Ph. D. COURSE WORK STRUCTURE w.e.f. 2021-22

PAPER – III: ADVANCED KNOWLEDGE IN CORE DOMAIN OF CONCERNED SUBJECT (Geoinformatics)

UNIT – 1 **Contact Hrs. – 6** **Credit – 0.5** **Marks – 10**

Topic – I: Advanced geospatial analysis:

Significance of geospatial analysis. *Tools for vector based spatial analysis:* Single layer operations: Feature identification, extraction, classification manipulation. Multilayer operation: Union, intersection, Identity. Overlay operations: Point-in-polygon, Line in-polygon, polygon-in-polygon; *Tools for vector based spatial analysis:* Map algebra, grid-based operations, local, focal, zonal and global functions, cost surface analysis, optimal path and proximity search. *Network analysis:* Concepts, evaluation of network complexity using Alpha-gamma indices. C-matrices for evaluating connectivity of the network. Network data model. Path analysis. Linear referencing and segmentation. Types of network analysis: Optimum cyclic path, vehicle routing, path determination and cost-path analysis**.** *Point pattern analysis:* Methods for evaluating point patterns: clustered and random distribution; *Surface analysis:* Interpolation methods: Trend surface analysis, IDW, kriging, measures of arrangement and dispersion, autocorrelation, semi-variogram, DEM, TIN, slope, aspect, hillshade and viewshed *Spatial modeling:* Role of spatial model, explanative, predictive and normative models. Correlation-regression analysis in model building. Handling complex spatial query and case studies

Topic – II: Advanced surveying techniques:

Ground truth data collection: Definition and Need and Purpose of Data Collection. Planning and Collection of Ground Truth Data. Fundamentals of GPS. Differential GPS systems. GPS survey principles, GPR, HAV (drone), DGPS

UNIT – 2 **Contact Hrs. – 24** **Credit – 2.5** **Marks – 40**

Topic – I Recent trends in remote sensing: *Hyperspectral remote sensing:* Hyperspectral Sensors and Data Collection, Hyperspectral Image Display and Basic Analysis, Pre-processing of Hyperspectral Data, Thematic Information Extraction from Hyperspectral Imagery, Hyperspectral Applications: Soil, Mineral & Rock, Urban Area and Water. *Microwave remote sensing:* Introduction-Plane waves, Interference, Radar remote sensing, Radar basics, Antenna Systems, Real aperture radar, Radar frequency bands, SLAR Imaging Geometry,

Resolution Concepts, Geometric Distortions, SAR – Concepts – Doppler principle & Processing. RADAR Interaction with earth surface. Basics of SAR Interferometry and applications

Topic – II Recent trends in GIS:

Web GIS: Concepts and Principles of Web GIS; Definition and significance of Web GIS; Web Mapping Basics Interactive Web Maps, Internet Map Services, Web Page Basics; HTML, & CSS, Software Architecture, Geospatial Web Services Conceptual design, Web GIS system Integration, Open-source GIS; Web Based Geo Portal; India Geoportal; State Geoportal, *Mobile GIS:* Mobile mapping, and Location Based Services. GIS Customization and Software Automation. Google earth engine.

Topic – III Advanced Geomorphology:

Weathering, erosion and deposition, fundamental concepts in geomorphology, Structural control of fluvial erosion and landforms, Introduction and energy flow in geomorphic systems, Mass wasting and hillslopes, The fluvial geomorphic system and its evolution, Semi-arid landscapes; development and processes, Shore-zone processes and landforms and Late Quaternary climatic geomorphology

UNIT – 3 Contact Hrs. – 24 Credit – 2.5 Marks – 40

Topic – I Geoinformatics for Watershed management:

Introduction and Concept of watershed management, different stakeholders and their relative importance, watershed management policies and decision making. Watershed Characterization, Components of watershed, Watershed delineation and codification. Watershed Conservation Planning and Management

Sustainable integrated watershed management, natural resources management, agricultural practices, Soil erosion and conservation; Watershed Management Practices in Arid and Semiarid Regions, Integrated water resources management, conjunctive use of water resources, rainwater harvesting; roof catchment system. Drought assessment and classification, drought analysis techniques.

