# Texas Higher Education Coordinating Board
# New Doctoral Degree Proposal

Directions: An institution shall use this form to propose a new doctoral degree program. In completing the form, the institution should refer to Texas Administrative Code (TAC) 5.46 relating *to Criteria for New Doctoral Programs.* This form requires signatures of (1) the Chief Executive Officer, certifying adequacy of funding for the new program; (2) a member of the Board of Regents (or designee), certifying Board approval; and (3) if applicable, a member of the Board of Regents (or designee), certifying that criteria have been met for Coordinating Board staff-level approval.

Note: If an institution does not have Preliminary Authority for the proposed doctoral program, it must first submit a separate request for Preliminary Authority. That request shall address criteria set in TAC Section 5.24 (b).

Information: Contact the Division of Academic Affairs and Research at 512/427-6200.

## Administrative Information

1. Institution: Texas A&M University – Corpus Christi

2. Program Name – Show how the program would appear on the Coordinating Board's program inventory.

Doctor of Philosophy (PhD) in Geospatial Computing Sciences

3. Proposed CIP Code: 11.0101.00 (may be changed later)

4. Program Description – Describe the program and the educational objectives.

The PhD in Geospatial Computing Sciences (GCS) is an interdisciplinary doctoral program with a clear emphasis on developing the theory of computer science for handling geospatial data and exploring emerging technologies enabled by geospatial data. The program will educate well prepared students who will become experts in computer science, especially in geospatial computing. The structure of the education provided by the program will ensure that graduates will be able to pursue careers in higher education, government, and industries related to or affected by geospatial information science. The Ph.D. degree is intended to attract students who are interested in teaching and conducting independent research or overseeing such research related to the collecting, processing, analyzing, and visualizing of geospatial data, as well as to the utilization of geospatial data for developing new technologies. For example, geospatial computing is now playing an increasingly important role in the development of the smartphone technology. The synergy of geospatial science and computer science will open a new horizon for innovation as 80% of information is geo-location dependent (Huxhold, 1991; Franklin, 1992; U.S. General Accounting Office, 2003; Dept. of the Interior, 2006). With this PhD program, the students will have the opportunity to use computer science theoretical and applied techniques to pursue research and scholarship that will advance the state of knowledge in geospatial computing. This degree will accomplish these goals with a strong curriculum, rigorous laboratory and field research, and faculty mentoring.

In 2008, the Chancellor of the Texas A&M University System visited Texas A&M University – Corpus

Christi (TAMUCC). After seeing all the geospatial work being done at the Conrad Blucher Institute for Surveying & Science (CBI), the Chancellor recommended to TAMUCC that they develop a graduate program in Geospatial Computing. Both computer science and geographic information systems faculty and students collaborate with the Harte Research Institute for Gulf of Mexico Studies, as well as with the CBI. All proposed faculty for the new program are already members of the graduate faculty at TAMUCC.

5. Administrative Unit – Identify where the program would fit within the organizational structure of the institution (*e.g., The Department of Electrical Engineering within the College of Engineering*).

School of Engineering and Computing Sciences (ENCS) within the College of Science and Engineering

6. Proposed Implementation Date – Report the first semester and year that students would enter the program.

September 1, 2015 or earlier.

7. Contact Person – Provide contact information for the person who can answer specific questions about the program.


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Title: Professor of Computer Science and Associate Director of ENCS

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**Geospatial Computing Sciences**
**Doctoral Program Proposal**
**Executive Summary**


The proposed PhD in Geospatial Computing Sciences is an interdisciplinary doctoral program with a clear emphasis on developing the theory of computer science for exploring emerging technologies enabled by geospatial data, including acquiring data by state-of-the-art unmanned aerial systems and remotely operated or autonomous undersea vehicles. The PhD degree is intended to attract students who are interested in teaching and conducting independent research or overseeing such research related to the collecting, processing, analyzing, and visualizing geospatial data, as well as utilizing geospatial data for developing new technologies. For example, geospatial computing is playing an increasingly important role in the development of smartphone technology. The synergy of geospatial science and computer science will open a new horizon for innovation as 80% of information is geo-location dependent. With this PhD program, students will have the opportunity to use computer science theoretical and applied techniques to pursue research and scholarship that will advance the state of knowledge in geospatial computing. This degree will accomplish these goals with a strong curriculum, rigorous laboratory and field research, and faculty mentoring. The structure of the education provided by the program will ensure that graduates will be able to pursue careers in higher education, government, and industries related to or affected by geospatial computing sciences.

