Las Positas College
3000 Campus Hill Drive
Livermore, CA 94551-7650
(925) 424-1000
(925) 443-0742 (Fax)

Course Outline for GEOG 15

INTRODUCTION TO GIS

Effective: Fall

I. CATALOG DESCRIPTION:
GEOG 15 — INTRODUCTION TO GIS — 3.00 units

GIS is a geographically-based, computer-assisted information technology that captures, stores, organizes, queries, and analyzes spatial relationships between locations and attributes of Earth's physical, cultural, and economic features. GIS facilitates visualization of spatial relationships and decision-making by interactively linking maps, databases, images, and charts. GIS is both a tool for learning across the curriculum and an integrated system and science for solving real-world spatial problems within and across every economic sector. This course introduces entry-level GIS theory, principles, concepts, applications, and operations through a combination of lectures, demonstrations, interactive web sessions and tutorials, and active learning strategies. Students will acquire basic hands-on GIS experience with current industry-standard software. Field trips may be required.

3.00 Units Lecture

Grading Methods:

Discipline:

	MIN
Lecture Hours:	54.00
Total Hours:	54.00

II. NUMBER OF TIMES COURSE MAY BE TAKEN FOR CREDIT: 1

III. PREREQUISITE AND/OR ADVISORY SKILLS:

IV. MEASURABLE OBJECTIVES:

Upon completion of this course, the student should be able to:

A. Define GIS and describe its subsystems and components;
B. Compare and contrast GIS with traditional mapping;
C. Describe or list some typical GIS applications;
D. Demonstrate basic computer literacy and skills for GIS;
E. Explain map feature concepts;
F. Apply fundamental cartographic concepts;
G. Explain or illustrate GIS data types and data models and their map structures;
H. Find, retrieve, download, and input various data types from a variety of sources;
I. Create metadata files and evaluate data quality, including sources of error;
J. Manage, query, analyze, and create spatial data using desktop GIS software;
K. Describe some of the data analysis functions that enhance visualization and decision-making capabilities of GIS;
L. Apply problem-solving and critical-thinking skills to the completion of several tutorial-based exercises, instructor assigned real-world mini-projects, and/or student-selected course projects;
M. Design and produce cartographic and graphical presentations that effectively communicate GIS project information.

V. CONTENT:
A. What is GIS?
1. Definition(s)
2. History
3. Advantages over traditional mapping
4. Introduction to GIS subsystems
a. Data input function
b. Data storage and retrieval function
c. Data manipulation and analysis functions
d. Data output function
5. Overview of GIS components
a. Hardware
b. Software
c. Data
d. People
e. Methods
B. GIS applications overview
1. Desktop GIS
2. GIS as a multi-disciplinary learning tool

3. GIS for spatial analysis

C. Basic computer literacy and skills for GIS
   1. Introduction to a GIS interface
      a. Graphical user interface
      b. Online help system
   2. Fundamental word processor, spreadsheet, and database skills
   3. Introduction to file management and working directories

D. Map feature concepts
   1. Points, lines, polygons
   2. Absolute and relative location
   3. Attributes
   4. Attribute symbols and codes
   5. Coordinate systems (location reference systems)
   6. Spatial distributions and relationships

E. Fundamental cartographic concepts
   1. Scale
      a. Definition
      b. Types
      c. Affect on point, line, polygon features and symbols
   2. Map properties
      a. Shape
      b. Area
      c. Distance
      d. Direction
      e. Proximity
   3. Map distortion
      a. Relation to size of area mapped
      b. Relation to projection of Earth to a plane
   4. Projections, ellipsoids, and datums

F. Overview of GIS data types and data models and their map structures
   1. GIS data types
      a. Spatial data
      b. Attribute (tabular) data
      c. Image data
   2. Spatial data models and their map structures
      a. Vector
      b. Raster
      c. Image
   3. Relationship of the “Paper Map World” to the “GIS Map World”
      a. Representation of points, lines, areas on a paper map
      b. Representation of points, lines, polygons on a GIS map
      c. GIS raster and vector storage of points, lines, polygons
   4. Overview of attribute data models
      a. Tabular
      b. Hierarchical
      c. Network
      d. Relational
      e. Object-oriented

