

**VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM**  
**SCHEME OF TEACHING AND EXAMINATION**  
**M.TECH--GEO-INFORMATICS**

II SEMESTER

CREDIT BASED

Subject Code	Name of the Subject	No. of Hrs/week		Duration of Exam in Hours	Marks for		Total Marks	Credits
		Lecture	Practical / Field Work		I.A.	Exam		
14CGI21	Fundamentals of Cartography, Geodesy and Global Positioning System	4	2	3	50	100	150	4
14CGI22	Web Applications in Geoinformatics	4	2	3	50	100	150	4
14CGI23	Satellite Data Image Processing	4	2	3	50	100	150	4
14CGI24	Application of Geoinformatics in Natural Resources and Environmental Management	4	2	3	50	100	150	4
14CGI25x	Elective-II	4	2	3	50	100	150	4
14CGI26	Lab Component		3	3	25	50	75	2
14CGI27	Seminar	--	3	--	25	--	25	1
	** Project Phase-I	--	--	--	--	--	--	--
<b>Total</b>		<b>20</b>	<b>16</b>	<b>18</b>	<b>300</b>	<b>550</b>	<b>850</b>	<b>23</b>

<b>ELECTIVE – II</b>	
14CGI251	Application of Geoinformatics in Urban Planning and Management.
14CGI252	Application of Geoinformatics in Ocean, Marine and Coastal Resource Management

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**Between the II Semester and III Semester after availing a vacation of 2 weeks.**

## **II SEMESTER**

### **FUNDAMENTALS OF CARTOGRAPHY, GEODESY AND GLOBAL POSITIONING SYSTEMS**

Subject Code: **14 CGI -21**  
No. of Lecture Hrs/ Week: 04  
Total no. of Lecture Hrs: 52

IA Marks: 50  
Exams Hrs: 03  
Exam Marks: 100

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## **Objective**

Upon completion of this subject students should have gained the knowledge of Cartography, Geodesy, and Global Positioning System and also they become familiar with the basic principles and their applications in Geoinformatics Projects.

## **Cartography**

**Introduction to Cartography:** Definitions, terms, concepts, types, history, applications, conventional cartography v/s digital cartography, cartographic process, cartographic products, cartographic materials, overview of cartography.

**Introduction to Map:** Types of map, map scale, classes of maps, map composition, the mapping process, map projection, Map Numbering Systems; Base Maps & Thematic Maps; Map Legend, Symbols & Border Information; Design & Layout of Maps, geographic content of the map, label placement.

**Digital Cartography:** Cartography in context of GIS, Principles of cartographic design in GIS, cartographic generalization, atlases and electronic atlases, hypermaps and digital spatial libraries.

## **Geodesy**

**Introduction to Geodesy: Definitions,** terms, types, history, fundamental goals of geodesy; shape and size of the earth, applications, overview.

**Projections and Co-ordinate Systems:** Classification of map projections, Datum surfaces and Coordinate system, Transformations, Introduction to Azimuthal, Conical and Cylindrical projections with emphasis on LCC, Polyconic and UTM.

**Geometric Geodesy:** Earth, geoid and reference Ellipsoid, Everest Spheroid, WGS 84, Vertical datum, Mean Sea Level, geometry of ellipsoid, level surfaces, plumb line and deflection of the vertical, coordinate system in geodesy.

**Satellite Geodesy:** Introduction – Normal orbits, Equation of motion and laws of Kepler, geometry of elliptic orbit, line orbit in space, perturbed orbit, Lagrange and Gaussian Planetary equations, Gravitational perturbation, Doppler surveying

