INTERDISCIPLINARY 607 – CE/CRP/GEOG/GS 607
Fundamentals of Geographic Information Systems
Autumn 2009

This course covers basic principles of geographic information systems and their use in spatial analysis and information management. The course is designed to give students an understanding of cutting-edge geospatial technologies, their capabilities, uses, and limitations. Representative applications for each discipline area are demonstrated in the computer laboratory portion.

Course Coordinator: Prof. Ningchuan Xiao, Geography (1132 Derby Hall, 292-4072, xiao.37@osu.edu).

Textbook: Longley, P.A., Goodchild, M.F., Maguire, D.J, and Rhind, D.W. (eds.) 2005. *Geographic Information Systems and Science.* 2nd Edition, John Wiley & Sons, Inc.

Class website: http://carmen.osu.edu

Lecture Format: The course will be team-taught, with three lectures per week (MWF) in Hitchcock Hall 0035 from 12:30 to 1:18 PM. Please contact each instructor if you need to meet outside the office hours listed below.

Instructor	*Dept.*	*Email*	*Office*	*Office Hours*
Ola Ahlqvist	GEOG	ahlqvist.1@osu.edu	1049B Derby Hall	M 1:00-3:00 PM
Steve Gordon	C&RP	sgordon@osc.edu	290 Knowlton Hall	Tu 3:00-5:30 PM
Desheng Liu	GEOG	liu.738@osu.edu	1189 Derby Hall	WM 4:00-5:00 PM
Carolyn Merry	CIVIL	merry.1@osu.edu	470 Hitchcock Hall	Tu 11:30-12:30 PM
Ningchuan Xiao	GEOG	xiao.37@osu.edu	1132 Derby Hall	Tu 3:00-4:00 PM

Lab Sections: The following is a list of lab sections for different department.

Call #	*Department*	*Day*	*Time*	*Location*	*Instructor*
6868	Civil Engineering	Tu	9:30 - 11:18 AM	BO 332	Merry
6767	City & Regional Planning	Tu	5:30 - 8:18 PM	KN 0430	Gordon
11247	Geography	Tu	10:30 AM - 12:18 PM	DB 140	Xiao
11248	Geography	Th	10:30 AM - 12:18 PM	DB 140	Xiao
12145	Geodetic Science	Tu	9:30-11:18 AM	BO 332	Merry

Student Evaluation

Grading will be based on four elements:

- Lab exercises (55%)
- Online quizzes (10%)
- Reflection essays (10%). Students are required to write five one-page reflection essays for five selected lecture topics. If a lecture topic is selected for a reflection essay, it will be announced after the lecture.
- Final exam (25%)

Course Schedule

This is a complex syllabus; there may be changes or corrections announced in class. Labs are typically due in two weeks, unless otherwise announced. The exact date and time for labs and quizzes vary with the specific section you are registered.

Week	*Date*	*Lecturer*	*Topic*	*Readings*	*Lab & Quiz*
1	9/23	Xiao	Introduction	Ch 1	No lab
	9/25	Gordon	Introduction to spatial data	§3.1-3.5; Ch 4: 85-90	
2	9/28	Ahlqvist	Maps and map analysis	§3.7-3.8; §5.6-7	**Lab 1** Introduction
	9/30	Ahlqvist	Maps and map analysis	Ch 12	
	10/2	*Davis*	*GIS activities in Ohio*		
3	10/5	Xiao	GIS data models	Ch 8	Quiz 1
	10/7	Xiao	Vector data	§3.6.2-3; §14.4.1-3; +	
	10/9	*Field*	*GIS in anthropology*		
4	10/12	Merry	Raster GIS data	§3.6.1; §6.3.1; +	**Lab 2** Vector
	10/14	Merry	Raster operations	§16.2.4; +	
	10/16	*Merry*	*GIS in civil engineering*		
5	10/19	Xiao	Georeferencing	Ch 5	Quiz 2
	10/21	Ahlqvist	GIS visualization	Ch 11, 13	
	10/23	Liu	GIS data acquisition	Ch 9	
6	10/26	Merry	GIS and remote sensing	Ch 9: 199-216; Ch 20: 459-464	**Lab 3** Raster
	10/28	Liu	Data quality	Ch 6: 136-149	
	10/30	*Crecelius*	*GIS in natural resources*		
7	11/2	Gordon	Spatial databases	Ch 10: 218-228	Quiz 3
	11/4	Gordon	Spatial databases	Ch 10: 218-228	
	11/6	*Janies*	*GIS in public health*		
8	11/9	Xiao	Spatial data storage	Ch 10: 229-234	**Lab 4** Data relations
	11/11		*Veterans' Day (no class)*		
	11/13	Xiao	Spatial analysis I	Ch 14, 15	
9	11/16	Xiao	Spatial analysis II	Ch 14, 15	Quiz 4
	11/18	Xiao	Spatial modeling	Ch 16	
	11/20	*Gordon*	*GIS in city & regional planning*	*42-46; 55-60; 350-358*	
10	11/23	Gordon	GIS implementation	Ch 17	**Lab 5** (*) Final project
	11/25	Gordon	GIS implementation	Ch 17	
	11/27		*Thanksgiving Break (no class)*		
11	11/30	Merry	Ethics in GIS	Ch 21: 471-486	Quiz 5
	12/2	Merry	The future of GIS	Ch 21: 471-486	
	12/4	Xiao	Review & wrap-up		
12	12/7		**Final 11:30 AM - 1:18 PM**		

\+ The symbol "+" denotes that additional materials will be used in the lecture.

* Due to holiday schedule in week 10, students enrolled in the 11248 section (Thursday) are encouraged to go to one of the Tuesday labs scheduled on November 24.

