Instructor: Wil Gorr <gorr@cmu.edu>, 2109D HB, Office Hours Wednesdays noon–1:30 p.m. and by appointment

Prerequisite: 90-728, Introduction to Database Management Systems, equivalent course, or permission of instructor.

TAs: (Office hours to be posted on Blackboard, 94-802, Teaching Staff)

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<tr>
<th>Katy Getsie</th>
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<tr>
<td>Michael Lampl</td>
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Class Web Site: [http://www.cmu.edu/blackboard](http://www.cmu.edu/blackboard)

Course Description:

A geographic information system (GIS) provides storage, retrieval, and visualization of geographically-referenced data as well as design and analysis of spatial information. GIS provides unique analytical tools to investigate spatial relationships, patterns, and processes of cultural, biological, demographic, economic, social, environmental, health care, criminal, and other phenomena.

The course includes lectures, self-paced computer labs, and a project using the leading GIS software, ArcGIS Platform (Pro, ArcMap, ArcCatalog, and Online) from Esri. Subject areas include:

- **Geodesy** (world coordinate systems, sea level/elevation, map scale, and map projections)
- **Spatial data infrastructure** (TIGER maps, census data, satellite and aerial photo images, and local government cadastral maps)
- **Map design** (cartographic principles, interactive maps, map layouts, and online GIS)
- **Geodatabases** (importing spatial and attribute data, geocodes, table joins, data aggregation, and map SQL criteria queries)
- **Creation of new spatial data** (digitizing, geocoding, and dissolving vector features)
- **Geoprocessing** (clipping, merging, appending, joining, and dissolving)
- **Spatial analysis** (proximity analysis, site suitability, optimal network modeling, and spatial data mining)
- **Web-based GIS** (map authoring on ArcGIS Pro with publishing on ArcGIS Online including apps)
- **Macros** (flowchart-based design, form-based processes, user interface)
- **3D GIS** (3D surface modeling, draping/extruding features, fly-throughs, line-of-sight analysis)
- **Raster GIS** (hillshade, kernel density estimation, risk index modeling)
Course Objectives:

- Identify and structure the spatial characteristics of diverse application areas for spatial data visualization, design, and analysis.
- Search for, access, and use the world’s quickly-growing spatial data infrastructure.
- Become a skillful user of leading GIS software.

Objectives are met and assessed through weekly homework assignments, a take-home case study, two exams, and a project.

Required items:

- Fairly-large three-ring binder for photocopied tutorials.
- Thumb drive with at least 4 GB space available for using the computers in 239 HBH. If using your own computer with ArcGIS Pro and ArcGIS 10.3 installed on it, you will not need a thumb drive.

Course Materials:

- Lab books: Photocopies of selected chapters provided for
- PowerPoint Slides: used in lectures for note taking (available from Blackboard and provided in hard copy at the start of each lecture)
- ArcGIS Pro 1.1 and ArcGIS Desktop 10.3.1 software: to install on your own computer, download from https://download2.heinz.cmu.edu/secure/sdl/ or to use online via Virtual Andrew download client software from http://www.cmu.edu/computing/clusters/software/virtualandrew/index.html.
- Publisher role, username, and password in Heinz College’s ArcGIS Online organizational account: cloud-based GIS for sharing and accessing GIS map layers and maps.

Grades:

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<th>Component</th>
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<tbody>
<tr>
<td>Homework</td>
<td>25%</td>
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<tr>
<td>Case Study</td>
<td>15%</td>
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<td>Exam 1</td>
<td>15%</td>
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<td>Exam 2</td>
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<td>Project</td>
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<td><strong>Total</strong></td>
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I will curve grades and attempt to follow Heinz College guidelines that elective courses should have a mean grade of A-.

Additional Learning Resources

Clarification and discussion of GIS course materials are not limited just to lectures and lab sessions. Also provided are the instructor’s office hours, TA office hours, and a Blackboard Discussion Board. Neither instructor nor the TAs will answer questions through email that would have benefit for the class, but instead will monitor the Blackboard Discussion Board daily and respond to questions.
Policy on Collaboration and Cheating:

This course follows Heinz College policies on ethics and discipline as stated in student handbooks. A specific policy of this course is as follows:

**Homework assignments**—Do not copy or modify homework solutions done by others for your homework solutions. Homework must be individual work unless otherwise stated. You may consult each other on clarification, technical and conceptual issues, but you must do individual problem solving and derive your own solutions, including your own computer work.

You are not permitted to be in possession of *any* assignments from another student or any other source either from the current semester or from past semesters whether they are in electronic or paper form. Possession of or sharing such files constitutes an infraction of the academic integrity policies of this course.

Plagiarism means using words, ideas, or arguments from another person or source without citation. Cite all sources consulted to any extent (including material from the internet), whether or not assigned and whether or not quoted directly. For quotations, four or more words used in sequence must be set off in quotation marks, with the source identified.

