*: definition and Components of GIS, application, Advantage and Limitation of GIS
ii. *GIS Data:* Spatial and Attribute Data, Raster and Vector data structures
iii. *Creating GIS Database*: Geo-database, Rectification, Digitization and Map Composition, *GIS Data Input,* Topology
iv. *Global Navigational Satellite System:* Introduction, Satellite constellation, GPS signals and data, Basic Concepts of NAVSTAR, GLONASS, IRNSS)
v. *Applications:* Mobile Mapping basic concepts and Applications, GPS Application in Surveying and Mapping.

Internal Assessment (10)

RSG-205 (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-206 (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	**Available Software's**
Atmospheric Correction, Image enhancement and filtering of multispectral optical data	
Radiometric correction, Bad band and bad line removal of hyperspectral data	
Image classification (Unsupervised, Supervised and advanced)	
Accuracy assessment, Class separability & contingency Matrix	
Stereo-SAR DEM generation, Rader image interpretation: Speckle suppression, Texture analysis, Texture & Object based classification.	

(20)

Practical Notebook and Viva-Voce (5)

RSG-207 (Practical)
ADVANCE GIS (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**
Vector Editing, Data base creation, Managing Attribute Table, Thematic Maps	
Charts and Diagrams generation Select and Query in vector layers, Use of SQL, GIS based models.	
Network, Neighbourhood, Buffer, Proximity [thiessen polygon], Overlay, Intersection, &Union	
Topographic & Morphometric analysis: TIN, DEM, Contour & Isopleth generation.	

(20)

Practical Notebook and Viva Voce (5)

RSG-208 (Practical)
GEODESY and GPS (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. Geodesy (10)

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 pro software and Export functions, GPS and GIS integrations output preparation

(10)

Practical Notebook and Viva-Voce (5)

SEM III PAPERS

SEM -III THEORY

RSG-301: (*Examination Time: 2 hours)*

APPLICATION OF GEO-INFORMATICS AND SPATIAL DATABASE MANAGEMENT (50marks)

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

RSG-301

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Application of Geo-Informatics:

i. *Introduction:* Emergence of Geoinformatics technology in different application areas, Indian satellite missions with focused applications
ii. *Areas of Applications:* Application in Disaster Management, Water, Soil, Urban Planning, Landuse/ Landcover, Environmental Management
iii. Remote Sensing in Water resource evaluation and Watershed Management, Runoff & Soil Loss estimation based on empirical models, Remote Sensing in hydro-geomorphological studies for ground water targeting.
iv. Geo-technical Engineering & Environmental Management, Digital terrain models for selection of dam site, road, and canal construction.
v. GPS in plate tectonic studies in Himalayas, Predicting seismicity in peninsular region through lineament studies, Study of hydro-geomorphology in West Bengal

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Spatial Decision Support System:

i. *GIS and Decision Support Systems*: Concept and characteristics of Decision Support Systems (DSS), Spatial Decision Support Systems (SDSS) and GIS
ii. *Multicriteria Decision Analysis(MCDA):*Elements and Structure of MCDA, Multiobjective and Multiattribute analysis
iii. *Spatial Multicriteria Decision Analysis (SMDA):* Framework of SMDA, Evaluation Criteria and GIS, Decision Alternatives and Constraints
iv. *Criterion Weighting and Decision Rules:* Estimation of Weights- Ranking, Rating, Pairwise Comparison and Trade-off analysis method; Decision Rules-Simple Additive Weighting method
v. Analytic Hierarchy Process

Internal Assessment (10)

RSG-302: (*Examination Time: 2 hours)*

RESEARCH METHODOLOGY, PROJECT MANAGEMENT & GEOSTATISTICS (50marks)

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

RSG-302

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Fundamental of Research and 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

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Geostatistics

i. Mean centre of population & settlement and their temporal shift, Neighbourhood Analysis, Z-Score
ii. Scatter Diagram, Bi-variate & Multiple correlation, Linear regression & Residual mapping
iii. Standard Error of Estimate, Significance Test, RMSE.
iv. *Surface Modelling*: Spatial autocorrelation, Variogram and its use for Interpolation
v. Role of Interpolation, Methods of Interpolation – Global and Local Deterministic Methods, Moving Averages, Inverse Distance Interpolation, Optimal Interpolation using Geostatistics
vi. Interpolation by Kriging – different types of Kriging