## **GPS**

**Introduction to GPS:** Definition, concept, GPS working principle, history and timeline, overview.

**Technical Description and GPS Observables:** System Segmentation – Space segment; control segment, user segment- types of receivers ; GPS satellite signals, GPS data, position and time from GPS, code phase tracking, pseudorange navigation, receiver position, time and velocity, carrier phase tracking, GPS positioning types – absolute positioning, differential positioning; Navigation signals -GPS frequencies; Calculating positions using C/A code using P(Y) code, code phase v/s carrier phase, augmented GPS, local augmentation; Accuracy and error sources – atmospheric effects, multipath effects, ephemeris and clock errors; selective availability, relativity, sagnac distortion. Factors that affect GPS - number of satellites, multipath, ionosphere, troposphere, satellite geometry, satellite health, signal strength, distance from the reference receiver, RF interference, loss of radio transmission; GPS interference and jamming – natural sources, artificial sources; Techniques to improve accuracy- augmentation, precise monitoring, GPS time and data, GPS modernization.

**DGPS –** History, need for DGPS, concepts and principles, differential corrections, accuracy in DGPS, local area DGPS, wide area DGPS, carrier phase DGPS, pseudolites, LAAS, WAAS; rapid methods with GPS – rapid static method, semikinematic method, kinematic method. Real time DGPS.

**Planning and Realization of GPS Observations:** Setting up an observation plan; practical aspects in field Observations; observation strategies & network design; Ground control for geometric correction of satellite imagery using DGPS. Ground control points, types, density, planning, reconnaissance survey, field observations, Criteria for Selecting reference station, reference station equipments, operational procedures, post processing, Georeferencing.

**Applications:** military – airborne, marine and land based navigation, and civilian –surveying and mapping, control surveys, cadastral surveying, navigation, RS, GIS and photogrammetry, geodesy, location, navigation, tracking, mapping and timing, Engineering and Monitoring; Special applications of GPS, etc., GPS Technique and project cost.

**REFERENCE BOOKS:**

1. **Satellite Geodesy:** Gunter Seebar,
2. **GPS satellite surveying:** Alfred leick
3. Essentials of GPS, N K Agrawal

**WEB APPLICATIONS IN GEOINFORMATICS**

Subject Code: <b>14 CGI -22</b>	IA Marks: 50
No. of Lecture Hrs/ Week: 04	Exams Hrs: 03
Total no. of Lecture Hrs: 52	Exam Marks: 100

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**Objectives:**

On completion of study of this subject, students would have a sound knowledge about the Web GIS and its Applications for serving the geospatial data to the clients. One would be able to web design utilizing web GIS softwares.

**Introduction to Web GIS:** Definition, concept of Web GIS, History of web GIS, components of web GIS, internet, web GIS v/s Internet GIS, Fundamentals of computer networking – network environment – network communication models –protocols – TCP/IP. Applications of web GIS, users and stake holders of web GIS, advantages and limitations of web GIS, overview of Web GIS.

**Client/server Computing:** Client – server – glue – client/server system partition– layered architecture – advantages and disadvantages of client server architecture. Distributed component framework – web mapping – static and interactive web mapping – open GIS web map server.

**Distributed geographic information services:** Principle – components – logic and data components.

**Geographic Markup Language:** Principles – characteristics – commercial web mapping programs - mobile GIS. Distributed GIS in data warehousing and data sharing.

**Functions of Web GIS:** Display of general information for the public, display of planning information, interactive display of spatial information sharing and distribution of spatial data as well as management of spatial data.

**Design of User Graphic Interface** User friendly interface, characteristics, menus and icons, common terms. Graphic Appearance - colours, sizes, fonts, scales and arrangement.

**Web GIS Software.** Brands of software used to develop web GIS at the server and client sides. Evaluation of different brands, ArcIMS, Map Objects, Mapguide, Map Server, Geomedia web map, Fulcrum, Vectoreyes.

**Web GIS Data.** Classification of WEB GIS data, Geospatial data, type, characteristics, distribution, GIS interactive maps, - general maps at regional level, very detailed maps down to lot level. Level of Service

(LOS) Level of Contents (LOC) Level of GIS Functions or Level of Functions (LOF). A Cross Tabular Matrix (CTM) approach.

**Stake-holders**, users, owners and organizations of web GIS, policies and laws pertaining to web GIS, Watermarking Geo-Spatial Data.

