Course structure M.Sc. Geoinformatics(GI)

First Semester

Theory

Course No.	Course Title	Marks
GI -T1	Computers & Geoinformation Management.	**100**
GI -T2	Cartography & Geoinformation Visualization.	**100**
GI -T3	Fundamentals of Remote Sensing.	**100**
GI -T4	Fundamentals of GIS.	**100**

Seminar

GI – S1	Related to Theory Courses**.**	**50**

Practical

Course No.	Course Title	Marks
GI - P1	Digital Image Processing.	**100**
GI - P2	Geospatial Analysis.	**100**

Second Semester

Theory

Course No.	Course Title	Marks
GI -T5	Fundamentals of Microwave Remote Sensing.	**100**
GI -T6	Advance Image Processing.	**100**
GI -T7	Advanced Geoinformatics.	**100**
GI -T8	Field Survey, Geodesy and GPS.	**100**

Seminar

GI – S2	Related to Theory Courses.	**50**

Practical

Course No	Course Title	Marks
GI - P3	Advance Image Processing.	**100**
GI - P4	Geospatial Modeling.	**100**
GI - GT	Ground Truth/Field Training.	**100**

Third Semester

Theory

Course No.	Course Title	Marks
GI -T9	Database Management System.	**100**
GI -T10	Geospatial Statistics.	**100**
GI -T11	Advanced GIS Data Analysis and Modelling.	**100**
GI - D	Project Work.	

Practical

GI – P5	Advanced Geospatial Analysis and Modelling.	**100**

Fourth Semester

GI - D	Project Work	**400**
GI – SP	Special Paper i) Hydroinformatics. ii) Natural Resources Management. iii) Remote Sensing for Urban and Regional Planning. iv) Land Degradation Studies. v) Disaster, Risk and Hazard Management.	**200**

Total 2400

Distribution of Marks

Theory Examination: 80 marks
Internal Assessment: 20 marks
Project Report/Dissertation: 300 marks
Viva Voce & Presentation: 100 marks

Instructions for paper setters of M Sc. Geoinformatics

Paper setter is requested to follow the below mentioned instructions while setting the question papers.

1. The duration of examination of each theory paper is **two and half-hours** with **80** marks.

2. The question paper should comprise of three sections: **A**, **B** and **C.**

   Section **A** should comprise of **Very Short Answer** questions,
   Section **B** should comprise of **Short Answer** questions,
   Section **C** should comprise of **Long Answer** questions.

3. Student will have to attempt all question from Section **A** and **B** and only two questions from Section **C.**

4. Section **A** will have **8 questions** with **2 marks** for each question, covering all the four units in the paper. Students are expected to answer each question in **10-20 words**

5. Section **B** will have **4 questions** with **8 marks** for each question, covering all the units in the paper. Students are expected to answer each question in **200-250 words**

6. Section **C** will have **4 questions** with **16 marks** for each question, covering all the four units in the paper. Students are expected to answer each question in **400-500 words**

COURSE CONTENT FOR EACH PAPER

SEMESTER- I

THEORY

GI - T1 COMPUTERS AND GEO-INFORMATION MANAGEMENT

Course Goals

- Develop basic skills and understanding of the computer operations.
- Development of basic computer programming skills.
- Geo-information data handling and management.

UNIT: I Computer Basics:

Introduction, characteristics of computers, history of computers, classification of computers, hardware, software. Input/ output devices, secondary storage devices , types of software, flowcharts and algorithms with examples, translators, interpreters, compilers, assemblers and editors. Introduction to operating systems: DOS, WINDOWS, and UNIX. Introduction to number system.

UNIT: 11 Fundamentals of 'C':

'C' character set, Identifiers and key words, data types, constants, variables, operators, expressions, statements, symbolic constants, library functions.

Control statements: If statements, If - Else, Nested if statements, Loops: While Loops, Do-While Loops, For Loop, Switch-Case statements, Functions: Defining Functions, Accessing a Function, Passing Arguments to a Function. Arrays: Defining an Array, Processing an Array, Pointers: An introduction Data Files: Introduction, Basic Operations on files.

UNIT: 111 Geospatial Data Handling:

Ideal computer configuration for satellite data analysis and geospatial modeling, Role of computers in GIS and remote sensing data analysis, Meta data: introduction, importance, and standards. RS data types: Signed, unsigned, integer float, double, complex. Data compression techniques-their advantages and disadvantages. Data conversion in RS/GIS: necessity, advantage/disadvantage

UNIT: 1V Geo-information Management:

Data mining and warehousing, Networking and data sharing, Web-based GIS, Global datasets: Soils, vegetation, topography, hydrology. Importance of local and global datasets for environmental management. Expert systems, Decision support system (DSS):

Books suggested:

Computers in Geography, *Maguire. D. J: John* Wiley and sons, Inc., New York.

Basic Programming with Application, *Jain, V.K.*; Tata Mc Graw Hill.

Computer concepts and C programming; Vikas Publishing House.

A first course in computer. *Saxena S*. Vikas publishing House.
Elements of Data Compression. *Drozdek Adam*. Vikas publishing House.
Modern Database Management. *Mcfadden. R. .Fred Hoffer.A. Jaeffery*. Addision Wisley. Education Publishers, Inc.
Programming in ANSI C, *E. Balaguruswamy; Tata* McGraw Hill.
Current review and comparisons of different hardware and software published frequently, particularly for the DOS environment in magazines such as Byte and PC Magazine.

GI - T2 CARTOGRAPHY AND GEO-INFORMATION VISUALIZATION

Course Goals

- Expose students to the advanced techniques of digital cartography for visual exploration and presentation of the geo-information data.
- Develop map design, composition and editing skills
- Teach techniques for Integration of thematic, spatial and non-spatial data at various scales

Unit I: Map Making:

Maps: Introduction, types of maps, uses of maps. Cartography: analogue and digital cartography, cartographic generalizations. Map composition: map design and layout, map scale, legend, annotations. Coordinate systems, Geoid, shape of earth and datums, Map projections: introduction, properties and aspects of map projections, classification of map projections.