Internal Assessment (10)

RSG-303: (*EXAMINATION TIME: 2 HOURS)*

ELECTIVE SPECIAL PAPER THEORY: (Any One)

1. Geoinformatics in Coastal Management
2. Geoinformatics in Watershed Management
3. Geo-informatics in Earth Sciences
4. Geo-informatics in Disaster Management
5. Geoinformatics in Soil and Agriculture
6. Geoinformatics in Urban, Rural Development & Regional Planning
7. Geoinformatics in Environmental Science & Management
8. Geoinformatics in Resource Management
9. Geoinformatics in Transport Management
10. Geoinformatics in Utility Management

Option-1 GEOINFORMATICS IN COASTAL MANAGEMENT

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Theoretical Considerations

i. Coastal morphodynamics: 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.

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Potential Application areas of RS /GIS

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 (10)

Option-2 GEOINFORMATICS IN WATERSHED MANAGEMENT

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Water Resources and 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.

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

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 (10)

Option-3 GEOINFORMATICS IN EARTH SCIENCES

Full Marks50. Number of lectures to be delivered for this paper is 70. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 35.

Fundamentals of Earth System:

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.

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 35.

Application of Geo-informatics in Earth 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, mineral targeting. Rock Information System. GIS based multivariate analysis in mineral targeting.
iv. *Case Studies:* GPS in plate tectonic studies in Himalayas, Predicting seismicity in peninsular region through lineament studies, Study of hydro-geomorphology in West Bengal

Internal Assessment (10)

Option-4 GEOINFORMATICS IN DISASTER MANAGEMENT

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

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.

Group B

Full Marks: 20. 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 (10)

Option-5 GEOINFORMATICS IN SOIL AND AGRICULTURE

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

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

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

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 (10)

Option-6 GEOINFORMATICS IN URBAN, RURAL DEVELOPMENT & REGIONAL PLANNING

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

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.

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Potential Application areas of RS / GIS:

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 (10)

Option-7 GEOINFORMATICS IN ENVIRONMENTAL SCIENCE & MANAGEMENT

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Theoretical Considerations:

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

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Application of Remote Sensing and GIS:

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 (10)

Option-8 GEOINFORMATICS IN RESOURCE MANAGEMENT

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to

have at least two parts in Group A & Group B.

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Concepts in Resources:

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,

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

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. Geoinformtics Models in Resource Management: Forest Fire Modeling, Wild Life Habitat Assessment Modeling, Soil Erosion Modeling, Land Resources Development Prioritization Modeling.

Internal Assessment (10)

Option-9 GEOINFORMATICS IN TRANSPORT NETWORK ANALYSIS

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Concepts in Transportation:

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

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

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 (10)

Option-10 GEOINFORMATICS IN UTILITY MANAGEMENT

Full Marks50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B.

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Concepts of 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 GISElectricity, Gas, Water supply, Sewerage system

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

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 (10)

RSG-304: (*EXAMINATION TIME: 2 HOURS)*

CBCS- II: ADVANCED REMOTE SENSING AND AREAS OF APPLICATIONS (50 Marks)

Full Marks: 50. Number of lectures to be delivered for this paper is 60. Pattern of setting questions: Four questions of 10 marks (Group A) and four questions of 10 marks (Group B) are to be set. Two questions of 10 marks and two questions of 10 marks from each of the module are to be answered. Each question is to have at least two parts in Group A & Group B

RSG-304

Group A

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Advanced Remote Sensing Techniques

i. *Introduction:* Definition of digital image, Source of Data, Data Formats, Ground Truthing: Ground Truth Collection for Image Classification, *Image Classification techniques,* Spectral Signature

ii. *Thermal Remote Sensing:* Basic Principles and Applications

iii. *Microwave Remote Sensing:* Basic Principles, Radar Operation, Polarization, Spatial Resolution, Radar Image Geometry, Relief Displacement, Shadows and Speckle effect, Side Looking Radar System (SLAR) Operation, Synthetic Aperture Radar (SAR), Radar Interferometry; *RADAR Environmental Considerations:*

iv. *Hyperspectral Remote Sensing:* Hyperspectral sensors and platforms, Sensor specifications; *Hyperspectral Data Processing:* Geometric and Atmospheric Corrections, End member Collection, Image Classification, Spectro-radiometer; LIDAR.

