PRINCIPLES OF GEOGRAPHICAL INFORMATION SYSTEM

ENGE 202

Lecture : 3 **Year : II**
Tutorial : 0 **Part : I**
Practical : 3

Course Objectives:
The objective of this course is to introduce basic principles, concepts and applications of Geographical Information System (GIS). The students will acquire knowledge and skill on the topics such as structures of spatial and attribute data including importance of metadata; importance of coordinate systems, coordinate transformations and projections; data integration, processing and analysis of GIS data to derive meaningful output and making map; and advantages of GIS over traditional map.

1 Overview of GIS and GIS Software (2 hours)

1.1 Basic concept of GIS
1.2 GIS functionalities
1.3 Components of GIS
1.4 Application and Integration of GIS in different disciplines
1.5 Historical developments of GIS
1.6 GIS software

2 Coordinate Systems and Map Projections (3 hours)

2.1 Fundamentals of coordinate systems
2.2 Geographical and projected coordinate systems
2.3 Coordinate transformations and map projections
2.4 Commonly used map projections
2.5 Georeferencing and spatial adjustment

3 Spatial Data Models (4 hours)

3.1 Vector data model
  3.1.1 Point, line and polygon
  3.1.2 Spaghetti data model, topological data model
3.2 Raster data model
  3.2.1 Raster data structure
  3.2.2 Discrete vs continuous data
  3.2.3 Thematic, imagery and spectral
  3.2.4 Data compression

3.3 Comparison between vector and raster data
3.4 TIN data model – Delaunay triangles
3.5 Data conversion – Rasterization and vectorization

4 Database Concepts (5 hours)

4.1 Database and database management system
4.2 Database components
4.3 Types of database models
  4.3.1 Flat files, hierarchical database, network database
  4.3.2 Relational database
  4.3.3 Object-oriented and object-relational database
4.4 Normalization: Relational database
4.5 Standard query language (SQL)
4.6 Metadata – data about data

5 Data Sources and Acquisition (5 hours)

5.1 Primary and secondary data sources
5.2 Acquiring spatial data (Vector and raster)
5.3 Acquiring attribute data
5.4 External sources
5.5 Ground surveying
5.6 Digitization, digitization process and errors
5.7 GIS data formats and issues of data interoperability
5.8 Data standards (OGC and open data standards, ISO Standards)
5.9 Data quality and data accuracy (Positional accuracy, attribute accuracy, logical consistency and completeness)
5.10 Sources of errors and managing errors in GIS

6 Spatial Data Analysis (12 hours)

6.1 Spatial analysis
6.2 Spatial join and spatial relate
6.3 Vector overlay operations (Point-in-polygon, line-in-polygon and polygon-in-polygon)
6.4 Raster Analysis (Single layer analysis-classification and reclassification, multiple layer analysis, raster overlay)
6.5 Measuring distance and length (Euclidean distance, Manhattan distance)
6.6 Measuring area and perimeter
6.7 Proximity analysis (Vector and raster buffer)
6.8 Pattern analysis (Cluster detection, measure of density and dispersion, seek computation)

6.9 Spatial Interpolation (Thiessen polygon, nearest neighbor (NN), inverse distance weighting (IDW), spline, kriging)
6.10 Map calculations (Raster calculator, zonal Statistics)
6.11 Network analysis (Geocoding, types of networks – undirected and directed networks, linear referencing)

7 Terrain Modeling (3 hours)

7.1 Digital elevation model (DEM)
7.2 Slope and aspect
7.3 Viewshed and hillshade
7.4 Contours, longitudinal profile and cross-sections, plan and profile curvatures

8 Watershed Analysis (5 hours)

8.1 Flow direction and flow accumulation
8.2 River network
8.3 Basin/watershed
8.4 Morphological parameters

9 Cartography and Map Making (6 hours)

9.1 Gentle introduction to cartography
9.2 Early development of mapping
9.3 GIS and modern map making
9.4 Cartographic process
9.5 Types of maps: Reference and thematic
9.6 Elements of map
9.7 Principles of map design
9.8 Map output formats

Practical (45 hours)

1. Familiarization with software and hardware and data
2. Spatial database development using field survey data
3. Linking non-spatial and spatial database – census data
4. Map projection based on modified UTM
5. Spatial data query – query by attributes, query by location
6. Vector and raster overlay
7. Surface analysis
8. Hydrological Analysis
9. Map layout (map elements, scale and print layout)
10. Mini-project on GIS application or customization

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	2	3
2	3	5
3	4	6
4	5	6
5	5	8
6	12	15
7	3	6
8	5	6
9	6	5
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Chang, K. (2019). Introduction to Geographic Information Systems (9th edition). New York: McGraw-Hill Education, Penn Plaza.
2. Bolstad, P. (2016). GIS Fundamentals: A First Text on Geographic Information Systems (5th edition). United States: Eider Press.
3. Jensen, J. R., Jensen, R. R. (2013). Introductory Geographic Information Systems. Boston: Pearson.
4. Campbell, J. E., Shin, M. (2012). Geographic Information System Basics (v. 1.0), Creative Commons.
5. Principles of Geographic Information Systems: An Introductory Textbook. (2004). Netherlands: International Institute for Geo-Information Science and Earth Observation.
6. Huisman, O., Rolf A. deBy (Ed.) (2009). Principles of Geographic Information Systems: An Introductory Textbook. The Netherlands: ITC Educational Textbook Series.
7. Longley, P. A., Goodchild M. F., Maguire, D. J., Rhind, D. W. (2015). Geographic Information Science and Systems (4th edition). NJ: John Wiley & Sons, Inc.
8. Anthamatten, P. (2021). How to Make Maps - An Introduction to Theory and Practice of Cartography. Taylor & Francis Group.
9. Sickle, J. V. (2004). Basic GIS Coordinates. Boca Raton: CRC Press LLC.