Graduates from PhD programs in computer science and engineering are in high demand, and many universities and companies report difficulties finding sufficient numbers of these highly skilled workers. The unemployment rate for new PhD's dropped considerably for 2011-2012 graduates, to 0.4 percent from 1.6 percent the previous year according to the 2011-2012 Taulbee (April 16, 2013) Survey. This indicates a working unemployment rate of zero, highlighting the reality that not enough PhD-level professionals are being produced. The Taulbee Survey further states that there were 372 tenure-track vacancies reported in 2011-2012 vs. 245 in 2010-2011, and indicates that 30-40% of openings for computer science doctoral applicants remain unfilled. The baby boomer factor is contributing to the high percentage of unfilled positions, and the negative impact of this factor is expected to increase over the next several years while demand continues to increase.

The proposed PhD in Geospatial Computing Sciences would complement and strengthen existing programs at the institution. The combined undergraduate and graduate programs in computer science and geospatial systems have averaged 346 students over the last two fall semesters (2011 and 2012). Master's students in computer science averaged about 80 over the last three years and geospatial master's students averaged 24 over the same period. The combined average of computer science and geospatial graduate students is more than 100. Projected fall 2013 enrollment is anticipated to show the total number of graduate students increasing to well over 125 students based on the number of admitted applicants for the semester, providing a strong basis for the PhD program.

Foundation courses for the proposed doctoral degree already exist in the two related MS programs in computer science and in geospatial surveying engineering. Additional coursework required could also serve the CMSS PhD program as well as our MS programs, generating additional enrollment to help sustain the program with state funding. Conservative enrollment projections indicate at least 20 doctoral students will be in the new PhD program within five years.

# Program Information

## I. Need

*Note: All proposals must include this section. If preliminary authority for the program was granted within the last four years, include updated information.*

A. Job Market Need – Provide short- and long-term evidence of the need for graduates in the national job market. Common sources for workforce need and workforce projections include the Bureau of Labor Statistics, the Texas Workforce Commission, and professional associations. In addition, identify existing programs in the state and nation, provide the number of graduates from these programs in the last five years, and explain how the proposed program would not unnecessarily duplicate them. Provide evidence that existing programs could not accommodate additional students and/or are not meeting current workforce need.

The widespread and increasing use of computers and information technology has generated a need for highly trained, innovative workers with extensive theoretical expertise. These workers, called *computer scientists (or PhD CS researchers)*, are the designers, creators, and inventors of new technology. By creating new technology, or finding alternative uses for existing resources, they solve complex scientific, business, and general computing problems. Many computer scientists work on multidisciplinary projects, collaborating with engineers and other specialists. Computer scientists conduct research on a wide array of topics. Artificial intelligence, software engineering, and networking continue to be the most popular areas of specialization for doctoral graduates, with databases, theory and algorithms being the next most popular (Taulbee Survey 2011-2012). For this request, the focus is on geospatial computing knowledge discovery, research and scholarship which incorporate these topics (Occupational Outlook Handbook, 2012).

Because the geospatial industry acquires, integrates, manages, analyzes, maps, distributes, and uses geographic, temporal and spatial information and knowledge, the job market need is high as can be seen from the discussion below. The industry is broad and includes basic and applied research, technology development, education, and applications to address the planning, decision-making, and operational needs of people and organizations of all types. Geospatial information is now playing an essential role in the information society, the knowledge-based economy and the new lifestyles. The development of geospatial computing technology is now becoming more and more dependent on computational and other sensing technologies. For example, the Unmanned Aircraft System (UAS) will play an important role in geospatial data acquisition in the future; e.g., in precise farming because of its flexibility and low cost of operation. This dependence will also indirectly increase the demand of the geospatial job market.

Computer scientists should enjoy excellent job prospects. Graduates from PhD programs in computer science and engineering are in high demand, and many universities and companies report difficulties finding sufficient numbers of these highly skilled workers. The Taulbee Survey indicates that 30-40% of openings for CS doctoral applicants remain unfulfilled. In addition to openings resulting from rapid growth in the occupation, some additional job openings will arise from the need to replace workers who move into other occupations or who leave the labor force (Occupational Outlook Handbook, 2012). Table 1 has specific information about growth rates for some common computer positions.