**Applications of WEB GIS:** Participatory GIS -Web-based GIS For Collaborative Planning And Public Participation, Digital Democracy for planning, web GIS An Aid To Local Environmental Decision-making, web GIS for regional and local level planning. Community GIS, Internet GIS Applications in intelligent transportation systems, planning and resource management. E-Governance, Bhoomi project, Bangalore-1, Electronic Government Proposals.

#### REFERENCE BOOKS:

1. Zhong- Ren Peng, Ming-Hsiang Tsou, (2003) **Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks**, Wiley.
2. Korte, G. B., (2001)}”**The GIS book**”: 5th Edition, Onward press, Australia.
3. Cartwright, W., M.P. Peterson, G. Gartner (Eds) “**Multimedia Cartography**”, Berlme: Springer.
4. Kraak, M., and A. Brown (2001)” **Web Cartography: Development and Prospects, London**”: Taylor and Francies.
5. Kraak, M. and F. Ormeling (2003) “**Cartography: Visualization of Geospatial Data**”, Delhi: Pearson Education.

#### SATELLITE DATA IMAGE PROCESSING

Subject Code: **14 CGI -23**  
No. of Lecture Hrs/ Week: 04  
Total no. of Lecture Hrs: 52

IA Marks: 50  
Exams Hrs: 03  
Exam Marks: 100

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#### Objective:

The course aims at introducing the various processing techniques used to enhance, interpret images and extract information from images.

**Digital Data:** Introduction- Satellite data acquisition –Storage and retrieval – Data Formats – Compression – Satellite System – Data products – Image display system – Current Remote Sensing Systems.

**Sensor and Data Models:** Introduction- Sensor model –Resolution, spectral and spatial response.

**Image Rectification and Restoration:** Geometric correction- Radiometric correction – Noise removal

**Image Enhancement:** Contrast Manipulation –Gray-Level Thresholding- Level Slicing Contrast Stretching – Convolution – Edge Enhancement – Spatial feature manipulation –Fourier Analysis.

**Multi Image Manipulation:** Spectral Ratioing –Principal and Canonical Components– Vegetative Components – Intensity – Hue – Saturation – Colour Space Transformation.

**Rectifying a Camera Image:** Perform Image to Image Rectification – Check Map Models – Orthorectification- Area correlation –Resampling- Multiimage fusion- Spatial and spectral domain fusion.

**Computational Intelligence:** An overview of computational intelligence: various paradigms - Expert Systems, Artificial Neural Network, Fuzzy Logic, enetic Algorithms/Programming, History and development.

**Expert Systems:** An Overview of expert systems, Knowledge Representation, Symbolic Representation, Rule-Based Systems, Logic Programming, Knowledge Acquisition, Heuristic Classification, Tools for Building Expert Systems, Machine Learning, Hybrid Systems

**Genetic Algorithm and Programming:** Introduction and background to genetic algorithm, Darwinian principle, Genetic operators, Schema theorem, Fitness and scaling problems, Introduction to Genetic programming, Introduction to Automatically Defined Functions -- Regression example. Application of GP to pattern recognition problems.

**Information Extraction:** Principal -Component Analysis- Ratio Images- Multispectral Classification – Supervised Classification Stage- Minimum distance to means classifier, parallelepiped classifier, Gaussian maximum likelihood classifier – Training Stage: Graphical representation of the spectral response patterns, Quantitative expression of category separation, Self-classification of training set data, interactive preliminary classification, representative and subsene classification – unsupervised classification- Hybrid –Classification – Classification of Mixed Pixels.

**Output Stage:** Graphic Products – tabular data, Digital Information files – Post Classification Smoothing – Classification Accuracy Assessment. Classification error matrix, sampling consideration, evaluating classification error matrix.

**Data Merging and GIS Integration:** Multitemporal Data merging – Change detection procedures- Multisensor image merging – Merging of image data with Ancillary data- Incorporating GIS Data in automated land cover classification.

**Hyper-spectral Image Analysis and Radar image analysis:** Atmospheric correction – Hyper-spectral image analysis techniques.