Any form of cheating on a homework assignment or the case study will result in the highest grade possible in the course being a “C” for the first offense and will drop a letter grade for each successive offense. Any form of cheating on the exams or project will result in failing the course. As a matter of Heinz College policy, when you fail a course, the failing grade remains on your transcript permanently and you cannot replace the failing grade by retaking the course.

By remaining enrolled, you consent to this policy.

**Late Homework Policy:**

I will not accept late homework unless you have an extenuating circumstance (illness, need to be out of town, etc.). Let me know ahead of time and I will grant an extension.

**Re-grading Policy:**

Grade sheets, available from Blackboard after grading is completed, contain solutions as well as feedback and scores for your assignments. If you believe that there was an error in grading an assignment, please contact the TA who graded it to resolve the issue. If you cannot resolve the issue to your satisfaction with the TA, then please send an email message to me with the issue.

Please ask for any re-grading of an assignment within one week after it was returned, otherwise we will not re-grade the assignment.

I’ll also post the solution to the exams on Blackboard after you have taken them. Do to the unique nature of the case study, there is no one solution for it. If you believe that there was an error in grading exams or the case study, please put your exam in my faculty mailbox with a note on the issues and I’ll re-grade.
Class Schedule
(subject to change)

Week 1, Introduction

1/11/2016—Lecture

Assignment #1, due 11:59 p.m., Tuesday, 1/19/2016 (see Blackboard > Assignments)

- Course overview and policies
- GIS definition
- Map layers and their properties
- Geospatial data types (vector, network, raster map, and 3D layers)
- Map scale (ratio, scale bar), scale thresholds
- Student projects
- Brief history of GIS (view two videos from Blackboard > Content > Week 1)

1/13/2016—Lab session (GIS Tutorial for ArcGIS Platform, chapter 1)

Note: Lab sessions will get you a good start on working through the assigned tutorial chapter, but normally you’ll have to finish tutorials on your own time, outside of class. Tutorial work is not graded, but is strictly for you to learn ArcGIS. An option, starting with week 2, will be for you to work the tutorial on your own ahead of lab time and then use lab time for questions on the tutorial and for working on the week’s homework assignments. If the TAs or I determine that you have not worked through a tutorial before starting corresponding assignments, we’ll not answer assignment questions on basics covered in the tutorial.

- Work with the ArcGIS Pro interface
- Navigate GIS maps (zoom, pan, spatial bookmarks, Search for features)
- Work with attribute data (sort records, modify data attributes, select records, get statistics)
- Symbolize maps (symbolize and label layers, add/remove layers, view 2D and 2D maps side-by-side)
- Publish maps on ArcGIS Online

Week 2, Map design

Assignment #2, due 11:59 p.m., 1/25/2016

1/18/2016—Martin Luther King Day, no class

View video of lecture 2 via Blackboard > Content > Week 2 before 1/20/2016 lab

- Design principles (contrast, graphic hierarchy, minimize ink)
- Color (spectrum, hue, wheel, saturation)
- Symbolizing points (unique, graduated-size, and mimetic point markers)
- Symbolizing lines (width, pattern, color)
- Symbolizing polygons (choropleth maps and color ramps, normalized attributes, polygon centroids and point symbols, dot density maps)
- Numeric scales (uniform, clustering, geometric, quantiles)
- Feature labels

1/20/2016—Lab (GIS Tutorial for ArcGIS Platform, chapter 2)

- Construct and symbolize point and choropleth maps
- Create normalized and density maps
- Create definition queries

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1 Homework assignments are normally due on Mondays at midnight, but an exception is made here with assignment 1 due on Tuesday because of MLK day.
• Create group layers and layer packages

**Week 3, Layouts and story maps**
*Assignment #3, due 11:59 p.m., 2/1/2016*

1/25/2016—Lecture
• Map layouts (*maps, legend, text, scale bar*)
• Story maps (*design of, resource folder for, apps*)
• Map animations
• Guided tour of Esri website

1/27/2016—Lab (*GIS Tutorial for ArcGIS Platform*, chapter 3)
• Build interactive maps with visibility ranges
• Build map layouts
• Build a Story Map using provided resources
• Review Excel and Windows Snipping tool for creating tables and charts

**Week 4, Geodatabases**
*Assignment #4, due 2/8/2016*

2/1/2016—Lecture
• Attribute table format and file types
• Geocodes (*ANSI, census, administrative*)
• Spatial data formats (*XY data, coverages, shapefiles, file geodatabases*)
• Attribute table joins (*1-to-1 and 1-to-many*)
• Spatial joins
• Attribute SQL queries

2/3/2016—Lab (*GIS Tutorial for ArcGIS Platform*, chapter 4)
• Build a file geodatabase using ArcCatalog
• Use ArcCatalog utilities (*preview, rename, copy, and import/export tables and feature layers*)
• Modify an attribute table (*delete unneeded columns, modify a primary key, calculate a new column*)
• Join tables to map layers
• Make attribute queries
• Aggregate point data to space and time series data (*spatial join*)

