George Mason University
Graduate Course Approval/Inventory Form
Please complete this form and attach a copy of the syllabus for new courses. Forward it as an email attachment to the Secretary of the Graduate Council. A printed copy of the form with signatures should be brought to the Graduate Council Meeting. Complete the Coordinator Form on page 2, if changes in this course will affect other units.

Please indicate:  
X  NEW  ___  MODIFY  ___  DELETE

Local Unit: SCS  
Graduate Council Approval Date:

Course Designation: EOS  
Course Number: 771

Full Course Title: Algorithms and Modeling in GIS

Abbreviated Course Title (24 characters max.): Algorithms and Modeling in GIS

Credit hours: 3  
Program of Record: ESS M.S., CSI Ph.D.

Repeatable for Credit?  
D=Yes, not within same term  
T=Yes, within the same term  
X=N=Cannot be repeated for credit

Activity Code (please indicate):  
X  Lecture (LEC)  __  Lab (LAB)  __  Recitation (RCT)  
__  Studio (STU)  __  Internship (INT)  __  Independent Study (IND)  __  Seminar (SEM)

Catalog Credit Format  3: 3: 0  
Course Level: GF(500-600)  ____  GA(700+)  __X__

Maximum Enrollment: 20  
For NEW courses, first term to be offered: F04

Prerequisites: Prior course or experience in GIS and computer programming

Catalog Description: This course examines several fundamental GIS algorithms based upon computational geometry and computer graphics. It will also discuss issues in modeling features of different dimensions and surfaces in GIS. Significant programming is expected.

For MODIFIED or DELETED courses as appropriate:
Last term offered:  
Previous Course Abbreviation:  
Previous number:

Description of modification:

APPROVAL SIGNATURES:
Submitted by:  
Department/Program:  
College Committee:  
Graduate Council Representative: 
email: 
Date: 
Date: 
Date: 
Date: 

Approval from other units:

Please list those units outside of your own who may be affected by this new, modified, or deleted course. Each of these units must approve this change prior to its being submitted to the Graduate Council for approval.

<table>
<thead>
<tr>
<th>Unit:</th>
<th>Head of Unit’s Signature:</th>
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Graduate Council approval: _______________________________ Date: ____________
Graduate Council representative: _________________________ Date: ____________
Provost Office representative: __________________________ Date: ____________
Course proposal to the Graduate Council
by
The School of Computational Sciences

1. COURSE NUMBER AND TITLE

EOS 771 Algorithms and Modeling in GIS

Prerequisites: Prior course or experience in GIS, programming experience is preferred

Catalog description: This course examines several fundamental GIS algorithms based upon computational geometry and computer graphics. It will also discuss issues in modeling features of different dimensions and surfaces in GIS. Significant programming is expected.

2. COURSE JUSTIFICATION

Course objectives: In this course, we will examine several technical aspects of GIS related to algorithms and spatial data modeling. These aspects include some fundamental concepts in computational geometry/computer Graphics, common analytical algorithms using in GIS environment, and the data modeling of spatial data of points (0D), lines (1D), polygons (2D), and volumetric objects (3D). Algorithms related to surface modeling will also be addressed.

Course necessity: There is no such course in SCS or in GMU addressing the algorithms issues behind the Geographic Information Systems operations. It is crucial for students to learn what are behind the scene, acquire the knowledge to develop new or improve existing algorithms, and implement them.

Course relationship to Exiting Programs: This course is currently offered (Fall 03 with 17 students) as CSI 759 Special Topics. It will be an elective course for students in the Earth Observing track in Ph.D. in CSI or the MS ESS students. It will also serve MS in Geography in CAS.

Course relationship to Other Existing Courses: There is no similar course in SCS. The Geography Department in CAS offered a course in spatial data structure with some concepts served as the bases of the proposed course, but no computational issues are addressed and programming or implementation is required.