**Image Analysis and Understanding:** Pattern recognition – Shape analysis- Textural and contextual analysis – Decision concepts – Fuzzy sets and evidential reasoning.

**Advanced Concepts:** Digital Terrain Modeling (DTM) – Stereo images – Artificial intelligence and expert systems – Artificial Neural Network concepts.

#### REFERENCE BOOKS:

1. John R Jenson ‘**Introducing Digital Image Processing**’ Prantice Hall. New Jersey 1986.
  2. R. A. Schowengerdt, ‘**Techniques for Image Processing and Classification in Remote Sensing**’; 1983
  3. Robert A Schowengerdt, ‘**Remote Sensing – Models and Methods for Image Processing**’ Academic Press 1997
- Hord R M, Academic Press, 1982.

### APPLICATIONS OF GEOINFORMATICS IN NATURAL RESOURCES AND ENVIRONMENTAL MANAGEMENT

Subject Code: **14 CGI -24**  
No. of Lecture Hrs/ Week: 04  
Total no. of Lecture Hrs: 52

IA Marks: 50  
Exams Hrs: 03  
Exam Marks: 100

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#### Objective

On completion of study of this subject the students would have a sound knowledge of application of remote sensing, GIS, GPS and other tools for understanding the concepts of natural resources management, changes in environment, monitoring the pollution affected areas and would be able to prepare suitable action plans for its sustainable development.

#### Land and Soil Applications:

Geomorphological Mapping: Mapping geological structures-folds, faults, joints and lineaments, Lithological mapping,

**Geological Resources Exploration:** Mineral resources exploration, Mineral mapping and Mineral Resources Information System; encroachment mapping, GIS in mine remediation and mine reclamation.

**Geo-Technical Studies:** Site suitability for dams, atomic power plants, solid waste disposal, roads, bridges, canals, river diversions.

**Geo-environmental Studies :** Earthquake prone area zonation, landslide prone area zonation Soil survey, soil classification, soil series establishment, profile studies, Land Use Land Cover Mapping, Natural Resources Census, Natural Resources Information System, National Natural Resources Management Systems, Wetland Mapping, Wasteland Mapping, Land Degradation Mapping, Desertification Mapping, Soil Conservation Measures, Soil Erosion Modeling, Land capability Maps, land/ soil irrigability Maps.

**Agro-ecosystem management:** Agro-climatic zonation, crop acreage estimation, crop inventory, crop production forecasting, CAPE and FASAL. Crop norm violation, RS basis for crop insurance claim. Satellite agro-meteorology; Thermal RS application for crop stress detection, & Microwave application in agriculture, Space inputs for precision agriculture, Precision farming in Indian scenario, Agro-climatic planning and information Bank (APIB), Site suitability studies for agricultural crops, horticultural crops. Horticulture, Sericulture- Inputs management- Cropping systems analysis.

**Sustainable Development:** Concept of sustainability, Integrated Mission for Sustainable Development, Watershed characterization, Action Plans for Sustainable development, watershed prioritization, developmental impact assessment. Land Resources Information System, Action plans for Sustainable Agriculture.

**Forest and Ecology Applications:** Mapping and inventorying of forest resources, Forest biomass estimation, carbon sequestration, mapping and monitoring of afforestation, deforestation, encroachment, forest depletion and degradation, forest fire mapping and monitoring, forest fire risk zonation, habitat studies, Biodiversity conservation planning, ecorestoration and ecodevelopment; deforestation / afforestation / encroachment mapping and monitoring, Forest Information System, Forest Management Plans, and Working Plans and conservation plans. Environmental Impact assessment of mining and Industrial activities., Microwave application in Forestry, Wildlife ecology applications- Habitat management- wildlife habitat selection, habitat fragmentation, protected areas, inputs for preparation of working plan/management plan. Forest land management- catchments area treatment plans, waste land development, forest plantations and its monitoring, joint forest management, forest resource information system.