Use of modern techniques in watershed management,Applications of Geographical Information System and Remote Sensing in Watershed Management, Role of Decision Support System in Watershed Management. Analysis and DEM generation: slope, Aspect, flow direction, Flow accumulation for watershed Analysis.

Standard modeling approaches and classifications, system concept for watershed modeling, overall description of different hydrologic processes, modeling of rainfall-runoff process, subsurface flows and groundwater flow. Case studies based remote sensing and GIS

Topic – II Geoinformatics for Planning and evaluation of Land

Land Use: Land use types and classification– rural and urban land uses and land use patterns, Municipal Lands and Open Spaces in Cities and Town, Agriculture and Forest Land Management, Recreational Lands,

Data Sources for Land Evaluation: Land-soil-water resources surveys by modern techniques; remote sensing and DGPS surveys of land uses, vegetation indices, supervised and unsupervised classification.

Land Use Planning: Importance and difficulty of land use planning, Urban Land Use Planning using RS & GIS techniques,

Topic – III Geoinformatics for Disaster management:

Fundamental concepts of hazards and disasters, their types, and characterization, natural and Man-made disasters, Mapping of hazard zonation, Disaster and National losses, case studis of major disasters in India. *Geological Hazards:* Landslide, Earthquake, Mining hazards, Volcanic hazards and Groundwater hazards. *Hydro meteorological Hazards:* Flash floods, River floods, Dam burst, Cloud burst, Cyclones, Coastal hazards and Drought. *Environmental hazards:* Forest hazards, Land, soil degradation, desertification and Pollution (Water, air and soil)

Disaster Management: Fundamental concept of Disaster Management, Involvment of government, NGOs and people in disaster management. Existing organization structure for managing disasters in India. Case studies of geoinformatics applications in disaster management.

UNIT – 4 Contact Hrs. – 6 Credit – 0.5 Marks – 10

Topic – I Python programming for earth sciences:

Python programming basics: Strings, Functions, Function Arguments, Lists, List Methods, Control Flow. Basic Object-Oriented Programming concepts. pandas, Data mining, Time series analysis with python, Statistical analysis and intro to machine learning with python, SciPy, Spatial analysis with python, intro to QGIS python console,

Topic – II Introduction to Geostatistics:

Fundamental Concepts Background on statistics and its importance, Data in Earth science *Spatial statistics:* Basic introduction to concepts in geostatistics Regionalized / spatial

variables. Quantifying the estimation of sources and errors in estimation; The variogram calculation, interpretation, linking variogram behaviour with physical causes. Variances, covariances. Optimal estimation and introduction to kriging. *Time series analysis:* Examples of time series; Purposes of analysis; Components (trend, cycle, seasonal, irregular); Stationarity and autocorrelation; Approaches to time series analysis; *Simple descriptive methods*: smoothing, decomposition; Regression.

Text & References:

Watershed management

1. Lillisand, T. M. and Keifer, R. W., 2007, Remote Sensing and Image interpretation', John Willey and Sons, New York, Third Edition
2. Drury, S.A. , 2004, Image interpretation in geology, Chapman & Hall India.
3. Thornbury, W. D., (I969),: Principles of Geomorphology, John Wiley and Sons, New York
4. Sabins, Floyd F., (2007), Remote Sensing: Principles and Interpretation, 2nd ed., Freeman, New York.
5. Allam, Gamal Ibrahim Y., Decision Support System for Integrated Watershed Management,< Colorado State University, 1994.
6. American Socy. of Civil Engr., Watershed Management, American Soc. of Civil Engineers, New York, 1975.
7. Black Peter E., Watershed Hydrology, Prentice Hall, London.
8. Michael A.M., Irrigation Engineering, Vikas Publishing House.
9. Murty, J.V.S. “Watershed Management”, New Age Intl., New Delhi.
10. Murthy, J.V.S., Watershed Management in India, Wiley Eastern, New Delhi,
11. Purandare, A.P., Jaiswal A.K., Waterhed Development in India, NIRD, Hyderabad.
12. Vir Singh, Raj , Watershed Planning and Management, Yash Publishing House, Bikaner

Geomorphology

1. Strahler A N and Strahler A N; Modern Physical Geography
2. Jeffrey H; The Earth-its origin and physical composition.
3. Fairbridge R W; Encyclopedia of Geomorphology
4. Monkhouse F J; Principles of Physical Geography
5. Sparks B W; Geomorphology
6. Woolridge and R S. Morgan; Physical basis of Geography
7. Dayal P; Textbook of Geomorphology, Rajesh Publications.