3. APPROVAL HISTORY

4. SCHEDULING AND PROPOSED INSTRUCTORS

Semester of Initial Offering: Fall 2004

Proposed instructors: Dr. Chaowei (Phil) Yang

5. TENTATIVE SYLLABUS: See attached.
EOS 771 Algorithms and Modeling in GIS

Instructors: Drs. Chaowei (Phil) Yang, David Wong

Time: Tuesday, 0430PM-0710PM  Place: IN 320, Fairfax Campus

Course Description:
How to find the centroid, perimeter, or area of a polygon? How can the system tell that the two lines cross each other? How can the system determine if the two polygons overlap and by how much? How are geographical surfaces represented? How to derive their properties (intervisibility, aspect, etc)? This course addresses these types of question.

In this course, we will examine several technical aspects of GIS related to algorithms and spatial data modeling. These aspects include some fundamental concepts in computational geometry/computer Graphics, common analytical algorithms using in GIS environment, and the data modeling of spatial data of points (0D), lines (1D), polygons (2D), and volumetric objects (3D). Algorithms related to surface modeling will also be addressed. Some Programming basics with extensive tutorials are also included for students without programming background. Therefore, students with very little programming background will gradually develop programming skill, but a solid conceptual/theoretical foundation of GIS is required (prerequisite).

ARC/INFO and related extensions from ESRI will be used as examples for interpreting the internal GIS functions. The course will provide hands on experience by implementing some algorithms. The programming languages supported by the instructors are Java and C++ (for Java, we will use JBuilder Personal Version, which is a very user-friendly Java compiler programming environment), but students can select any programming language of their choice. A term project and some short exercises will help student develop the skill and capability to understand spatial data structure and implement spatial algorithms and data models. Students will also develop a solid and in-depth understanding of the geographic system internal organization and operations in related to spatial data handling and analysis. Potentially students will develop the ability to solve geographic related problems at the algorithm level.

References
The following books and websites will serve as references:

Programming Language
Java, VB, or C++ or others

Grading
All exercises and the term Project are to be submitted online (class website will be available online when class began).
Short Exercises 70%
Term Project (20%) and Presentation (10%)
## Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
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<tbody>
<tr>
<td>1(^{st}) Class</td>
<td>Class overview and review of basic data models: point, line, polygon, Introduction to UML: Object, Class, Inheritance, abstraction, encapsulation</td>
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<tr>
<td>2(^{nd}) Class</td>
<td>Mathematical foundation and Geometry computing: point-in-polygon, line intersection, polygon overlap</td>
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<td>3(^{rd}) Class</td>
<td>Programming language foundation I: Introduction to JBuilder &amp; Microsoft VC++</td>
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<td>4(^{th}) Class</td>
<td>Programming language foundation II: Point, Array, Pointer, Shape file</td>
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<td>5(^{th}) Class</td>
<td>Raster Data Algorithms: run length encode, quadtree</td>
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<td>6(^{th}) Class</td>
<td>Raster Data Algorithms: area calculation, classification</td>
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<tr>
<td>7(^{th}) Class</td>
<td>Vector Data Algorithms: line intersection, area, length, centroid</td>
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<tr>
<td>8(^{th}) Class</td>
<td>Vector Data Algorithms: topology &amp; spatial relation</td>
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<td>9(^{th}) Class</td>
<td>Network Data Algorithms: Network data maintenance and shortest path</td>
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<tr>
<td>10(^{th}) Class</td>
<td>Surface Data Algorithms: DEM, TIN, Contours</td>
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<td>11(^{th}) Class</td>
<td>Surface Data Algorithms: Slope, Aspect, Flowing direction</td>
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<td>12(^{th}) Class</td>
<td>Spatial Indexing and Querying: bounding box, overlap, binary search, R-tree</td>
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<tr>
<td>13(^{th}) Class</td>
<td>Introduction to Advanced Topics (System performance, reliability, etc.)</td>
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<tr>
<td>14(^{th}) Class</td>
<td>Final Presentation</td>
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## Contact Information

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<tr>
<th>Instructors</th>
<th>Chaowei (Phil) Yang</th>
<th>David W. Wong</th>
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