**Surface Fresh Water Resources:** Surface water resources mapping and management; Integrated river basin management, Inter river basin connectivity mapping, river diversion studies, Site suitability for surface storages and hydro-electric power plants, Digital elevation models and their applications, storage yield analysis and reservoir sizing, Floodplain mapping and flood plain zoning, flood mitigation measures, flood water diversion for irrigation.

**Water Pollution Applications:** Mapping and inventorying of surface water bodies, siltation estimation and storage loss estimation, water quality index mapping, point source pollution mapping, non-point source pollution modeling, eutrophication and water vegetation mapping, methane production area mapping and modeling, Modeling of dams and reservoirs for estimation of damage to natural resources, oil slicks tracing and monitoring, sea turbidity and sedimentation mapping, coastal erosion mapping, coastal habitat degradation mapping, ground water contamination studies, Groundwater-pollution hazard assessment and protection planning, evaluation of groundwater vulnerability using GIS techniques; groundwater quality index mapping. RS and GIS technologies for sustainable groundwater management.

**Air and Atmospheric Pollution Applications:** Aerosol remote sensing, air quality indexing and mapping, dynamic air pollution modeling, mapping and measuring troposphere pollutants, environmental sensitivity index mapping; spread and dispersion of smoke plumes from industries and power plants, forest fires, oil wells, etc.

**Miscellaneous Applications:** RS and GIS Applications in noise pollution and light pollution monitoring. GIS modeling for bioterrorism, ecology of vectors of epidemics, mapping epidemic vulnerable zones.

**REFERENCE BOOKS:**

1. **Introduction to Environmental Remote Sensing** by Barrett E.C., Curtis, I.F., Chapman and Hall, New York, 1982
2. **Remote Sensing principles and Interpretations-** Sabins, F.F., (Ed) W.H. Freeman and Co., New York, 1986
3. **Remote sensing and Image interpretation** - Thomas M. Lillesand and Ralph W. Kiefer, John Wiley and Sons Inc., New York, 1994.

**APPLICATIONS OF GEOINFORMATICS IN URBAN PLANNING  
AND MANAGEMENT**

Subject Code: <b>14 CGI -251</b>	IA Marks: 50
No. of Lecture Hrs/ Week: 04	Exams Hrs: 03
Total no. of Lecture Hrs: 52	Exam Marks: 100

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**Objective:**

Upon completion of this subject the student would be able to understand the concepts and principles and use the tools and techniques of geo-informatics for efficient planning and management of Urban area.

**Large Scale Mapping and Cadastral Information System:** Technologies for Large Scale Mapping (LSM) of urban areas – Aerial Photography - High- Resolution Satellite Remote Sensing - Electronic Distance Measurement (EDM) -Total Station - Differential Global Positioning System (DGPS) – Issues in Large Scale Mapping – Selecting appropriate technologies and methodologies. Concept of Cadastre, History of cadastral survey, Cadastral survey methods and survey maintenance, cadastral map reproduction, development of cadastral information system.

**Urban Mapping and Spatial Analysis:** Urban process, the physical structure and composition of urban areas, Urbanisation process, growth trend, problems of urbanisation, information requirements for perspective planning, Scale and resolution concepts and interpretation techniques for urban and regional analysis, urban GIS, spatial analytical techniques, statistics and visualization, conceptual modelling of urban processes; Urban Sprawl: Change detection in Land Use Land Cover monitoring physical growth of urban area, trends in urban sprawl and associated problems.

**Urban Planning:** Plans – planning needs, types of plans, urban and regional planning; LU/LC mapping Urban Planning: Zoning of Land Use, Zonal Land Use Plan, Object oriented GIS data modeling for urban design, landscape architecture, urban infrastructure, Site selection for urban development, site suitability analysis for utilities and civic amenities, interim master plan, Master Plan.