G. Introduction to accessing and creating data
   1. Sources
      a. Hard-copy maps
      b. CAD drawings
      c. Aerial photographs
      d. Remotely-sensed satellite imagery
      e. Point data samples from surveys and GPS
      f. Existing digital files and the
   2. Data examples
      a. Demographic
      b. Transportation
      c. Land records
      d. Natural resources
      e. Terrain
      f. Other
   3. Data quality
      a. Metadata
      b. Precision, accuracy, and error
   4. Downloading and input techniques
      a. Digitizing
      b. Scanning
      c. Data compression and decompression
      d. Data conversion (source format to system-compatible format)
      e. Data projection
      f. Registration and conflation

H. Managing, querying, analyzing, and creating spatial data
   1. Thematic data (theme) concept
      a. Vertical organization of features and their attributes
      b. Spatial data source formats for themes
      c. Image and tabular data source formats for themes
   2. Managing thematic data
      a. Adding themes to a data view
      b. Features based on a spatial data source
      c. Images based on aerial photographs or satellite images
      d. X,Y coordinates from a table
      e. Accessing a theme attribute table
   3. Referencing thematic data to the real-world
      a. Review of the fundamental map projection concept
         1. Real-world (globe) locations measured in spherical latitude/longitude coordinates
         2. Corresponding map locations measured in planar x,y coordinates
         3. Distortion of map properties due to conversions of locations from spherical to planar coordinates
      b. Understanding when a map projection is required

1. Making measurements
2. Comparing map features
3. Aligning images and features

c. Setting properties of a data view
1. Definitions of unprojected and projected data
2. Working with unprojected and projected data
3. Setting distance units
4. Changing the scale

d. Measuring distance and area

4. Classifying, displaying, and symbolizing thematic data
a. Accessing the theme's legend
b. Legend types
1. Single symbol
2. Unique value
3. Graduated color
4. Graduated symbol
5. Dot density
6. Chart symbol

c. Classifying data for symbolization
1. Natural breaks
2. Quantile
3. Equal interval
4. Equal area
5. Standard deviation

d. Manipulating classes
1. Adding and deleting classes
2. Editing values and labels

e. Modifying legend elements
f. Changing symbols through palettes
g. Scaling symbols

5. Managing thematic data display
a. Selecting feature subsets
b. Setting scale thresholds for display of features
c. Labeling theme features
d. Creating linkages to images and documents

6. Querying features in a data display
a. Accessing information about features
b. Selecting features based on attributes

7. Managing tabular data
a. Adding tables from external sources
b. Creating a new table
c. Editing tables
1. Field definitions
a. Numeric
b. String
c. Boolean
d. Data

2. Adding records
3. Deleting fields and records
4. Editing cell values
5. Calculating new values

d. Creating a summary table for attributes tables

8. Querying records in a table
a. Selecting records based on attributes
b. Modifying the selected set
1. Adding records
2. Refining the selection
3. Creating a new selected set

c. Displaying statistics for a field
d. Creating a summary table

9. Joining and linking relationships between tables
a. Reasons for associating tables
b. Relational database basic concepts
1. Destination and source tables
2. Common field

c. Table record relationships
1. One-to-one
2. Many-to-one
3. One-to-many

d. Joining and linking
1. Operations
2. Results

10. Analyzing spatial relationships between two themes
a. Theme-on-theme selection concept:
1. Selector theme
2. Target theme(s)

b. Types of relationships
1. Proximity
2. Adjacency
3. Containment
4. Intersection

11. Analyzing spatial relationships by spatially joining tables
a. Spatial join concept
b. Kinds of spatial relationships to compare locations
1. Containment
2. Proximity

c. Join attributes based on containment
d. Join attributes based on proximity

12. Creating and editing coordinate files
a. Functions of coordinate files

1. Stores feature geometry (shape and location)
2. Stores indexes of feature geometry
3. Stores attribute information

b. Creating new coordinate files
1. Converting an existing theme to a coordinate file
2. Converting selected feature(s) to a coordinate file
3. Adding new features
4. Snapping features with a tolerance distance
5. Add attributes

c. Editing coordinate files
1. Reshaping a feature by moving, adding, or deleting vertices
2. Splitting line or polygon features and update attributes
3. Merging features and updating attributes
4. Optional operations (combine, intersect, subtract)