Unit II: Data Sources and Visualization:

Data sources for mapping: remote sensing, field observations, GPS, maps and other ancillary data. Use and users of geo-spatial data, Data products w.r.t land surface processes, disasters, EIA and geology. Visualization techniques: Visual exploration for different features/surfaces, virtual reality and scenario mapping.

Unit III: Statistical Data Analysis:

Measurement Scales: nominal, ordinal, interval, and ratio. Measures of central tendency: mean, median, mode, Measures of Dispersion: range, Variance, standard deviation, coefficient of variation, skewness, kurtosis. Regression and correlation analysis. Basic concepts of time series data analysis.

Unit IV: Data Presentation:

Geospatial data dissemination: maps, graphics, animations, multi-media, internet and posters. Quantitative representation of spatial and non-spatial data. Comparison between digital landscape and digital cartographic models. Misuse of maps: exaggerations and omissions. Map updating using GPS and Remote Sensing data. Assessing the accuracy of maps.

Books suggested:

Cartography: visualization of geospatial data, *M. J. Kraak & F.J. Ormeling*, Harlow, Essex: Longman.

Elements of Cartography. *Robinson, Arthur H., Joel L. Morrison, Phillip C. Muehrcke, A. Jon Kimerling, and Stephen C. Guptill*: John Wiley and Sons, New York.

Fundamentals of spatial information systems, *Laurini, R and Thompson, D.:* Academic Press London.

Geographic Information Systems and Science, *Longley, Paul A., M. F. Goodchild, D. J. Maguire, and D. W. Rhind:* John Wiley & Sons, New York.

Fundamentals of Geographic Information Systems, *Michael N. Demers:* John Wiley and Sons, Inc.

Planning Support Systems: Integrating Geographic Information Systems, Models, and Visualization Tools, *Richard K. Brail, and Richard E. Klosterman,* ESRI Press.

Fundamentals of Remote Sensing *Panda C.B*: Viva Books Private Ltd.

Concepts and techniques of Geographic Information System *: Lo C.P: Albert*.

Prentice Hall.

GI -T3 FUNDAMENTALS OF REMOTE SENSING

Course Goals

- Developing an understanding of the current state of knowledge in remote sensing
- To expose the students to the principles of electromagnetic radiation
- Interpretation of digital images, and how to effectively extract desirable information from images

UNIT I: Concepts and Overview of Remote Sensing:

Remote sensing: Definition, history and scope. Overview of remote sensing systems: Typical Remote Sensing system and its components, sensor resolution (Spatial, spectral, temporal), important satellite systems; LANDSAT, SPOT, IRS, MODIS, IKONOS. Electromagnetic radiation (EMR) and Electromagnetic Spectrum (EMS): radiation laws, sources of electromagnetic radiation, theories of electromagnetic radiation, scattering, absorptance, reflectance, transmittance and atmospheric windows. Interactions of EMR with atmosphere, interaction of EMR with earth's surface features; vegetation, water, and soils.

UNIT 1I: Satellite Data Interpretation:

Spectral signatures: homogeneity/heterogeneity, size, statistical inference. Principles of Visual image interpretation: elements of visual image interpretation, importance and factors governing the interpretability. Photo-grammetry: characteristics of aerial photographs (scale, resolution, projection, overlaps), measurement of scale and height. Stereo-imaging: principles, and sensors for stereo-imaging (ASTER). Use of ancillary information for satellite data interpretation. Ground Truth Collection: importance, methods, and Ground truth details.

UNIT III: Digital Image Processing:

Digital Image processing (DIP): Introduction and DIP systems. Digital data and storage formats (BSQ, BIL and BIP). Statistics and Digital image processing particularly histogram and scatter plots. Pre-processing of satellite data (radiometric and geometric corrections),

Color composites: band combination, false color composite and true color composites. Image enhancements: Linear, Non- linear, and histogram equalization.

UNIT IV: Applications and Case Studies:

1. Disaster management (landslides, flooding, earthquake)
2. Agriculture applications (crop acreage estimation, cropping patterns/monitoring)
3. Land use / land cover mapping and monitoring.
4. Fishery and wildlife application (fish forecasts, wildlife habitat mapping)
5. Urbanization (urban land use, urban sprawl)
6. Integrated natural resource management

Books suggested:

Remote Sensing and Image Interpretation, *Lillesand, R. M. and R. W. Kiefer,* 1994, 3rd Ed. NY: John Wiley and Sons, Inc.

Introductory Digital Image Processing, A Remote Sensing Perspective, *Jensen, J. R.*,1996, Upper Sanddle River:, Prentice Hall.

Introduction to Remote Sensing *Cracknell, A.P and L.W.B. Hayes,* 1993*, London*: Taylor & Francis.

Manual of Remote Sensing Colwell, R.N. (ed), 1983, 2nd Ed. Falls, Chruch, V.A American society of Photogrametry.

Remote Sensing: Principles and Interpretation, *Sabins, F.J. Jr.* 1996. 3rd Edition. W.H. Freeman and Company, New York.

Introductory Digital Image Processing. *Jensen, John R.* 2004. 3rd Edition. Prentice Hall

Asian Journal of Geoinformatics, *Asian Society on Remote Sensing.*

Indian Journal of Remote Sensing, *Indian Society of Remote Sensing.*

GI - T4 FUNDAMENTALS OF GEOGRAPHIC INFORMATION SYSTEM

Course Goals

- Impart the basic knowledge of the principle concepts of spatial data handling with GIS
- Develop competence in the use of geospatial tools for acquisition, processing, analysis, storage and use of thematic, spatial and spatio-temporal data.