8. Sharma H S; Perspectives in Geomorphology, Concept 9. Singh S; Geomorphology, Prayag Publications

Remote sensing:

1. Jensen, J.R. 2000, Remote Sensing of the Environment: An Earth resource Perspective. Prentice Hall.
2. Joseph George,2003, Fundamentals of remote sensing. Universities Press
3. Lillesand, T.M., and Kieffer, R.M., 1987, Remote Sensing and Image Interpretation, John Wiley.
4. Sabbins, F.F., 1985, Remote sensing Principles and interpretation. W.H.Freeman and company
5. American society for Photogrammetry and Remote Sensing, 1999, Remote Sensing for the Earth Sciences,Manual of Remote Sensing,3rd ed.,vol. 3, Wiley,New York.
6. Avery, T.E., and G.L. Berlin,1992, Fundamentals of Remote Sensing and Airphoto Interpretation,5th ed.,Macmillan, New York.
7. Campbell, J.B., 1996, Introduction to Remote Sensing, 2nded., Guilford, New York.
8. Curran, Paul J., (1985); Principles of Remote Sensing, Longman, London & New York.
9. Drury, S.A., Images of the Earth: A Guide to Remote Sensing,2nd ed.,Oxford University Press,Oxford.
10. Elachi,C., 1987, Introduction to the Physics and Techniques of Remote Sensing, Wiley, New York.
11. Jensen, J.R., (2004); Remote Sensing of the Environment: An Earth Resource Perspective,Pearson Education.
12. Joseph, G., 2003: Fundamentals of Remote Sensing, Universities Press, Hyderabad.
13. Sabins, F.F,Jr., (1997): Remote Sensing: Principles and Interpretation,3rd ed., W.H. Freeman, New York.
14. Star, J.L., J.E. Estes, and K.C. McGwire,1997, Integration of GIS and Remote Sensing, Cambridge University Press.

WEB GIS:

1. Fu, P and Sun, J, et al, 2011. Web GIS: Principles and Applications, Redlands: Esri Press. (*referred to in this course as Fu&Sun)*
2. DuVander A 2010. Map Scripting 101: An Example-Driven Guide to Building Interactive Maps with Bing, Yahoo!, and Google Maps, No Starch Press, Inc. (*referred to in this course as DuVander).* Available as an eBook (free) through USC Libraries.
3. Foote, Kenneth E. and Anthony P. Kirvan. (1997) WebGIS, *NCGIA Core Curriculum inGIS*

Geostatistics

1. Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2016). *Data Mining: Practical machine learning tools and techniques*. Morgan Kaufmann.

2. Islam, T., Srivastava, P. K., Gupta, M., Zhu, X., & Mukherjee, S. (Eds.). (2014). *Computational intelligence techniques in earth and environmental sciences*. Springer Netherlands.

3. Wackernagel, H. (2013). *Multivariate geostatistics: an introduction with applications*. Springer Science & Business Media.

4. Chun, Y., & Griffith, D. A. (2013). *Spatial statistics and geostatistics: theory and applications for geographic information science and technology*. Sage.

Python:

1. ArsheepBahga, Vijay Madisetti, “internet of Things: A Hands-On Approach”, Universities Press

2. Mark Lutz, “Learning Python: Powerful Object-Oriented Programming: 5th Edition”, O’REILLY, 2013

3. Simon Monk, “Programming Arduino – Getting started with Sketches”, McGraw Hill, 2012.

4. Donald Norris, “The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and Beagle Bone Black”, Copyright Material, Edition 1, 2015

5. Modeling in Resource Management and Environment: through Geoinformatics - Sharma H.S. and Binda P.R 2.

6. Guidelines for land use planning, UNFAO- FAO 3.

7. Agricultural land use planning - Vink, A.P.A.