**AM/FM Applications:** GIS/GPS applications in Automated mapping (AM) and Facility management (FM) - Water and sewage related- GIS based urban water demand analysis, pipeline planning and alignment, Electric and power supply related, fuel and food supply related, Telecom applications, Radio coverage Prediction, Signal Strength Mapping

**Demographic and Business Applications: Geo-demographics-**Population distribution maps by age, gender, education, occupation, socioeconomic grouping, health criteria index, crime rates and types.

**Business GIS-** Market analysis, retail site selection, retail planning, health care planning, financial services planning, educational institutions planning, water demand modeling and planning distribution network, household analysis, real estate inventory, mapping and GIS. Crime Analysis, Electoral Redistricting.

**Network Applications:** Transportation demand modeling and analysis, transportation planning, Vehicle Routing and Scheduling, Vehicle Tracking and Navigation: Integration of GPS and GIS data, intelligent transportation

systems, streets network analysis; pavement management system (PMS) Water and sewage related- GIS based urban water demand analysis, pipeline planning and alignment

**Urban Ecology Applications:** Air quality indexing and mapping, monitoring atmospheric haze, smoke, toxic gas movement and prediction of vulnerable zones. Noise pollution zonation, Natural resources inventory and management- conservation of water bodies, vegetation, storm water system GIS; soil and groundwater conservation, site suitability for ground water recharging and rain water harvesting, urban area heat budgeting, Logistic management and spatial planning for solid waste management.

**Urban Disaster and Emergencies Management:** Mapping vulnerable zones with respect to earth quake, flood, fire, terrorist attacks, and finding optimum routes for ambulances, and emergency services, GIS modeling for Hazard risk and emergencies management

**Cultural GIS:** Mapping heritage buildings, monuments, places of worship, tourism spots, recreation facilities, sports facilities and serving on web GIS.

**Urban Governance:** Governance of urban regions: mapping administrative boundaries, city base map generation, property enumeration and property GIS, tax revenue rationalisation, e-governance, Metropolitan Spatial Data Infrastructure, metropolitan information management system, Urban GIS.

#### **REFERENCE BOOKS:**

1. **Remote Sensing and Urban Analysis** Jean-Paul Donnay et al, GISDATA Series, 2001, Taylor and Francis Inc.
2. **GIS and GPS based asset management for Road and Railway Transportation Systems** - GPS based vehicle tracking system. [www.gisdevelopment.net](http://www.gisdevelopment.net) [www.esri.com](http://www.esri.com) [www.aboutgis.com](http://www.aboutgis.com)

### **APPLICATION OF GEOINFORMATICS IN OCEAN, MARINE AND COASTAL RESOURCES MANAGEMENT**

Subject Code: **14 CGI -252**  
No. of Lecture Hrs/ Week: 04  
Total no. of Lecture Hrs: 52

IA Marks: 50  
Exams Hrs: 03  
Exam Marks: 100

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#### **Objective:**

Upon completing the study of this subject the student would be able to use RS/GIS software and various modeling tools in integrated water resources management. They will have been exposed to geo-informatics applications to oceanography, glaciology, hydrometeorology, irrigation, watershed development, water pollution studies, sustainable use of water resources.

**Hydrological cycle :** Hydrology, processing and parameterisation in hydrology; water budgeting, water demand estimation, surface water bodies, water content in oceans, seas, ice, lakes, dams, tanks, rivers and ground. Water resource scenario in India and Karnataka, Hydrological modeling. RS and GIS applications in water resources development and management.

**Oceanographic Studies:** Remote sensing of oceans, ocean processes, ocean resources, satellites and sensors for ocean studies, spectral bands for study of ocean parameters, sea ice monitoring, Physical applications – Estimation of wind velocity & direction, sea surface temperature, upwelling, sea surface velocities, mixed layer depth, salinity, ocean colour, etc; Biological applications - Phytoplankton mapping, Ocean primary production, potential fishing zones, Suspended Sediment concentration mapping; monitoring seafloor morphological changes, Coastal

Bathymetry; Coastal Geomorphology, identification & monitoring of Coastal habitat (Mangrove, Coral reefs, wet lands etc); Integrated Coastal Zone Management, addressing coastal environmental issues. Marine Atlas Project;

**Coastal Engineering Applications:** Coastal Hydrodynamic – coastal erosion and protection – different Coastal protection works – design of Breakwaters – Hydrodynamics of pollution dispersion – Estuaries and their impact on coastal process – Modelling of suspend sediment.