Unit I: Overview of GIS:

GIS basics: Introduction, Definition, historical perspective, Components of GIS, types of GIS. Concept of data, information, knowledge and intelligence. Geographic data sources (Remote Sensing, GPS, Maps and Field observations). Spatial and non-spatial data: introduction, importance and integration. Concept and applications of Topology in GIS:

Unit II: Databases and Data Models:

Data models: Concept and types, Raster data model, Vector data model, Advantages and disadvantages of raster and vector data models, Applications of raster and vector data models, issue related to data model conversation. Data input: Methods, data quality, data

errors, data editing. Databases: definition and importance. Spatial data infrastructure; structure, importance and applications.

Unit III: Geospatial Data Analysis:

Geospatial analysis: Introduction, vector-based analysis (Non-topological and topological functions with examples of each type), Raster-based analysis (Local operations, neighborhood operations, extended neighborhood operations, regional operations with examples of each type). Network analysis: concept and applications.

Unit IV: Applications and Case Studies:

Utility mapping using GIS, Wild life habitat analysis, Land suitability analysis, Geoinformatics for Environmental impact analysis (EIA), Disaster vulnerability analysis (seismic microzonation, landslide hazard zonation), Geoinformatics for Land information System (LIS).

Books suggested

Principles of Geographic Information Systems for land resources assessment: *Burrough, P.A.*, 1996. Oxford: Clarendon Press.

Fundamentals of Geographic Information Systems, *Demer,Michael, N.*, 2000., John Wiley and Sons, Inc.

Introduction to GIS, Chang, K. 2004.. 2nd Edition. McGraw-Hill, Dubuque, Iowa.

Getting Started with Geographical Information Systems *Clarke, K.C.* 2003.. 4th Edition. Prentice Hall, Upper Saddle River, New Jersey.

Concepts and techniques of Geographic Information System *: Lo C.P: Albert*. Prentice Hall.

Fundamentals of Geographic Information Systems. *DeMers, M.N.* 2002 2nd Edition. John Wiley and Sons, New York.

Exploring Geographic Information Systems, *Chrisman, N.* 2002. 2nd Edition. John Wiley and Sons, New York.

Introduction to GIS, *Chang, K.* 2004. 2nd Edition. McGraw-Hill, Dubuque, Iowa.

International Journal of Geographical Information Systems.

SEMINAR

GI – S1 (RELATED TO THEORY COURSES)

PRACTICAL

GI - P1 DIGITAL IMAGE PROCESSING

- Tutorial on different modules of image processing software,
- Import and export of satellite data,
- Different image and remote sensing data formats
- Visual interpretation of different earth features from the images
- Preparation of satellite data for analysis like rotate, reflect, subset, layer stacking.

- Pre-processing of satellite data like image registration and geo-correction, and other Image processing operations like filtering, image enhancements, math operations, Reprojecting and resampling.
- Spectral response of different earth features from multi-spectral image data
- Final processing (classification algorithms and statistical analysis)
- 3-4 days field trip for the ground truth of the generated products
- *Individual/group-wise assignments*

GI - P2 **GEOSPATIAL ANALYSIS**

- Familiarization with GIS software systems
- Data input; digitization, scanning
- Data editing of spatial and non-spatial data
- Use of attributes and other tabular data
- Database creation, linking, joining and registration
- Geo-processing of geospatial data like buffering, proximity analysis etc.
- Data query and preliminary data analysis
- Map making and production
- 3-4 days field trip for the ground truth of the generated products
- *Individual/Group assignment*

SEMESTER II

THEORY

GI -T5 **FUNDAMENTALS OF MICROWAVE REMOTE SENSING**

Course Goals

- Develop an understanding of the radar remote sensing principles.
- Promote complimentary use of optical and microwave remote sensing products
- Expose the students to new applications in the field of remote sensing

Unit I: Introduction:

Microwave region of Electromagnetic spectrum, Definition and concept of Synthetic Aperture Radar (SAR). Historical perspective of microwave remote sensing. Details of the Space-borne and airborne radar systems viz., ERS/JERS/AIRSAR SAR systems. Advantages/disadvantages of radar remote sensing vis-à-vis optical remote sensing, SAR viewing geometry: slant range, ground range, azimuth, look angle, incidence angle, Local incidence angle. Backscattering coefficient and sigma naught expression, Radar equation for point and distributed targets.

Unit II: Sensor and Target Characteristics:

Concept of wavelength and frequency in SAR, Radar penetration, polarization, Dielectric constant: SAR dependence on dielectric constant w.r.t. angle and frequency. SAR sensitivity to surface roughness, Roughness-frequency dependence, Roughness-incidence angle dependence. Speckle: Definition and causes of speckle in SAR images, multi-looking, speckle removal methods; Lee, Lee-sigma, Frost, Gamma adaptive filters. Topographic influences on

radar imaging: shadow, foreshortening and layover, methods for minimizing topographic influences on SAR images.

Unit III: Radar Backscattering Modeling:

Reflectivity of earth's features, Introduction to radiative transfer theory, some common modeling approaches like discrete, continuous, first order scattering, and second order scattering. Examples of these modeling approaches viz. cloud model and MIMICS model. Scattering mechanisms of SAR signals with surface (bare soil) and volume (vegetation). Interferometry: concept and application, base line, repeat pass interferometry. Polarimetry: Definition and scope

Unit IV: Radar Applications and Case Studies:

Hydrologic and geologic: Soil moisture estimation, Snow and glacier studies, disaster management, volcanic eruption and crustal deformation; Forestry: Woody biomass and tree height estimation; Topographic: DEM generation; Agriculture: Crop discrimination and crop growth monitoring

Books suggested:

Satellite microwave remote sensing, *Allan, T. D.:* Chichester, Ellis Hardwood

Microwave remote sensing, *Ulaby, F. T., Moore, R. K., Fung, A. K.*, vol. I, II and III. Massachusetts, Adison Wilsey.

