SPECIAL REPORT

OF THE

ACADEMIC MATTERS, ACADEMIC PRIORITIES AND
PROGRAM AND BUDGET COUNCILS

concerning a

GEOGRAPHIC INFORMATION SCIENCE
AND TECHNOLOGY (GIST) CERTIFICATE PROGRAM

Presented at the
753rd Regular Meeting of the Faculty Senate
December 10, 2015

COUNCIL MEMBERSHIP

ACADEMIC MATTERS COUNCIL


ACADEMIC PRIORITIES COUNCIL

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PROGRAM AND BUDGET COUNCIL

ACADEMIC MATTERS COUNCIL

The Department of Geosciences is proposing to establish a 16-credit undergraduate certificate in Geographic Information Science and Technology (GIST). The certificate will require three foundation courses, one required advanced course, and one elective course that includes a project-based integration of GIST skills and spatial thinking. The proposal notes that the foundation courses would typically be taken by interested students as part of their majors. The purpose of the proposed certificate is to give students a foundation and credential in geospatial technologies that will enable them to pursue careers or further studies in geography and related fields.

The Program Subcommittee recommends approval of the proposed certificate.

At its meeting on October 7, 2015, the Academic Matters Council voted unanimously to recommend Faculty Senate approval of the Geographic Information Science and Technology (GIST) Certificate Program, submitted as proposal # 1678 in the Course and Curriculum Management System.

ACADEMIC PRIORITIES COUNCIL

The Department of Geosciences’ geography program proposed an undergraduate Geographic Information Science and Technology (GIST) certificate program that will enable students to obtain focused training and credentials in Geospatial technologies and spatial thinking, including Geographic Information Systems (GIS), Remote Sensing (RS), and computer mapping (CM), beyond the foundation level. These technologies and techniques enable users to acquire, manage, store, visualize, analyze and represent various types of location-based data. These are core concerns of the academic field of geography, building on geography’s long-standing emphasis on traditional cartography. GIS, RS, and CM have become fundamental geographic skills, and courses providing training in them are typically provided by geography programs.

At its meeting on October 15, 2015, the Academic Priorities Council recommended approval of the GIST certificate, proposal #1678 in the Course and Curriculum Management System.

PROGRAM AND BUDGET COUNCIL

The Program Subcommittee of the Program and Budget Council met on October 14, 2015, reviewed the Geographic Information Science and Technology (GIST) Certificate Program and recommended it for approval.

At its meeting on Wednesday, October 21, 2015, the Program and Budget Council voted to unanimously approve the Geographic Information Science and Technology (GIST) Certificate Program. It was submitted as proposal #1678 in the Course and Curriculum Management System.

MOVED: That the Faculty Senate approve the Geographic Information Science and Technology (GIST) Certificate Program, as presented in Sen. Doc. No. 16-020.
I. PROPOSAL DEVELOPMENT

A. Describe the Proposal.

The Department of Geosciences’ geography program\(^1\) proposes an undergraduate Geographic Information Science and Technology (GIST) certificate program which will enable students to obtain focused training and credentials in Geospatial technologies and spatial thinking, including Geographic Information Systems (GIS), Remote Sensing (RS), and computer mapping (CM), beyond the foundation level. These technologies and techniques enable users to acquire, manage, store, visualize, analyze and represent various types of location-based data. These are core concerns of the academic field of geography, building on geography’s long-standing emphasis on traditional cartography. GIS, RS, and CM have become fundamental geographic skills, and courses providing training in them are typically provided by geography programs.

At the University of Massachusetts Amherst the geography program provides sequenced GIST courses (foundational, advanced, and practicum/internship), which are options in the geographic skills and techniques requirement, as well as open electives, for the BA and BS degrees in geography. Other departments offering GIST courses include Environmental Conservation, Landscape Architecture and Regional Planning, and Civil Engineering. The certificate program will enable undergraduate students who have taken the foundation courses in any department to continue with more advanced education and certification.

The GIST certificate program is designed to provide students with the background and skills needed for GIST-related employment and graduate studies, and certification to assist them in securing jobs in this field. The demand for geospatial skills is growing worldwide, with job opportunities growing and diversifying as geospatial technologies prove their value in ever more areas (Nature, 2004). The US Department of Labor identified geotechnology as one of the three most important emerging and evolving fields, along with nanotechnology and biotechnology, in 2004. GIST career opportunities have continued to develop. “Geographic Information Systems Analyst” was ranked among the top 100 Best Jobs in America by CNN Money in 2010. But GIST skills are gaining much broader relevance as skills are also used in a wide variety of academic and applied fields today, including planning, environmental monitoring, natural resource management, health and human services, and homeland security.