Group B

Full Marks: 20. Number of lectures to be delivered for each module is 30.

Application of Geo-Informatics:

i. *The Earth System:* Concept of Earth System, lithosphere, biosphere, hydrosphere & atmosphere, Relationships in seismic wave, earthquakes and volcanic activity. Rock types and rock Structures

ii. *Geomorphology:* Fundamental concepts, geomorphic agents and processes, drainage patterns, classification of landforms

iii. *Visual/ Digital Satellite Image Interpretation:* Elements of image interpretation, Digital image enhancement techniques for different environmental modelling

iv. *Areas of Applications:* Application in Disaster Management, Water, Soil, Urban Planning, Landuse/ Landcover, Environmental Management, Remote Sensing in Watershed Management, ground water targeting, Runoff & Soil Loss estimation based on empirical models, Remote Sensing in different hydrological modelling.

SEM -III PRACTICAL

RSG-305 (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. Application of Geo-informatics in Environmental issues, Measurement of Canopy Cover through Leaf Area Index (LAI) Meter
ii. Morphometric analysis of terrain, satellite image based hydro-geomorphological interpretation for ground water targeting.
iii. Runoff & Soil Loss estimation based on empirical models.
iv. Digital terrain models for selection of dam site, road, and canal construction, Cut & Fill analysis using DEM
v. Application of Spatial Decision Support System in site suitability analysis

(20)

Practical Notebook Viva-voce (5)

RSG-306 (Practical)

GENERATION OF CASE STUDIES (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-307 (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.

i. Introduction of Statistical Software: Time series, Charts, Scatter plot with regression line, Bi-variate and Multiple Correlation, Significance test
ii. Mean Centre of Population, Z-Score
iii. Principal Component analysis
iv. IDW and Krigging through GIS softwares
v. Extraction of image statistics

(20)

Practical Notebook and Viva-Voce **(5)**

RSG-308 (Practical)
ELECTIVE SPECIAL PAPER THEORY: (Any One)

1. Geoinformatics in Coastal Management
2. Geoinformatics in Watershed Management
3. Geo-informatics in Earth Sciences
4. Geo-informatics in Disaster Management
5. Geoinformatics in Soil and Agriculture
6. Geoinformatics in Urban, Rural Development & Regional Planning
7. Geoinformatics in Environmental Science & Management
8. Geoinformatics in Resource Management
9. Geoinformatics in Transport Management
10. Geoinformatics in Utility Management

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
M.Sc. RESEARCH DISSERTATION (200marks)

RSG-401 (GROUP A & B)
GROUP A (*Dissertation Examination 100)* + GROUP B (*Dissertation Viva-Voce 100)*

- 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
- 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-402
GRAND VIVA (100marks)

Grand viva will be based on the overall understanding of the subject in front of external and internal examiner

LIST OF REFRENCES:

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., Hyderabad, India
3. Lillesand, T.M. and Kieffer, R.W., 2003. Remote Sensing and Image Interpretation, 5th Edition., Wiley, New York
4. 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,5th ed, Macmillan, New York,1992
2. Barrett,E.C., and L.F.Curtis, Introduction to environmental remote sensing, 3rd ed, 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 & Ferojan Ormeling, 2003, Cartography – Visualisation of Geospatial data, 2nd Edn, , 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 Vidyarthi Griha Prakashan, 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 Basudeb Bhatta, 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 Guochang Xu, 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, Janan S.Bethel & Chris Mc Glone, 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 & Ferojan Ormeling, 2003, Cartography – Visualisation of Geospatial data, 2nd Edn, , 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. 1.991 : 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. Evangelos Petroutsos "Mastering Visual Basic 6.0" , BPB Publications, Edition 1998
3. Mohmmed Azam " 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. Yashwant Kanetkar, "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. and Pottier, 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. Lerinsons Aronoft.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. 1.991 : 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.and Simonent,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. Ghassem Asrar, 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.Donald A 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.