Imaging radar for resource survey, *Trevett, J. W.,* Chapman and Hall, London

Microwave Remote Sensing of the Earth: Physical Foundations, *Eugene A. Sharkov, Springer Verlag.*

Remote Sensing and Image Interpretation, *Lillesand, R. M. and R. W. Kiefer,* 1994,3rd Ed. NY: John Wiley and Sons, Inc.

Remote sensing principles and interpretation, *Sabins, F. F.,* W H Freeman, San Francisco.

Introduction to remote sensing, *Campbell, J. B.,* Taylor and Francis, London.

GI –T6 ADVANCED IMAGE PROCESSING

Course Goals

- Develop skills for advanced image processing of satellite data.
- Impart know-how on the methods of extracting information from the satellite data.
- Demonstrate the usefulness of satellite data for real world applications

UNIT I: Advanced Remote Sensing Systems:

Remote sensing systems: active, passive, imaging and non-imaging. Remote sensing in 21st century. Geophysical Remote Sensing and its applications. Hyper-spectral remote sensing:

introduction and applications. Thermal remote sensing: introduction and applications. Integration of multi-sensor data: introduction, technique, constraints and applications.

UNIT II: Image Processing Techniques:

Uni-variate and multi-variate statistics in Digital Image Processing. Filtering: introduction, high pass filter, low pass filters, density slicing, edge enhancement and detection filters. Band math and ratioing: image indices (VI, NDVI, PVI, SAVI). Principal component analysis (PCA): introduction, technique and applications.

UNIT III: Classification of Satellite Data:

Image classification: Supervised, Unsupervised, training samples and statistical issues. Classification algorithms: ISODATA, K-means, Maximum likelihood, Mean distance to means, parallel piped, Mahalanobis. Advanced image classification techniques: Knowledge based classifier, Neural networks and fuzzy logic. Classification accuracy: test sites, error matrix, errors of commission and omissions, Kappa statistics.

UNIT IV: Remote Sensing Applications and Case Studies:

Vegetation applications (Deforestation, Net primary productivity estimation, Leaf area index, Cadastral mapping, Geological applications (lithology, tectonics), Water resources management (snow and glaciers, ground water exploitation, Environmental evaluation and monitoring (wetlands, desertification)

Books suggested:

Manual of remote sensing, American Society of Photogrammetry and Remote Sensing, vol. I and II, Falls church, Virginia, US

Remote Sensing and Image Interpretation, *Lillesand, R. M. and R. W. Kiefer*, 1994 ,3rd Ed. NY: John Wiley and Sons, Inc.

Remote sensing principles and interpretation, *Sabins, F. F.,* WH Freeman, San Francisco.

Introduction to remote sensing, *Campbell, J. B.,* Taylor and Francis, London.

Remote Sensing Digital Image Analysis, *John A. Richards:* Springer-Verlag, 1993.

Introductory Digital Image Processing, A Remote Sensing Perspective, *John R. Jensen*, Prentice Hall.

Digital Image Processing, *R.C. Gonzales, R. E. Woods:* Addison Wesley, 1993.

Techniques for Image Processing and Classification in Remote Sensing, *R. A. Schowengerdt:* Academic Press, 1983.

International Journal of Photogrammetry and Remote Sensing (ISPRS), *Taylor and Francis UK.*

GI –T7 **ADVANCED GEOINFORMATICS**

Course Goals

- Teach advanced concepts of geo-informatics including GPS
- Development of skills in the use of geo-information technology for modeling land surface processes.

Unit I: Contemporary Issues in Geoinformatics:

Emerging tends and scope of geoinformatics. Relationship between Geoinformatics, Information Technology and Sensor technology.Data standardization: Data standards, data quality, sources of Scale issues in RS and GIS. GIS design methodology, design and implementation, technical, manpower and institutional issues.

Unit II: Recent advancements in Geoinformatic Science and applications:

Enterprise Geographic Information System (GIS): definition trends, implementation and its applications. Global positioning system (GPS): Introduction, and GPS data use and importance in geospatial analysis. Data integration in GIS: Socio-economic GIS, integration and application of socio-economic and environmental data, fundamentals of multi-criteria analysis. GIS based decision support system: fundamentals and applications.

Unit III: Digital Terrain Modeling:

Sampling theory: Geographic data sampling methods Interpolation: Introduction, importance, data sources for interpolation, types of interpolation, Methods for interpolation (thesein polygons, inverse distance weighted, splines and krigging).Uses of interpolation, Issues involved with interpolation of spatial data. Surface mapping: Concept, types of surfaces and application. Digital Elevation Model (DEM): Definition, methods of development, and applications of DEM.

Unit IV: Geospatial Modeling and Case Studies:

Geospatial Modeling: introduction, importance and techniques. Land degradation modeling, watershed prioritization. Hydrological modeling, flood vulnerability zonation. Environmental modeling: Integrated Environmental analysis and assessment of Carrying Capacity using GIS, Eco-zonation mapping. Crop growth modeling in GIS environment.

Books suggested:

Principles of Geographic Information Systems for land resources assessment: *Burrough, P.A*., 1996. Oxford: Clarendon Press.

Fundamentals of Geographic Information Systems, *Demer,Michael, N*., 2000., John Wiley and Sons, Inc.

Introduction to GIS, Chang, K. 2004.. 2nd Edition. McGraw-Hill, Dubuque, Iowa.

Getting Started with Geographical Information Systems *Clarke, K.C.* 2003.. 4th Edition. Prentice Hall, Upper Saddle River, New Jersey.

