GIS – 824: Advanced Geographic Information Systems (2+1=3)

1. **Course Objectives:**
   a. To enhance the geospatial knowledge aligned with the latest advancements in GIS.

2. **Course Outcomes:**
   a. Apply and demonstrate the principles of geographic information science.
   b. Formulate requirements and constraints in spatial analysis.
   c. Develop skills for designing and implementing real-world GIS projects.
   d. Gain hands-on experience with popular proprietary and open-source geospatial software.

3. **Course Code:**
   a. GIS – 824

4. **Credit Hours:**
   a. Theory = 02
   b. Practical = 01
   c. Total = 03

5. **Detailed Contents:**
   a. Introduction to GIS: What is GIS? GIS applications, Geospatial Data, GIS Operations
   b. Coordinate Systems: Geographic Coordinate Systems, Map Projections, Commonly Map Projections, Projected Coordinate System
   c. Vector Data Model: Representations of simple features, topology, geo-relational data model, object-based data model
   d. Raster data model: elements of the raster data model, types of raster data, raster data structure, raster data compression
   e. GIS Data Acquisition: Existing GIS data, Metadata, conversion of existing data, creating new data
   f. Geometric Transformation: Geometric Transformation, root mean square error, interpretation of RMS error on digitized maps, resampling of pixel values
   g. Spatial Data Accuracy and Quality: location errors, spatial data accuracy standards, topology errors, topology editing, non-topological editing, other editing operations
   h. Attribute Data Management: Attribute data in GIS, The relational model, joins, relates, and relationship classes, attribute data entry, manipulation fields and attribute data
   i. Data Display and Cartography: Cartography representation, types of quantitative maps, typography, map design, map production
   j. Data Exploration: Data exploration, map-based data manipulation, attribute data query, spatial data query, raster data query
   k. Vector Data Analysis: buffering, overlay, distance management, pattern analysis, feature manipulation
   l. Raster Data Analysis: Data analysis environment, local operations, neighborhood operations, zonal operations, physical distance measure operations, other raster data operations, map algebra, comparison of vector and raster based data analysis
   m. Terrain Mapping and Analysis & Watershed Analysis: Data for terrain mapping and analysis, terrain mapping, slope and aspect, surface curvature, raster vs. TIN
   n. GIS Models and Modeling: Basic Elements of GIS modeling, process-based and statistical model, Multivariate data analysis
   o. Application of AI in Geographic Information Systems: A general overview of some popular ML models that can be used in most GIS applications.

p. A general overview of different classification techniques i.e., Support Vector Machine (SVM), Random Forest (RF), Decision Trees (DT), and regression models.

6. **Detail of Lab work, workshop practice, if applicable:**
   a. Coordinate systems, Projections, Import a coordinate system, Conversion from one coordinate system to another,
   b. Vector data model, Coverage and Shapefiles, Geodatabase, Conversion of shapefile to a geodatabase, Conversion of vector data to raster
   c. Raster data model, View, and import DEM, Visualization of satellite images in GIS software, Conversion of raster data to vector,
   d. GIS data acquisition, Download satellite images, DEM and other spatial data, Digitization, Add XY into GIS software,
   e. Geometric transformation, Georeferencing, and Rectification of a scanned map, Vectorization of raster lines, Image to map transformations,
   f. Assessment of spatial data accuracy and quality, Use of cluster tolerance to fix digitization errors, use of topology,
   g. Attribute data management, Join and Relate spatial data, Advance methods for attribute data classification, Attribute queries,
   h. Data display and cartography, Choropleth mapping, Use of graduated, line and text symbols,
   i. Data exploration, Select features by location, Dynamic chart making, Combination of attribute and spatial queries,
   j. Vector data analysis, perform buffering, Overlay analysis, Computation of general and local G-statistics
   k. Raster data analysis, Local and combine operation, Neighborhood and zonal operations
   l. DEM for terrain mapping, Derive slope, aspect, and curvature from DEM, Watershed analysis
   m. Various ESRI online courses will be offered to the students.

7. **Textbooks/Reference Books:**

   a. Chang, K. T. (2016). Geographic Information System. John Wiley & Sons, Ltd.
   b. Burrough, P. A., McDonnell, R.l, & Lloyd, C. D., (2015). Principles of geographical information systems (Third edition). Oxford University Press, Oxford.3rd Edition. ISBN – 9780198742845.
   c. Clarke, K. (2010) “Getting started with Geographic Information System”, Prentice Hall, New York, 5th Edition. ISBN – 10: 0131494988
   d. Heywood, I., Cornelius, S. and Carver, S. (2006) “An introduction to Geographic Information System”, Prentice Hall, 3rd Edition. ISBN-10: 0131293176
   e. Stillwell, J. (2005) “Applied GIS and Spatial Analysis”, John Wiley & Sons, Ltd. England.
   f. Aronoff, S. (2004) "Geographic Information Systems: A Management Perspective", WDL Publications, Ottawa, 5th Edition. ISBN – 0912804008
   g. Fotheringham, S., Brunsdon, C., Charlton, M. E. (2000) “Quantitative Geography: Perspectives on Spatial Data Analysis”, SAGE Publications ISBN: 0761959483.
   h. Malczewski, J. (1999) “GIS and Multicriteria Decision Analysis”, John Wiley & Sons, Inc. ISBN: 0471329444.
   i. Related Journal Papers (Class handouts)