**Week 5, Importing geospatial data**
*Assignment #5, due 2/15/2016*

2/8/2016—Lecture
• Map coordinate systems (*geographic/spherical versus rectangular*)
• Map projections (*small and large scale, conformal versus equivalent projections, map infrastructure*)
• Geodesy (*geoid, ellipsoid, datum*)
• Geospatial data packaging (*metadata, quadrangles, seamless maps, spatial reference data*)
• Spatial data sources (*physical surface, environmental, political, populations, biology/ecology*)
• Census and American Community Survey (ACS) data

2/10/2016—Lab (*GIS Tutorial for ArcGIS Platform*, chapter 5)
• Work with map projections (*world, US, coordinate systems*)
• Download maps and spatial data (*Census website*)
• Download and process Census/American Community Survey data
**Week 6, Geoprocessing**

Assignment #6, due 2/22/2016

Proposal for GIS Project is due on 3/23/2016

2/15/2016—Lecture
- Building study regions from basemaps
- Extraction (by attribute query of geocodes, by spatial relationships)
- Geoprocessing (Clip, Dissolve, Append, Merge, Union, Intersect)
- Macros (work flow automation using geoprocessing tools)
- Assign and discuss class project

2/17/2016—Lab (Chapter 6, *GIS Tutorial for ArcGIS 10.3*)
- Overview of ArcMap user interface and relative paths
- Clip features
- Dissolve features
- Append layers
- Union layer
- Use ModelBuilder to automate a work flow

**Week 7, Geocoding**

Assignment #7, includes case study, due 3/2/2016

2/22/2016—Lecture
- “Fuzzy” matching process and algorithms
- Polygon geocoding
- Linear geocoding with street address data
- Problems with geocoding and solutions
- Reference data (ZIP Codes, TIGER, parcel address points, StreetMap Premium, online geocoders)
- US Postal Service address standards
- Geocoding results and reporting

2/24/2016—Lab (GIS Tutorial for ArcGIS Platform, chapter 9)
- Creator an address locator file
- Geocode using ZIP codes
- Batch match street address data
- Work with address match statistics
- Use a place name alias file
- Rematch addresses interactively
- Using StreetMap in ArcMap

**Week 8, Exam, project assignment, and case study**

2/29/2016—Exam
- Covers weeks 1 through 7
- Paper and pencil (*no computer work*)
- One-page cheat sheet allowed (*front and back, handwritten or typed*)

3/2/2016—Work on case study

Spring Break, no class week of 3/7-11/2016
Week 9, Analytical methods
Assignment #9, due 11:59 p.m., 3/21/2016
3/14/2016—Lecture
- Proximity analysis
- Site suitability analysis
- Transportation network elements (*edges, junctions, turns, connectivity, impedance*)
- Network optimization models
- K-means clustering

3/16/2016—Lab (*GIS Tutorial for ArcGIS Platform*, chapter 10)
- Multiple-ring polygons,
- Service area polygons
- Site suitability modeling
- Traveling salesman problem
- Location-allocation modeling
- Cluster analysis
- Optional video and tutorial on spatial regression analysis

Week 10, Raster GIS
Assignment #10, due 11:59 p.m., 3/28/2016

3/21/2016—Lecture
- Raster format data and basemaps
- Hillshade
- Kernel density smoothing (*methodology, parameters, calibration*)
- Improper linear models and risk surface modeling

- Extract and symbolize raster maps
- Create a hillshade map
- Estimate mean surfaces using kernel density smoothing
- Build a risk index model

Week 11, Operations Management
Assignment #11 (turn in completed tutorial for credit), due 11:59 p.m., 4/4/2016

3/28/2016—Lecture
- Event data management methods
- Models for data management and mapping
- Operations Dashboard
- Collector for field data viewing, input, and editing

3/30/2016—Lab (*GIS Tutorial for ArcGIS Platform*, chapter 12)
- Building data and mapping models
- Building a dashboard
- Using Collector

Week 12, 3D GIS
Assignment #12 (turn in completed tutorial for credit), due 11:59 p.m., 4/11/2016

4/4/2016—Lecture
- Triangulated Irregular Network (TIN) 3D surface model
- Draped and extruded features
• Rule packages for symbolizing built environment
  4/6/2016—Lab (GIS Tutorial for ArcGIS Platform, chapter 12)
• Navigating 3D scenes
• Working with elevation surfaces
• Creating 3D map scenes
• Applying rule packages

**Week 13, Exam and work on project**
  4/11/2016—Exam
  4/13/2016—Lab, work on project

**Week 14, Project**
  4/18/2016—Lab, work on project
  4/20/2016—Lab, work on project

**Week 15, Project**
  4/25/2016—Lab, work on project
  4/27/2016—Lab, work on project

Completed project is due at 11:59 p.m., 4/29/2016