Concepts and techniques of Geographic Information System *: Lo C.P: Albert*.

Prentice Hall.

Fundamentals of Geographic Information Systems. *DeMers, M.N.* 2002 2nd Edition. John Wiley and Sons, New York.

Exploring Geographic Information Systems, *Chrisman, N.* 2002. 2nd Edition. John Wiley and Sons, New York.

Introduction to GIS, *Chang, K.* 2004.. 2nd Edition. McGraw-Hill, Dubuque, Iowa

International Journal of Geographical Information Systems.

GI –T8 FIELD SURVEY, GEODESY AND GPS

Course goals

- To make students understand the importance of fieldwork and enable them to collect field data on various aspects of earth system.
- To acquire the skills of interpreting, synthesizing and disseminating field data and information.
- To make use of data derived from the field into a GIS.

Unit I: Introduction to Field Surveying and Mapping:

Geographic data collection, spatial location and reference. Identification of problems studied during the fieldwork. Development of global surveying techniques, Procedure of field survey. Utilize geoinformation techniques for the storage and analysis of the spatial data. Designing database structure for the data collected.

Unit II: Digital Field Data Capture Techniques:

Application of latest technology instruments like GPS, field spectrometers to validate field mapping. Post assessment field works: Data quality assessment, Digitizing and the creation of a geospatial database. Data interpretation by integration of field and remotely sensed data. Cartographic compilation of primary field data and map interpretations. Report writing.

Unit III: Global Positioning System (GPS):

Introduction, concept, types, components. GPS satellite constellation including Russian and European. Geo-positioning basic concepts, GPS accuracy, Wave frequencies , error corrections. Ground data collection: spatial and nonspatial data for analysis and modeling. GPS signal interferences. Applications of GPS in resources surveys, mapping, crustal deformation and navigation.

Unit IV: Geophysical Surveys:

Exploration geophysics. Origin, structure and evolution of planet earth, Basic principles of geophysical survey design and interpretation, including gravity, magnetic, electric, electromagnetic and seismic methods, physics of the earth, origin, evolution, structure and processes of the planet earth. Geophysical properties of geological materials, Interpretation of geophysical data for real world applications.

Books suggested:

GPS Satellite Surveying, *Leick A* (1995): 2nd end. Wiley, New york Chicheste Brisbane Toronto Singapore.

GPS Theory and Practice, *Hofmann-Wellenhof B, Lichtenegger H:* (2007). Springer (5th eds), Wien New York.

Global Positioning System and GIS, An Introduction, Kennedy, M. Ann Arbor,MI,1996.

Concepts and techniques of Geographic Information System *: Lo C.P: Albert*.
Prentice Hall.

Remote Sensing and Image Interpretation, *Lillesand, R. M. and R. W. Kiefer*, 1994 ,3rd Ed. NY: John Wiley and Sons, Inc

SEMINAR

GI - S2 **(RELATED TO THEORY COURSES)**

PRACTICAL

GI - P3 **ADVANCED IMAGE PROCESSING**

- Advanced image processing techniques viz.,
  - Principle component analysis of remote sensing data
  - Mosaicing of images
  - Density slicing
- Comparison of different classification algorithms Accuracy assessment of data products
- Microwave data processing and Quantification of backscattering from different features
- Indicator development using optical remote sensing data
- Developing geospatial models using inbuilt modules.
- Individual/Group-wise assignment

GI - P4 **GEOSPATIAL MODELING**

- Geospatial data editing, and attributes
- Use of Model Builder for Geospatial Analysis.
- Spatial data analysis
- Census and other socio-economic data analysis. Detailed analysis of the Census data for different applications.
- Spatial modeling in GIS environment particularly land degradation, and hydrological modeling
- *Individual/Group-wise assignment on spatial modeling*

GI – GT **GROUND TRUTH/FIELD TRAINING**

- Accuracy assessment of the satellite based land use and land cover data.
- GPS survey of the University Campus or Dal Lake, Shalimar/Nishat garden.
- Validation of the Satellite based Digital Elevation Model with the GPS data.
- Signature development for forest, aquatic and agriculture vegetation.
- Field data collection for vegetation, soils and water.
- 2 weeks field visit to the advanced national facility in Geoinformatics.
- Group assignment on any of the above field based observations.

SEMESTER III

GI -T9 DATABASE MANAGEMENT SYSTEM

Coarse goals

- **To make an understanding about the working of database management system.**
- **To define queries in the standard language SQL, stored tables and queries.**
- **To learn about the aspects of database design and its applications.**

Unit I: Fundamentals of Database Management System:

Database concepts, database development, implementation and design, Database management system (DBMS): Network DBMS, Hierarchical DBMS, Relational DBMS, Object oriented DBMS. Comparison between these DBMS. Storing of GIS databases, Importance of editing GIS databases.

Unit II: DBMS Software Packages:

Theoretical and mathematical understanding of database querying. Database querying using SQL (MS Acess/ Oracle). First steps in database design. GIS database application development. GIS database application development tools.

Unit III: Advanced Programming Software Packages:

Object-oriented programming language, GIS database object models. Object-oriented software development (domain analysis, user requirement analysis, design models). Principles of user interface design (windows-based user interface design).

Unit IV: Local, Regional and Global databases:

Global land use datasets, global ecosystem maps, datasets related to vegetation, topography, land use. Agriculture data sets like FAOSTAT etc., global NPP datasets. Global forest datasets AVHRR global forest resource assessment. Global Seeps database. Global topographic data SRTM 90m Digital Elevation Data. Other global datasets like BALANS land cover data, NIMA DCW VMAP0, GEOnet names server, gridded population of the world, Version 3, Landsat GeoCover 2000/ETM+ Edition mosaics.

Books suggested:

An introduction to Informatics in Organizations Benynon-Davies, P. (2002).Information Systems: Palgrave (formally Macmillan).