13. Address geocoding
a. Concept: linking addresses to geographic locations
b. Required input data
1. Reference street theme with attributes
a. Street name
b. Street type
c. Address rang
d. Direction
e. ZIP codes
2. Address table

c. 3-step geocoding process
1. Making the reference theme matchable
a. Set geocoding theme properties
b. Creating a geocoding index file
2. Batch-matching addresses in table to reference theme
a. Creating output geocoded point theme
b. Interpreting match scores
3. Re-matching addresses not batch-matched
a. Interactive re-match
b. Geocoding editor

d. Testing: locate a single address

I. Overview of other data analysis functions that enhance visualization and decision-making capabilities of GIS
1. Buffering and neighborhood functions
2. Surface analysis
3. Network analysis
4. Image analysis
5. 3D analysis
6. Business analysis
7. Tracking analysis

J. Cartographic and graphical presentation of GIS information
1. Cartographic layouts
a. Concepts
1. Interface for creating presentation-quality maps
2. Collections of documents, images, graphics, and text

b. Design factors
1. Purpose of map
2. Audience
3. Map elements
a. Map body
b. Legend
c. Scale bar
d. North arrow
e. Title
f. Neatline

c. Creating a map layout
1. Page layout: size, orientation, margins, grid
2. Defining, creating, and scaling frames

d. Adding and modifying graphics
e. Layout templates
1. Using standard templates
2. Creating custom templates

f. Layout print options

2. Charts
a. Creating a chart
1. Specifying elements to be graphed
2. Choosing a chart format
a. Area
b. Bar
c. Column
d. Line
e. Pie
f. S
g. X,Y scatterplot

b. Changing chart elements
c. Querying and editing charts
1. Extracting information from the table
2. Editing/selecting records in the table to change chart content
3. Adding and deleting data markers

VI. METHODS OF INSTRUCTION:

A. Lectures and learning modules (on a need-to-know basis)
B. **Demonstration** -
C. **Field Trips** - (some instructors may have field trips to government and commercial sites so students can experience “GIS at work”)
D. Hands-on computer experience with desktop GIS software and tutorials
E. Active learning

F. Interactive Web Sessions

VII. TYPICAL ASSIGNMENTS:

A. Read Part 1 "Getting to Know Desktop GIS" in Getting to Know ArcView GIS. The six chapters in Part 1 provide, through illustrated examples, an overview of desktop GIS: what it is, what it does, how it works, and how it is used to ask and answer questions about where things are and the spatial relationships between them. Part 1 also introduces you to what you need to know about data and how GIS is used to effectively communicate spatial information. Reading Part 1 will provide context for learning how to use ArcView GIS through completion of Part II tutorial-based exercises. You should supplement your Part 1 reading by viewing the following two parts of the Getting to Know ArcView GIS CD-ROM: "Desktop GIS Primer" and "ArcView GIS Showcase". Also, access The GIS Primer: An Introduction to Geographic Information Systems (by D. J. Buckley) on the web. Read the first six chapters: http://www.innovativegis.com/education/primer/primer.html Upon completion of the above, you should be prepared to complete several activities, of which the following are representative: 1. Write your own definition of GIS and compare it to definitions presented in the above materials and those you may find on the . What terms are common across the definitions? Include a summary description of GIS subsystems and components. 2. Describe or list some typical GIS applications. Choose one or two to compare and contrast GIS with traditional mapping. For the applications selected, consider the "static" nature of traditional mapping and the "dynamic" nature of GIS. B. Through active learning and assistance from the instructor, find, retrieve, download, and input various data types from a variety of sources. For example: 1. Access the on-line USGS digital terrain or line files and unzip the files. 2. Access ESRI's ArcData website and download the Tiger demographic files 3. Access and download data conversion programs on the web 4. Access tabular data and convert it to Excel format C. Using Part 2 of Getting to Know ArcView GIS and the "ArcView Tutorial" section of the CD-ROM, complete all of the tutorial-based exercises. These exercises will provide hands-on experience with the ArcView interface, how map features and their attributes are linked, and how to manage, query, analyze, and create spatial data. You will also learn how to communicate GIS project information by designing and executing a chart and map layout. Opportunities will be provided to transfer your newly learned skills to real-world mini-projects and/or a course project. These activities require you to follow a sequence of problem-solving and critical-thinking steps. For example: 1. Add themes to a view, by: a. Creating a personal directory b. Creating a project and a view c. Adding feature themes to a view d. Renaming the view e. Adding an image theme and a CAD theme to a view f. Saving and closing the project g. Adding an event theme to a view 2. Set view properties, by: a. Opening an existing project b. Checking the scale and map units c. Measuring distances on an unprojected view d. Applying a projection to the view e. Changing the projection You might be asked, for example, to consider how the projection type affected the measured distance or shape. D. As part of a project, you might be asked to: 1. Use GIS to compute the extremes, the mean, and the standard deviation for all the attributes in the data set. 2. Compute the length of a line and the area of a polygon in a vector GIS theme and in a raster GIS theme and consider why they might be expected to give different results.