**Coastal Zone Applications :** Introduction – Major issues/problem – wetland classification – thematic maps on coastal resources- site suitability analysis for aquaculture – Coastal Regulation zone – Coastal aquifer modeling using GIS- Integrated coastal Zone Management – conflict analysis – Resources association.

**Meteorology Applications:** Estimation of weather and climate parameters, and modeling aspects, global climatology. Rainfall mapping, hydrometrics and field measurement of water flows and water quality parameters, potential and actual Evapo-transpiration, Hydrometeorology: atmospheric watercontent, cloud mapping, rain forecasting, artificial rain, cyclone forecasting

#### REFERENCE BOOKS:

1. **Introduction to Environmental Remote Sensing** Barrett E.C., Curtis, I.F., Chapman and Hall, New York, 1982
2. **Remote Sensing principles and Interpretations** Sabins, F.F., (Ed) W.H. Freeman and Co., New York, 1986
3. **Remote sensing and Image interpretation** Thomas M. Lillesand and Ralph W. Kiefer, John Wiley and Sons Inc., New York, 1994.
4. **Coastal and Marine Geo-Information Systems: Applying the Technology to the Environment.** David R. Green, Stephen D. King, 2003.

### GEOINFORMATICS LABORATORY-II

Subject Code: <b>14 CGI -26</b>	IA Marks: 25
No. of Lab Hrs/ Week: 03	Exams Hrs: 03
Total no. of Lecture Hrs. 39	Exam Marks: 50

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#### Digital Image Processing

1. Atmospheric & Radiometric Correction of Satellite Images
2. Image Enhancement Techniques(Spatial, Spectral and Radiometric)
3. Classification Techniques – Unsupervised and Supervised Classification and Change Detection
4. Calculation of area and Accuracy Assessment

#### Geographic Information System

5. Editing Vector Layers
6. Spatial and Non spatial querying using open source and proprietary GIS packages
7. Spatial data quality evaluation
8. Overlay Analysis
9. Buffer Creation and Analysis
10. Network Analysis
11. DEM and TIN Creation

#### Global Positioning System

12. Familiarization with GPS Instrument and Software

13. GPS Survey of Natural and Man-made features
14. GPS & GIS data integration and output preparation

**Environmental Management Applications:**

15. Delineation of Lithological/geomorphic units
16. Identification of forest types and area estimation
17. Use of spectroradiometer and crop signature generation
18. NDVI and biomass relationship
19. Field visit and soil profile study
20. LU/LC Map Preparation
21. Delineation of Watershed
22. Familiarization with Bhutan and other Geoinformatics Portals

**REFERENCE BOOKS:**

1. **ERDAS Field Guide**, 4<sup>th</sup> Edition, 1997, ERDAS Inc, Georgia
2. **Using ArcCatalog**, Aleta Vienneau, 2001, ESRI
3. **ArcGIS 9 – Using ArcGIS Desktop**, 2006, ESRI
4. **ArcGIS 9- Getting Started with ArcGIS**, 2004, ESRI
5. **Building a Geodatabase**, Andrew McDonald, 2001, ESRI
6. **ArcGIS 9 – Geodatabase Workbook**, 2004, ESRI
7. **Introducing Geographic Information Systems with ArcGIS**, Michael Kennedy, 2006, John Wiley & Sons Inc, New Jersey
8. **Using ArcGIS Geostatistical Analyst**, Kevin Johnston, Jay M. Ver Hoef, Konstantin Krivoruchko and Neil Lucas, 2001, ESRI
9. **Using ArcGIS Spatial Analyst**, Jill Mc Coy and Kevin Johnson, 2001, ESRI
10. **ArcGIS 9 – Geoprocessing in ArcGIS**, 2004, ESRI