Database Systems, Beynon-Davies, P. (2000), 3rd (eds) Palgrave (formerly Macmillan.

Modern Database Management, *Mcfadden .R .Fred;Hoffe .A Jaffrey*. Addision Wisley. Education Publishers, Inc.

An introduction to Database Systems, Date, C..J.(2000). Reading, M.A. Addison-Wesley.

Database Management Systems, *Ramakrishnan, R. and J. Gehrke* (2003). Boston, M. A, McGraw.

Database Model Design: The fundamental Principles *Teorey, T.J*. (1994). San Mateo, CA, Morgan Kaufmann.

GI -T10 GEOSPATIAL STATISTICS

Unit I: Fundamentals of Geospatial Statistics:

Fourier Series, Fourier transform, Fast Fourier Transform Vectors and Linear Space. Matrix algebra. Overview of Numerical methods in Digital Image Processing and GIS Cluster analysis and automatic classifications. Maximum likelihood, minimum distance, parallelepiped approaches, Multivariate distances, factor analysis, discriminant analysis.

Unit II: Applications and Techniques for Geospatial Statistics:

Overview of applications and techniques for univariate and multivariate statistics for multi-dimensional satellite data; spatial continuity analysis; estimation; simulation. Overview of spatial statistics, estimation, and modeling with examples. Autocorrelation principles. Variogram analysis. Applications of variogram analysis for continuously varying phenomena like soil moisture, forest structure

Unit III: Statistical Analysis:

Summarization, analysis; histogram and probability distribution, scatter plots and data redundant analysis for multi-dimensional satellite data, correlation in multivariate data, data transformations (logarithmic, indicator, normal-score, rank-order); principal component analysis,

Unit IV: Time Series Analysis of Geospatial Data;

Time series analysis and representation, time-space correlation and representation. Multidimensional analysis and representation. Applications of time series analysis for feature extract from the multi-temporal satellite data, remote sensing applications like soil moisture, vegetation analysis and disaster management.

Books suggested:

Statistics for Spatial Data *Cressie,N.A.C*, Wiley,New York,900 pp.,1993.

Statistical Tables and Formulas, *Hald,A*., Wiely,New York,1952.

Advanced spatial statistics, *Daniel A. Griffith* ,Emerald City (Glebe, NSW).

Metheron,G., Principals of geostatistics, conomic Geology,58,1246-66,1963.

A review of Statistical Spatial analysis in geographical information system,

Bailey, T.C 1994 Taylor and Francis.

Fundamentals of Geographic Information Systems. *DeMers, M.N.* 2002 2nd Edition. John Wiley and Sons, New York.

Exploring Geographic Information Systems, *Chrisman, N.* 2002. 2nd Edition. John Wiley and Sons, New York.

Introduction to GIS, *Chang, K.* 2004.. 2nd Edition. McGraw-Hill, Dubuque, Iowa.

International Journal of Geographical Information Systems

GL -T11 ADVANCED GIS - DATA ANALYSIS AND MODELLING

Coarse goals

- To apply models for planning (e.g. decision support, risk analysis)
- To integrate numerical and statistical part of different types of geospatial data using various GIS software's

Unit I: Data Analysis and Modeling:

General approaches to modeling: deduction vs. induction, hypothesis testing vs. exploratory data analysis, forward modeling vs. inversion, knowledge-driven, data-driven, model-driven, iterative methods, regional trends, data integration techniques. Abstraction of reality, representation of physical properties in numeric terms, statistical approach of representing natural variations.

Unit II: Cartographic Modeling:

Knowledge driven models: Boolean logic, Index overlaying, Multi-class overlaying, fuzzy logic. Data-driven models: Bayesian methods, Weights of evidence, Evidence belief, Logistic regression, other techniques. Model validation: selection of the "best model", expert judgment, statistical measures of agreement, logical arguments (e.g. coherence, conflicts with physical laws).

Unit III: Modeling Concepts:

Model concepts: distributed models, lumped models, empirical models, semi-empirical models, theoretical models; Model Input parameters w.r.t. hydrological, erosion and nutrient models. Role of Remote sensing and GIS in land surface process modeling. Modeling the Human-ecosystem interactions (Agent modeling). Concepts on modeling the historical and futuristic Land cover changes. Assessing the impacts of Climate change on Water resources, biodiversity and Agriculture

Unit IV: Application of GIS Modeling:

GIS case studies, dealing with aspects such as waste disposal site selection, landslide hazard assessment, Disaster risk reduction, Disaster vulnerability assessment (Physical and social vulnerability) for earthquake and flooding, Air quality modeling and assessing its impacts on human health using GIS, Data infrastructure Models; NSDI and SSDI. Introduction to PC Raster, Modeling and programming.

Books suggested:

A review of Statistical Spatial analysis in geographical information system,

Bailey, T.C 1994 Taylor and Francis.

Quantitative Geography:Prespective on Spatial data Analysis, Fortheringham A.S.2000 Sqage Publications.

Spatial Analytical Prospective on GIS, London: *Fischer ,M., Scholten* .Taylor and Francis.

Dynamic Modelling and Geocomputation .*Burrrough, Peter A.19*98. A Primer, P. Longley, S .Brooks ,B. Macmillan, and R. Mc Donnell (eds),pp 165-192,New York: Wiley.

Fundamentals of spatial information systems, Laurini, R and Thompson, D.: Academic Press London

Exploring spatial analysis in geographical information systems, *Chou, Y. H.:* Onward Press, New Mexico, US.