GIST degree and certificate programs have proliferated nationwide, normally offered by geography programs. In 2007 there were 22 on-campus GIS masters programs and 45 on campus GIS certificate programs in US universities (University Consortium for Geographic Information Science, 2014); by 2014, this number has grown to about 177 GIST programs in the U.S. (www.urisa.org). Most of these programs are in geography departments in public universities. In New England, there are 11 four-year institutions offering GIS certificates. The geography program has been offering both foundational and advanced level GIS, remote sensing, and digital mapping courses for more than 10 years to students from more than 10 departments. Our program provides sufficient courses to enable undergraduate or non-degree students to earn a 16 credit GIST certificate that combines solid basic skills in GIS, remote sensing, and computer cartography and advanced training in either GIS or remote sensing. We anticipate that we can accommodate the increased number of students (5-10 per year) that the GIST certificate will attract with existing faculty, TA, and classroom resources.

\(^1\) The geography degree program comprises core geography faculty within the Department of Geosciences as well as faculty affiliates in other departments, administers four unique degree options (B.A. – General Geography, B.A.-Environmental Geography, B.S. Geography and M.S. Geography) and shares in the Geosciences Ph.D. program. For more information about geography at UMass, see http://blogs.umass.edu/umgeog.
The proposed certificate program is designed to be accessible to students in other majors. Students in several other departments and programs can combine foundation courses in their home departments with further breadth and advanced courses in order to complete the certificate.

Curriculum

The program requires 16 credits total, 3 foundation required courses, 1 advanced-level required course, and 1 elective course.

Three required foundation courses (10 total credits) provide fundamental background knowledge, skills, and breadth in GIS, Remote Sensing, and computer mapping respectively. The GIS courses which can be used to fulfill the introductory course requirement are currently offered in four departments on campus, each of which (other than geography/geosciences) restricts these courses to majors due to high demand. In addition to the foundation courses in GIS, the geography program and the Dept. of Environmental Conservation offer foundation-level Remote Sensing courses, and geography offers computer mapping courses.

The certificate is designed to ensure that students develop advanced skills in one technology as well as a foundation in all three. Students can fulfill the requirement for an advanced course with an advanced course in GIS (offered in geography and in the Dept. of Environmental Conservation) or Remote Sensing (offered in geography).

The final requirement is one elective course which includes an extended, project-based integration of GIST skills and spatial thinking. This can be fulfilled through any additional course in GIST or an approved course or independent study that involves a GIST project in the context of a course involving spatial thinking/problem solving (most upper division or graduate level geography courses can fulfill this requirement).

It will be possible for students to complete the certificate in a single year of focused study, although most students will likely integrate GIST courses into their degree program studies and complete the GIST courses over two or more years.

No new courses are proposed for the certificate.
<table>
<thead>
<tr>
<th>Topic</th>
<th>Course number</th>
<th>Course</th>
<th>Credit</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation in GIS</td>
<td>GEOGRAPH 468</td>
<td>GIS and Spatial Analysis</td>
<td>4</td>
<td>Fall</td>
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<tr>
<td>(1 out of 4)</td>
<td>NRC 585</td>
<td>GIS for Natural Resource Management</td>
<td>4</td>
<td>Fall &amp; Spring</td>
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<tr>
<td></td>
<td>CEE 597G</td>
<td>Geographic Information Systems for Engineers</td>
<td>4</td>
<td>Spring</td>
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<td></td>
<td>RP 625*</td>
<td>Introduction to Geographic Information</td>
<td>4</td>
<td>Spring</td>
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<td>(a 400-level option is being developed</td>
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<td>Systems for Planning</td>
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<td>for this course.)</td>
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<tr>
<td>Foundation in Remote Sensing</td>
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<td>Remote Sensing and Image Interpretation</td>
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<td>Digital Remote Sensing</td>
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<td>years)</td>
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<tr>
<td>Foundation in Cartography/Mapping</td>
<td>GEOGRAPH 352</td>
<td>Computer Mapping</td>
<td>3</td>
<td>Fall &amp; Spring</td>
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<td>Advanced required course or practicum</td>
<td>GEOGRAPH</td>
<td>Advanced remote sensing</td>
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<td>Spring (Odd</td>
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<td>(1 course; 3 credits)</td>
<td>494ARS</td>
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<td>years)</td>
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<td>(substitutions possible (such as</td>
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<td>graduate courses) with permission of</td>
<td>GEOGRAPH</td>
<td>Spatial Data Analysis (advanced GIS)</td>
<td>3</td>
<td>Spring (Even</td>
</tr>
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<td>certificate adviser).</td>
<td>494SDA</td>
<td></td>
<td></td>
<td>years)</td>
</tr>
<tr>
<td></td>
<td>GEOGRAPH</td>
<td>Advanced Practicum in GIS</td>
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<td>Spring</td>
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<tr>
<td>Applied project-based elective course</td>
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<td>3</td>
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<tr>
<td>(1 course; 3 credits)</td>
<td></td>
<td>(with certificate adviser’s approval;</td>
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<td>GIST project in the context of a course</td>
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<td></td>
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<td>involving spatial thinking/problem solving</td>
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*Advanced Remote Sensing and Spatial Data Analysis have been offered for undergrads under experimental course numbers. Professor Yu (on sabbatical in Fall 2014) will apply for standard designations (Geography 436 and Geography 478, respectively) in Spring 2015.
B. Provide a brief overview of the process for developing the Proposal.