Topics in *Fundamentals of GIS*

1. Introduction (Xiao)
    a. Basic concepts
    b. What is a GIS?
    c. Users of GIS
    d. History of GIS
    e. Recent developments

2. Introduction to spatial data (Gordon)
    a. Spatial elements – points, lines, areas and surfaces
    b. Spatial measurement levels
    c. Spatial location and reference
    d. Spatial relationships
    e. GIS data models
    f. Attribute data

3. Maps and map analysis (Ahlqvist)
    a. Map elements and their properties
    b. Real and virtual maps
    c. Map projections, distortions and transformations
    d. Map referencing – direct, relative
    e. Mapping principles applied to digital maps and spatial analysis
    f. Coordinate systems

4. Spatial data modeling vector GIS (Xiao)
    a. Concepts of data modeling
    b. Continuous field and discrete objects
    c. Vector data and its characteristics
    d. Advantages and limitations of vector mapping systems
    e. Topology
    f. Vector GIS capabilities
    g. TIN model
    h. Network model
    i. Connectivity

5. Raster GIS (Merry)
    a. Raster data and its characteristics
    b. Advantages and disadvantages of raster mapping systems
    c. Raster functions – raster data overlay, buffers
    d. Grid model; DTM
    e. Accuracy
    f. Quadtree model

6. Georeferencing
    a. What is georeferencing?
    b. Placenames
    c. Postal codes and addresses

d. Linear referencing systems
e. Spatial coordinate systems
f. Converting georeferencing systems

7. GIS visualization (Ahlqvist)
   a. Data to display
   b. Cartographic considerations
   c. Map symbols
   d. Potentials and limitations

8. Data in a GIS – acquisition (Liu)
   a. Digitizing
   b. Scanning
   c. Surveying
   d. GPS data
   e. Photogrammetry
   f. Metadata

9. Data in a GIS – remote sensing (Merry)
   a. Electromagnetic spectrum
   b. Images – aircraft and satellite
   c. Radiometric and geometric correction
   d. Supervised vs. unsupervised classification

10. Data quality (Liu)
   a. Accuracy vs. precision
   b. Measurement of logical consistency
   c. Completeness; lineage; timeliness; attribute data accuracy
   d. Accessibility needs
   e. Available tools
   f. Sources of error

11. Spatial databases (Gordon)
   a. Basic file structures
   b. Data structures – relational, hierarchical, network
   c. Integration of spatial, attribute and topological data
   d. Object-oriented databases

12. Data in a GIS – storage (Xiao)
   a. Geometry
   b. Attributes
   c. Distributed
   d. SQL
   e. Database design
   f. User interfaces

13. Spatial analysis (Xiao)
   a. Spatial objects, measurements and models
   b. Application of measures

c. Proximity and contiguity analysis
d. Map data retrieval and search; map overlay; classification and reclassification
e. Neighborhood functions
f. Cartographic algebra
g. Logic & geometric operations
h. Network representation
i. Hydrologic modeling

14. GIS implementation (Gordon)
    a. Requirement analysis and system design
    b. Time and cost analysis for data, hardware and software
    c. Cost/benefit analysis of GIS
    d. Organization issues
    e. Choosing hardware and software
    f. Operation and maintenance

15. Ethics in GIS (Merry)

16. The future of GIS (Merry)
    a. Technological developments
    b. New applications
    c. Data access
    d. Research and development

17. GIS applications (Guests)
    a. Geography/human resources
    b. Geology
    c. Transportation/engineering
    d. Environment/natural resources
    f. Anthropology

Computer laboratories:

Each department that sponsors the interdisciplinary course is responsible for developing, delivering, monitoring and grading an appropriate set of laboratory exercises. All participating departments will include an agreement upon common minimum set of exercises for each lab. Each department may also assign its own weight to the lab assignments. Lab assignments will include the following:

Lab 1. *Introduction to ArcGIS, Geodata, and Map Projections.* Using ArcGIS, students will become familiar with the ESRI ArcGIS software, explore different types of geodata available, learn basic database operations, and learn about the different types of map projections. Specific objectives include learning how to use ArcGIS; the types of geodata in a GIS environment – vector, raster and images; how to display data in ArcGIS; types of map projections; and how to generate a meaningful map. (2 weeks)

Lab 2. *Vector Data Operations.* Using ArcGIS, students will become familiar with vector data operations. Specific objectives are to perform visual interpretations of vector data,

learn vector buffer operations, and learn basic vector operations using the ArcGIS GeoProcessing wizard. (2 weeks)

Lab 3. *Raster Data Operations.* Using ArcGIS, students will become familiar with raster data and learn simple data manipulations in a raster system. Specific objectives are to understand and learn general aspects and display of raster data (grid dataset), map algebra/data reclassification, and raster buffer operations. (2 weeks)

Lab 4. *Data Relations.* The purpose of this lab is to become familiar with data relationships in a GIS. Specific objectives are to understand the relationships in datasets and attribute/spatial relations, and to learn the difference between a join and relate operation. (2 weeks)

Lab 5. *Applications of GIS – Final Project.* Students will perform a spatial analysis exercise, given only the criteria to use for reaching a conclusion. Objectives are to explore a data set and the geographic distribution of the variables and to arrive at several conclusions. Other objectives include learning to design and perform the necessary data analysis in a vector-based or raster-based GIS. Data export utilities to other applications, such as Microsoft Access or Excel, will be learned for developing a more complete statistical analysis of spatial data. (2 weeks)

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the Committee (Faculty Rule 3335-5-847). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Disability Services: Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD292-0901; http://www.ods.ohio-state.edu/.