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PRACTICAL

GI – P5 ADVANCED GEOSPATIAL ANALYSIS AND MODELLING

- Socio-economic GIS database
- NSDI data models and developing a prototype NSDI/SSDI
- Assessing the social vulnerability to disasters, earthquake and flooding
- PC Raster modeling and programming
- Assessing the hydrological processes using geospatial modeling environment
- Nutrient load assessment using geospatial modeling environment
- Assessing the climate change impacts on water resources using geospatial tool

SEMESTER IV

GI - D PROJECT WORK

As a part of the curriculum, the students would be assigned research/project work related to the use of remote sensing and Geographic Information System for any of the themes/areas on landuse/landcover mapping, cartography, geomorphology, civil engineering, hydrology, agriculture, urban and regional planning, database development, assessment of earth resources and other general environmental problems. The objective is to expose students to various techniques so that they would consolidate their skills learned in the theory and practical sessions of related to various courses.

GI - SP OPTIONAL FOR SPECIAL PAPER

GI – SP (i) HYDROINFORMATICS

Coarse goals

· To assess and manage the water resources *vis a vis* the application of geoinformatics.

· To learn to develop site specific strategies or plans for water resource management using the geoinformatics.

· To enable the identification and management of potential ground water resources

Unit I: Hydrological Cycle and Processes:

Hydrological Processes: Precipitation, Evaporation, Transpiration, interception, Infiltration, Percolation and Groundwater recharge. Global water resources. Water resources in Kashmir Himalayas. Water resource assessment methods. Importance of hydrology to society w.r.t. Jammu and Kashmir state. Water Resources Planning and Management. Hydrometeorology. Biogeochemical cycling, Watershed management and conservation principles. Eco-hydrology, Land water interactions. Statistical analysis of hydro-meteorological data.

Unit II: Remote Sensing for Surface and Ground Water:

Remote sensing techniques for water resources assessment: Interpretation of satellite data for water resources, impact of spatial resolution on water resources mapping, Monitoring the surface extent of water bodies. Surface water bodies mapping (visual interpretation and digital image processing for mapping irrigation tanks, ponds, reservoirs, lakes etc.). Role of remote sensing for quantifying the hydrological processes. Groundwater exploration using remote sensing and GIS. Geophysical investigations for Ground Water Hydrology.

Unit III: Geoinformatics for Water Resources:

Watershed characterization and hydrological modelling. Concept of Runoff and overland flow, Factors affecting runoff processes. Watershed factors that affect runoff: size, topography, shape, orientation, aspect, geology, soil interflow and base flow. Geoinformatics for Watershed conservation and planning, DEM applications in water resources. Water quality and quantity modelling using remote sensing and GIS

Unit IV: Snow and Glacier Studies using Geoinformatics:

Snow and glacier resources of Kashmir. Climate change and glaciers. visible, infrared and microwave remote sensing for snow and glacier studies. Normalized Difference Snow Index (NDSI) and other ratio methods for snow/glacier mapping. Snow hydrology, snowmelt run-off modeling. Glacier inventory (areal extent, depth) Change detection studies of glaciers. Mass balance studies of glaciers. Traditional and remote sensing approaches for snow parameter retrieval (snow depth, snow water equivalence, snow density).

References:

Hydroinformatics Tools, 1998. *Jiri , Marasalak, Cedo, Maksimovic, Evzen Zaman.* Kluwer Academic Publishers**.**

Practical Hydroinformatics, 2008 **.** *Robert J. Abrahart, Linda M. See, Dimitri P. Solomatine* . Morgan Kaufmann Publishers, Inc., San Francisco.

Distributed hydrological modeling*, 1996. Michael B. Abbott, Jens Christian Refsgaard* .Kluwer Academic Publishers

Flood Issues in Contemporary Water Management - 2000 , *Jiri Marsalek.* Kluwer Academic Publishers

Drury,S.A.& Berhe,S.M.(1991) Remote sensing in ground water exploration in arid regions:examples from arid regions:examples from the Red sea Hills of NE Africa.*Association of Geoscientists In Development* (AGID)News 67/68,17-20

Geographic Information Systems for land resources assessment. *Burrough, P.A.*: Oxford: Oxford University Press.

Lillesand, R. M. and R. W. Kiefer, 1994, *Remote Sensing and Image Interpretation*,3rd Ed. NY: John Wiley and Sons, Inc.

Wilk, J. Andersson, L. Plermkamon, V., 2001. Hydrological impacts of forest conversion to agriculture in a large river basin in northeast Thailand. *Hydrol. Process.* 15, 2729– 2748.

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GI – SP (ii) NATURAL RESOURCE MANAGEMENT

Coarse goals

- To acquaint the students with the applications and use of Geoinformatics for Natural Resource Conservation and Management
- To impart knowledge about the GIS analytical capabilities to solve environmental problems.
- To equip the students with the know-how about integrated environmental analysis using Geoinformatics

Unit I: Fundamentals of Natural Resource Management:

Introduction about natural resources. Inventory and monitoring major Natural resources of Jammu and Kashmir with special reference to water and forest resources. Nature and importance of climate, particularly with reference to ecosystems, habitat, and human land use practices. Ecosystem: concept, components, Energy flow, energy models and energy relations in ecosystems. Laws of thermodynamics. Primary productivity and secondary productivity. Biodiversity loss and conservation, Major biomes of the world; distribution and characteristic features of Forests, Grassland, Tundra, Desert and Marine.

Unit II: Climate Change; Process and Consequences:

Basic concepts of climatology. Climate change: introduction, causes & consequences. Green house gases and green house effect. Impacts of climate change on natural resources particularly forest, agriculture and water resources. Energy sources and Climate change. International environmental conventions viz., UNFCCC, UNCBD, UNCCD. Kyoto & Montreal Protocol. Sustainable development of natural resources, concept, principles and limitations. Integrated Environmental analysis. Systems approach to Ecosystem studies.