This proposal was developed by Professor Qian Yu in consultation with other geography faculty. The concept was then reviewed by faculty in four departments which provide GIST courses (GEO, ECO, LARP, & CEE) for comments and suggestions before the submission of the proposal.

The conversation on coordinating GIS teaching and offering a concentration/degree program began several years ago. In 2009, Prof. Schweik, Bradley, and Yu submitted a program proposal for a Graduate Certificate in GIS and Spatial Analysis. That specific proposal required new instructional faculty. It was not sufficiently funded to hire the new instructors for teaching elective courses and managing an online program, so the project was not carried forward.

More recently, we have developed the idea of starting an undergraduate certificate program through coordinating current teaching efforts. Discussions among geography and GIS faculty at UMass and in the colleges in Fall 2013 identified a structural challenge: while there are a number of foundation courses, most departments lack the capacity to offer a formal sequence of courses to students interested in GIST. The UMass undergraduate certificate proposal is the first effort to address this curriculum issue.

Departmental context in Geosciences: there are 13 credits of GIST coursework offered in Geosciences regularly each year and 16 credits in two years. In the near future, the department will possibly offer more elective courses with Geosciences’ recent hire of a geologist with GIS experience.

II. PURPOSE AND GOALS

Describe the Proposal’s purpose and the particular knowledge and skills to be acquired.

Purpose: This certificate program will provide a solid foundation and a useful credential in the field of geospatial technologies (Geographic Information Systems (GIS), remote sensing (RS), and computer mapping (CM)) for undergraduate and non-degree students. GIS are computer systems for integrating and analyzing spatial data. RS uses satellite or airborne sensors to acquire spatial information, particularly for earth observation. Computer mapping has largely replaced traditional cartography for presenting data and analyses in maps. The GIST certificate program will provide students with a background in the science, techniques, and application of these geographical methods and techniques that will enable them to embark on public and private sector careers or to undertake further studies in geography and other fields.

Learning Objectives:

1. General knowledge
   • Understand and have skill in applying spatial and cartographic concepts, including projection, map editing, symbolization and visualization.
   • Understand major GIS theories, including spatial relationships, GIS data models, and spatial statistics.
   • Integrate and apply spatial thinking to specific fields and projects.
   • Understand optical and physical remote sensing theory.
   • Be familiar with commonly used remote sensing sensors.

2. Hands-on skills
   • Spatial analysis using ESRI ArcGIS for both vector and raster data
   • Remote sensing image interpretation and processing using ENVI software
   • Common information retrieval methods from digital multispectral images.
III. RESOURCES

If this proposal requires no additional resources, say so and briefly explain why. If this proposal requires additional resources, explain how they will be paid for. For proposals involving instruction, indicate how many new enrollments are expected and whether the courses have room to accommodate them.

No additional resources will be required to offer this certificate program. All required courses are already offered on a regular basis. Geography courses can be increased in enrollment size as necessary by making use of existing classrooms and the present GIST lab. We expect the new enrollment in GIST courses will be around 5-10 per year in the first three years.

IV. OVERLAP

At present the geography degrees (BA, BA-Environmental Geography Concentration, and BS) do not require students to take a GIST course. Many geography majors currently take one or more GIST courses to meet their geographic methods and techniques requirement. The GIST certificate may encourage such students to take additional GIST courses. The certificate may also encourage students in other degree programs to take additional GIST courses in aspects of GIST for which courses are not offered by their departments.

The certificate has been developed in consultation with faculty from across the campus who teach GIST courses and is meant to increase opportunities and credentials for students from all majors. Flexibility in how the introductory level requirements are met will also make the GIST certificate program accessible for transfer students and for participation by non-degree students.

In other departments on campus GIS courses are offered in the Department of Environmental Conservation (Profs. Charlie Schweik, Jack Finn, Bethany Bradley), Landscape Architecture and Regional Planning (Prof. Henry Renski), and Civil and Environmental Engineering (Prof. Mi-Hyun Park). Most of these courses are foundation-level (despite their 400-/500- level designations), and in the proposed GIST certificate many of them can be used to meet the requirement for an introductory level GIS course.

Existing courses do not overlap. While it may appear that there is an overlap of foundational GIS courses, it should be noted that most of the courses are typically fully-enrolled and that all except the geography courses are normally open for enrollment only by majors.