VIII. EVALUATION:

A. **Methods**

1. Exams/Tests
2. Papers
3. Projects
4. Other:
    a. Methods (including typical examples of evaluation) Performance-based evaluations will be structured around criterion-referenced, competency-based learning modules. Each module will include: goals/objectives; required background reading/related media; procedures; resource information; and the following evaluation methods:
        1. Written (or oral) feedback on assigned background reading/media
            a. Examples: see "A" under Typical Assignments
        2. Demonstration of procedural skills to instructor
            a. Example: see "B" under Typical Assignments
        3. Maintenance of an electronic log or journal
            a. The following kinds of information will be stored on a zip disk for instructor review:
                1. Metadata
                2. Sequenced operational procedures in sufficient detail to ensure repeatability for future applications
                3. Other instructor-designated components
        4. Completion of module-based exercise(s) and/or mini-project(s)
            a. Example:
                1. Step 1: Using ArcView, create four views
                2. Step 2: Convert a designated theme for the U.S. to a shapefile
                3. Step 3: Add the shapefile to View 1
                4. Step 4: Copy the shapefile to the other three views
                5. Step 5: Assign a different projection to each view
                6. Step 6: Measure and record the distance between San Francisco and Washington D.C. in each view
                7. Step 7: Save the project in your working directory as modproj1.apr
                8. Step 8: Respond in writing (sample question):
                    1. How does the projection type affect the measured distance? Use available course resources, including appropriate websites, to address the map properties preserved and distorted by the selected projections.
        5. "Final" Project: An instructor may elect to have students complete a "final" course project. This project should be evaluated on the student's ability to demonstrate basic levels of awareness and competency for a specified number of course concepts and operations.
            a. Example: Select a GIS application of interest to you (e.g., spatial relationships between Bay Area faults, population, and infrastructure). Find data that may be publicly available on the or from other accessible sources. Be sure to maintain a metadata file. Use the data input capabilities of ArcView. Consider the necessary data structure conversions. Create and edit shapefiles as necessary. Perform queries and analyze spatial relationships using theme-on-theme selection and spatial joining, as appropriate. If your project involves notification of affected parties, consider geocoding addresses. Finally, prepare an effective presentation, using charts and layouts. Your project will be evaluated on your demonstrated problem-solving and critical-thinking abilities as they relate to the expected course outcomes.

B. **Frequency**

1. Frequency The frequency of evaluation will be based upon:
    a. Occasional assignments based upon background reading/media

b. The number of units in ArcView Part 2 (approximately 20)
c. The number of criterion-referenced, competency-based learning modules (to be developed)
d. One "final" project (instructor's option)

IX. TYPICAL TEXTS:

1. Buckley, David J *The GIS Primer: An Introduction to Geographic Information Systems.*, Innovative GIS Solutions, Inc, 1997.
2. Clarke, Keith C *Getting Started with Geographic Information Systems.* 2nd ed., Prentice Hall, 1999.
3. DeMers, Michael N *Fundamentals of Geographic Information Systems.* 2nd ed., John Wiley & Sons, Inc, 1999.
4. Environmental Systems Research Institute (ESRI) *Getting to Know ArcView GIS, Version 3.1.*, ESRI Press, 1998.
5. Heywood, Ian and Sarah Cornelius and Steve Carver *An Introduction to Geographical Information Systems.*, Addison Wesley Longman, 1998.

X. OTHER MATERIALS REQUIRED OF STUDENTS:

A. Computer Usage Card ($4.00 fee)
B. Zip Disk