Unit III: Remote Sensing of Natural Resources:

Forest Resources Inventory and Management using high and moderate resolution satellite data. Vegetation mapping for change detection studies and biomass estimations. Remote Sensing for Sustainable Agriculture, crop acreage and production estimates. Pasture lands, spatial and temporal variation in distribution of pasture and highlands, change detection analyses based on satellite imagery, mineral wealth, application of hyperspectral remote sensing data for mineral exploration and

distinction, water resources (snow and glaciers) inventorying of these resources, change detection studies, glacier retreat etc.

Unit IV: GIS for Natural Resource Management:

Decision Support Systems for NRM. GIS for modeling land surface processes particularly erosion and hydrological processes. Monitoring and management of Biodiversity. Conservation of plants (with special reference to medicinal plant wealth of Jammu and Kashmir) and animals, Role of Geoinformatics for management of wildlife reserves, habitat analysis of musk dear, black bear and snow leopard in Jammu and Kashmir. GIS for watershed prioritization. GIS for Wetland restoration.

References:

Natural Resource Management.1997.*Lalit Kumar Jha,*Pearl Publications

International research on natural resource management. Hermann Waibel, David Ziberman. Lit Publisher,Germany.

Integrating landscapeecology into natural resource management,2002 Jianguo Lui, William w. Taylor. Lewis Publishers

Geographic Information Systems for land resources assessment. *Burrough, P.A*.: Oxford: Oxford University Press.

Grayson, R. B., I. D. Moore and T. A. McMahon, (1992a), "Physically Based Hydrologic Modeling 1. A Terrain-Based Model for Investigative Purposes," Water Resources Research, 28(10): 2639-2658.

Lillesand, R. M. and R. W. Kiefer, 1994, *Remote Sensing and Image Interpretation*,3rd Ed. NY: John Wiley and Sons, Inc.

Siegal,B.S.& Goetz,A.F.H.(1997) Effect of vegetation on rock and soil type discrimination.

Photogrammetric Engineering and Remote Sensing **43,**191-196

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GI – SP (iii) REMOTE SENSING FOR URBAN AND REGIONAL PLANNING

Coarse goals

- To use different high-resolution satellite data products for urban planning.
- To develop a credible remote sensing and GIS system for urban area related problems.

Unit I: Introduction to Urban Planning:

Principles of urban area development and land use planning. Importance of Urban and regional planning. Urbanization trends in Jammu and Kashmir with special reference to the Srinagar and Jammu city centers. Impact of urbanization on different natural resources of Jammu and Kashmir with reference to some case studies. Master planning for urban land use. Reckless urbanization and resource mismanagement.

Unit II: Remote Sensing for Human Settlement Analysis:

Urban area identification and interpretation using high and moderate resolution remote sensing data, Various classification systems; Residential area classification; Space use classification system; Urban land use classification systems, interpretation, monitoring and change detection analysis using satellite imagery. Mapping urban land use and urban sprawl with remotely sensed data.

Unit III: Socio-economic GIS:

Census operation in India, census data and field observations, Demographic and social patterns, Socio economic and residential area evaluation. Remote sensing for population studies and settlement, slum settlement detection. Updating of population data, Traffic and parking survey with high spatial resolution satellite data Role Geoinformatics in Transportation Planning. Geoinformatics for cadastral based land information system.

Unit IV: GIS for Urban Resources and Services Planning:

Eco-zonation of ecologically fragile landscapes. Urban facility mapping, Advancement of Geoinformatics in services sector particularly Utilities. Urban land evaluation and suitability analysis, Urban hazards and risk management. Seismic microzonation of urbanized areas.

References:

Urban Crowding and its Consequences,Breese, Gerald 1974.Praeger Publishers, New York.

Albert, M. 1999. Modeling the Urban Ecosystem: A conceptual Framework. Environment and Planning B 26,no.4,605-630.

Urban Ecosystem studies in Malaysia, 2003. Noorazuan MD-Hashim,Ruslan Rainis.

Remote sensing of urban environment .1999 Jenson,SK and FA, Rashid.

Branch ,M.C., 1971,City Planning and Aerial Information. Cambridge, Harvard University Press.

Lillesand, R. M. and R. W. Kiefer, 1994, *Remote Sensing and Image Interpretation*,3rd Ed. NY: John Wiley and Sons, Inc.

Burrough, P.A., 1996.*Principles of Geographic Information Systems for land resources assessment*: Oxford: Clarendon Press.

Demer, Michael, *N*., 2000. *Fundamentals of Geographic Information Systems*, John Wiley and Sons, Inc.

Gottmann,J.,1994,Towards a Global Urbanization-The post-Industrial City, Systema Terra-Remote Sensing and the Earth,3(3):4-7

Green, K., Kempka and L.Lackey,1994,Using Remote Sensing to Detect and Monitor Land cover and Landuse change, Photogrammetric Engineering and Remote sensing,60:331-337

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GI – SP (iv) LAND DEGRADATION STUDIES

Coarse goals

- To implement geoinformation techniques for the collection, storage and analysis of spatial data including field data capture techniques for soil resources

- To enable interpretation satellite images including digital image processing and GIS for such studies

Unit I: Principles of Soil Science:

Aspects of physical, chemical, and biological properties of soils. Process of soil formation. occurrence of soils on the landscape, and soil classification. Soils and climate; emphasis on soil forming factors and their contribution to fertility e.g. leaching of nutrients vs. non-leached; accumulation of organic matter. Major soil types in India with special reference to soil types in Jammu and Kashmir.

Unit II: Remote Sensing in Soil Studies:

Spectral characteristics of soils, physiographic analysis and soil mapping using satellite remote sensing data, soil information system. Use of hyperspectral remote sensing in soil resource inventory, soil spatial variability, soil morphology and classification, Digital image processing techniques for soil resource mapping.

Unit III: Digital Terrain Modelling for Soil Studies: