Course Title: Geographical Information System (GIS)

Course Code: Elective

Duration: One Semester

Class Load: 3 – 0 – 1

Pre-requisite: No pre-requisite

Evaluation:

	Theory	Practical	Total
Sessional	40	20	60
Final	40	-	40
Total	80	20	100

Course Objectives:

By the end of the course, students will be able to:

- Identify, locate, and acquire spatial data pertinent to projects in their field of interest, as well as find major gaps in or problems with existing information.
- Evaluate fitness for use of the existing data sources for use in a project.
- Understand the data creation process and create simple data sets and/or add to existing data
- Perform basic spatial analyses (attribute and spatial queries, buffering, overlays) as well as linking these methods together in a more complex analytical model.
- Create high-quality maps
- Automate available GIS tools using programming language

1. Introduction [2]
   - 1.1. Definition of GIS
   - 1.2. Brief history of GIS
   - 1.3. Components of GIS
   - 1.4. Applications of GIS
   - 1.5. GIS related technologies

2. GIS data model [3]
   - 2.1. Spatial and non-spatial data
   - 2.2. Spatial data types
     - 2.2.1. Vector data
     - 2.2.2. Raster data
     - 2.2.3. Triagulated Irregular Network (TIN)
   - 2.3. Advantages and disadvantages of vector and raster data models
   - 2.4. Contextual use of GIS data models
   - 2.5. Spatial data collection methods
     - 2.5.1. Existing data eg. Paper maps
     - 2.5.2. Traditional / modern surveying
     - 2.5.3. Remote sensing and Photogrammetry
     - 2.5.4. Clearing house

3. Geometric aspect of mapping [8]
   - 3.1. Introduction
   - 3.2. Coordinate systems
     - 3.2.1. 2D geographic coordinates/Rectangular Coordinates
     - 3.2.2. 3D geographic coordinates/Geographical Coordinates
     - 3.2.3. Geocentric coordinates
     - 3.2.4. 2D Cartesian coordinates

3.2.5. 2D polar coordinates
3.3. Reference surfaces
3.3.1. The Geoid
3.3.2. The ellipsoid
3.3.3. The sphere
3.3.4. Local and global ellipsoids
3.3.5. The local and global horizontal datums
3.4. Map projections
3.4.1. Map projection definition
3.4.2. Classification of map projections
3.4.2.1. Class
3.4.2.2. point of secancy
3.4.2.3. aspect
3.4.2.4. distortion property
3.4.3. Scale distortions on a map
3.4.4. Choosing a map projection
3.4.5. Universal Tranverse Mercator (UTM) projection
3.5. Coordinate transformations
3.5.1. Changing map projection
3.5.2. Datum transformations
3.5.2.1. Datum transformations via geocentric coordinates
3.5.2.2. Datum transformations via geographic coordinates
3.5.3. Conversions from geographic to geocentric coordinates and vice versa
3.5.4. 2D Cartesian coordinate transformations

4. Data quality [5]
4.1. Concept and definition of data quality
4.1.1. The scope of geographic data quality
4.1.2. Accuracy, precision, error and uncertainty
4.1.3. Sources of error in geographic data
4.2. Components of geographic data quality
4.2.1. Lineage
4.2.2. Positional accuracy
4.2.3. Attribute accuracy
4.2.4. Logical consistency
4.2.5. Completeness
4.2.6. Temporal accuracy
4.2.7. Semantic accuracy
4.3. Assessment of data quality
4.3.1. Evaluation of positional accuracy
4.3.2. Evaluation of attribute accuracy
4.4. Managing spatial data errors
4.4.1. Quality assurance and quality control
4.4.2. Error propagation and error management
4.4.3. Sensitivity analysis
4.4.4. Data quality reporting

5. Database and data exploration [5]
5.1. Reason for using a Database management system (DBMS)
5.2. Relational DBMS
5.3. Querying RDBMS
5.3.1. Attribute data query
5.3.2. Spatial data query
5.3.3. Combining attribute and spatial data query

6. Vector data Analysis [5]

6.1. Buffering: constant and variable size
6.2. Overlay
    6.2.1. Feature type and Overlay
    6.2.2. Overlay methods
    6.2.3. Error propagation
6.3. Pattern analysis
    6.3.1. Nearest Neighbour analysis
    6.3.2. Spatial autocorrelation
6.4. Map manipulation

7. Raster data analysis [5]
    7.1. Resampling
    7.2. Reclassifying / changing cell value
    7.3. Map algebra
    7.4. Surface analysis: Slope, aspect, contour etc
    7.5. Neighbourhood analysis: Filtering, Aggregation, Proximity
    7.6. Path analysis
    7.7. Suitability analysis

8. Data presentation and Cartography [7]
    8.1. GIS and maps
        8.1.1. The function of maps
        8.1.2. The nature of maps
            8.1.2.1. Map definition
            8.1.2.2. Map scale
            8.1.2.3. Dimensions
        8.1.3. Map types
            8.1.3.1. topographic
            8.1.3.2. thematic
    8.2. Map visualization
        8.2.1. The visualization process
        8.2.2. Visualization strategy
        8.2.3. Map Projection Systems
    8.3. The cartographic toolbox
        8.3.1. Types of data Nominal, Ordinal, Interval, Ratio data
    8.4. Mapping of Data
    8.5. Map cosmetics
        8.5.1. Map elements
        8.5.2. Use of text on the map
        8.5.3. Visual hierarchy
    8.6. Map dissemination

9. GIS automation [5]
    9.1. Introduction and importance of automation
    9.2. Introduction to Python
    9.3. ArcGIS automation with Python

Practical Exercise:
Practical exercise will cover the above chapters and will be performed in ArcGIS software. The individual practical sessions will have the following topics:

SN	Topics
1	Introduction to ArcGIS
2	Introduction to ArcGIS
3	Projection System
4	Vector Data Structure
5	Digitization & topology
6	Database and attribute query
7	Spatial query
8	Vector Analysis
9	Raster Structure
10	Raster Analysis
11	Visualization
12	Data Output

References:

1. Otto Huisman and Rolf A. De By; Principles of Geographic Information Systems: An introductory text book. ITC publication, The Netherlands, 2009.
2. C. P. Lo and Albert K. W. Yeung; Concepts and Techniques of Geographic Information Systems. PHI publication, 2005.
3. Kang-tsung Chang; Introduction to Geographic Information Systems. Tata McGraw-Hill publication, 2006.
4. Paul Bolstad; GIS Fundamentals. 3rd Edition. Eider Press, White Bear Lake Minnesota, 2007. ISBN 978-0971764729.