Computer science positions abound and are typically found in *Chronicle of Higher Education*, *Computer Magazine* of the IEEE Computer Society, *Communications of the ACM*, the Computing Research Association, and many other venues. The online search firms for geospatial jobs (GIS Jobs Clearinghouse; GeoSearch, Inc.) have many jobs posted. The combined postings for geospatial computer scientists are in the hundreds of positions in academia, research centers, government, and industry. A National Geospatial Technology Resource Center survey of Community College Geospatial Sciences faculty showed 83.1% of 99 respondents being self-taught by reading geospatial literature (GeoTech Center, 2012). The GeoTech survey also indicates that there are a growing number of geospatial programs in community colleges and a lack of formally qualified faculty, with 64% of the programs reporting this deficit. The proposed program will attract current and prospective community college faculty into the program. Texas A&M University-Corpus Christi will be helping community colleges meet some of their needs for properly credentialed faculty.

Potential employers of the graduates of this program include entities such as Google, Apple, Microsoft Research, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, Texas General Land Office, Environmental Systems Research Institute, Citgo, Shell Oil, and BP Oil. Moreover, many opportunities exist for these graduates to participate in the development of a host of new, smaller companies, which will have the potential to grow into larger organizations.

However, the GIS Jobs salary survey shows low numbers of geospatial professionals having graduate degrees in Texas, indicating many professionals lacking in preparation. To meet the needs of the industry, persons with a variety of educational backgrounds and educational levels are filling geospatial positions in Texas. Graduates of the proposed degree program in geospatial computer science will have the advanced education that will allow them to fill leadership positions in the emerging geospatial industry.

The need exists for more PhD graduates to fill positions that require advanced geospatial computing sciences knowledge and skills. These positions include the employers listed above as well as universities and community colleges (Jeffress, 2007).

In addition, employment growth for computer scientists and related positions is expected to be much faster than the average. Employment of computer scientists is expected to grow by 19 % from 2010 to 2020, computer software developers by 30% and database administrators by 31%, much faster than the average of 10-19% reported for all occupations as shown in the Occupational Outlook Handbook. Employment of these computer specialists is expected to grow as individuals and organizations continue to demand increasingly sophisticated technologies. Job increases will be driven, in part, by very rapid growth in computer systems design and related services industry, as well as the software publishing industry, which are projected to be among the fastest growing industries in the U.S. economy (Occupational Outlook Handbook, 2012). Computer scientists develop the theories that allow many new technologies to be developed. The demand for increasing efficiency in areas such as networking technology, computing speeds, software performance, and embedded systems will lead to employment growth. In addition, the growing emphasis on information security will lead to new jobs.

The U.S. Department of Labor also projects a "high growth industry profile" for geospatial technology:

- Revenues from the public sector lead geospatial market growth and account for more than one-third of total revenue. While federal government agencies were among the early adopters of GIS technology, recent trends toward devolving more responsibilities to states and localities have spurred those entities to become important consumers of GIS. While industries in the regulated sector, such as utilities, telecommunications, transportation and education, are the largest consumers of GIS/geospatial solutions, private-sector growth remains dependent upon business adoption based on the added-value these technologies provide. (Daratech, GIS/Geospatial Markets and Opportunities, http://www.gislounge.com/gis-industry-trends/)
- Geospatial products and specialists are expected to play a large role in homeland security activities. Information gathering needs to protect critical infrastructure have resulted in an enormous increase in the demand for such skills and jobs. This statement made by Castro (2003) almost a decade ago is even more true today with the increasing cybersecurity risks.
- Because the uses for geospatial technology are so widespread and diverse, the market is growing at an annual rate of almost 35 percent, with the commercial subsection of the market expanding even faster (Geospatial Information & Technology Association, 2012).

With the high demand for both computer scientists and geospatial experts, a program that combines both of these high demand areas into one focus area will be assured of success for its graduates. Examples of employment opportunities that graduates of the new degree will be prepared for include industries such as architecture/engineering/construction, ICT industry (e.g., Google and Apple), business, conservation, defense/intelligence, Homeland Security, education, government, health and human resources, natural resources, public safety, transportation, utilities and communication, and disaster mitigation. The degree can contribute to small business startups and regional economic growth with graduates positioned to establish computing and geospatial consulting and services companies.

In May 2004 the U.S. Department of Labor issued a job growth profile of the geospatial technology industry. The report indicates that demand is increasing for readily available, consistent, accurate, complete, and current geographic information and the widespread use of advanced technologies. According to Emily Stover DeRocco, head of the U.S. Labor Department's Employment and Training Administration, "In a period of nationwide economic downturn, the geospatial industry offers hope. Across the country, tens of thousands of trained workers are needed to fill positions that are going begging" (2004).

Table 1 lists some common occupations related to the geospatial computing sciences program. Most of the occupations were found in the Bureau of Labor Statistics Occupational Outlook Handbook 2012-2013. Two occupations were found in DOLETA's O*NET database, which includes information on hundreds of standardized occupations (National Center for O*NET, http://www.onetonline.org/). Remarkably, these few occupations related to geospatial computing sciences indicate a growth of more than 520,000 additional workers will be needed over the 2010-2020 decade. The growth anticipated is greatly dependent on qualified faculty that this PhD program in Geospatial Computing Sciences will produce.

Table 1: Geospatial occupations defined by U.S. Department of Labor Employment and Training Administration.

| Occupation | Estimated Employment (2010) | Projected Growth (2010-20) | Projected Growth Rate (2010-20) |
|---|---|---|---|
| Computer and Information Research Scientists | 28,200 | 5,300 | About as fast as average (19%) |
| Computer Software Developers | 913,100 | 270,900 | Much faster than average (30%) |
| Computer Database Administrators | 110,800 | 33,900 | Much faster than average (31%) |
| Computer Systems Analysts | 544,400 | 120,400 | Faster than average (22%) |
| Surveying and Mapping Technicians | 56,900 | 9,000 | About as fast as average (16%) |
| Cartographers and Photogrammetrists | 13,800 | 3,100 | Faster than average (22%) |
| Surveyors | 51,200 | 13,000 | Faster than average (25%) |
| Remote Sensing Technicians* | 62,000 | 33,500 | Average (10-19%) |
| Precision Agriculture Technicians* | 62,000 | 33,500 | Average (10-19%) |

*Source: U.S. Department of Labor, Employment & Training Administration O*NET Online http://online.onetcenter.org/ Accessed April 17, 2013
Average is defined by as 10-19% for all occupations (http://www.bls.gov/ooh/About/Occupational-Information-Included-in-the-OOH.htm)

Following these trends, there is a strong demand for PhD graduates in this field to undertake the research and development of newer ways to efficiently collect, manage, and disseminate geospatial data and information. Much of the basic research used in the geospatial arena is focused on computing technology, database design, computer visualization, and information bandwidth.

Powered by the theory and applied techniques of computer science, the PhD program proposed will extend the current scope of geospatial science for collecting, processing, analyzing, and visualizing the geospatial data to a large extent; e.g., including ubiquitous positioning and mobile sensing, location and context awareness, and spatial thinking and cognition. The opportunities offered by the synergy of geospatial science and computer science will be limited only by our imagination. It has a high potential for offering new job opportunities that are not available in the current job market.

This proposal will uniquely establish a focused effort to address the high demand for PhD graduates in a department (ENCS) that has more than 15 years of teaching and research experience in geospatial science and computer science at the undergraduate and Master's level.

A. 2. Whether the proposed addition would complement and strengthen existing programs at the institution.

*Instructions: Describe the existing resources that would be leveraged and/or strengthened with the proposed program. For example, a proposed bachelor's degree in computer engineering could potentially complement and strengthen an existing program in electrical engineering.*

The proposed PhD in Geospatial Computing Sciences would complement and strengthen existing programs at the institution. The combined undergraduate and graduate programs in computer science and geospatial systems have had an average of 346 students over the last two fall semesters

(2011 and 2012). Master's students in computer science averaged about 80 students over the last three years. Geospatial master's students averaged 24 students over the same period. The combined average of computer science and geospatial graduate students is more than 100 and fall 2013 is anticipated to show the total number of graduate students to increase to well over 125 students based on the number of admitted applicants for the fall. Fall 2013 projections show an increase of master's students that provide a strong basis for the PhD in Geospatial Computing Sciences.

Given the multidisciplinary framework for a PhD in Geospatial Computing Sciences, this program would also serve the rapidly growing mechanical engineering undergraduate program which shows 262 students enrolled for fall 2012, and this number is projected to grow to 300 students in fall 2013, after only three years in operation.

The Conrad Blucher Institute for Surveying and Science (CBI) is heavily involved in the geospatial systems Master's program. A PhD program will be able to take advantage of the existing research infrastructure of CBI and the addition of doctoral students would accelerate growth in research and scholarship. The Harte Research Institute (HRI) focuses on stewardship of the Gulf of Mexico. Geospatial issues abound in their research. In addition to existing geospatial techniques, new techniques need to be developed for HRI to conduct their research. The proposed PhD program will allow HRI researchers to work closely with doctoral students in geospatial computing sciences.

One of the newest doctoral programs in the College of Science and Engineering is the one in Coastal and Marine System Science (CMSS). CMSS focuses on integrative concepts that have emerged in recent years, linking biogeochemistry, geographic information science, ecosystem dynamics, and quantitative modeling. Students in CMSS have diverse backgrounds in natural and computational sciences. A PhD program in Geospatial Computing Sciences will be a great resource for research that supports the work of the CMSS faculty and students.

A. 3. Whether a future program would unnecessarily duplicate other programs within the region, state, or nation.

*Instructions: Identify similar programs and explain how the future program would not unnecessarily duplicate them. Provide evidence that existing programs could not accommodate additional students and/or are not meeting current workforce need.*

*NOTE: CB Rule 5.45(2): "The offering of basic liberal arts and sciences courses and degree programs in public senior institutions is not considered unnecessary duplication."*

There are numerous graduate degree programs in Texas and the nation with computer science or geographic information systems, but there is no Geospatial Computing Sciences degree. Although there is nothing close to the proposed program, a related program is the University of Texas at Dallas PhD program in Geospatial Information Systems which is jointly offered by the School of Economic, Political and Policy Sciences, the School of Natural Sciences and Mathematics (specifically in the Department of Geosciences), and the Eric Jonsson School of Engineering and Computer Science, with administration by the School of Economic, Political and Policy Sciences. The State University of New York College of Environmental Science and Forestry has a PhD in Geospatial Information Science and Engineering with a focus on environmental monitoring. There appears to be no degree program that duplicates or is close to the proposed Geospatial Computing Sciences PhD program which has a core of computer science and geospatial sciences.

The proposed program at TAMUCC would be located in the College of Science and Engineering, School of Engineering and Computing Sciences. The TAMUCC program is an interdisciplinary study of computer science and geospatial science. This will be a technology-based degree with a computer science basis, which does not appear to be duplicated in the state or the nation.

B. Student Demand – Provide short- and long-term evidence of demand for the program. Types of data commonly used include increased enrollment in related programs at the institution, high enrollment in similar programs at other institutions, qualified applicants rejected at similar programs in the state or nation, and student surveys.

The Computing Research Association's 2011-2012 Taulbee Survey Report provides a current perspective related to computer science programs, even though none of them are in geospatial computer science or computing sciences. There was a significant increase in the fraction of new PhD's who took positions in North American industry (to 55.5 percent vs. 47.2 percent in 2010-11 and 44.7 percent in 2009-10). This elucidates the growing trend for PhD graduates to work in industry positions with companies like Google, Apple, Microsoft Research, BP, etc. A smaller fraction (28.9 percent) of 2011-12 graduates took North American academic jobs as compared with 2010-11 graduates (34.6 percent). The fraction taking tenure-track positions in North American doctoral granting institutions dropped again this year, from 7.1 percent for 2010-11 graduates to 6.6 percent for 2011-12 graduates. Falling rates of employment in these fields within universities is an indicator of growing demand for such professionals within industry positions.

The unemployment rate for new PhD's dropped considerably for 2011-12 graduates, to 0.4 percent from 1.6 percent the previous year. This indicates a working unemployment rate of zero, highlighting the reality that not enough PhD-level professionals are being produced. There were 372 tenure-track vacancies reported in 2011-12 vs. 245 in 2010-11. The strongest increase in vacancies (over 50%) was in U.S. CS departments. In aggregate, 31.7 percent of the total number of vacant tenure-track positions went unfulfilled, lower than the 37.6 percent in 2010-11 but higher than the 29.9 percent in 2009-10. Public universities had a better success rate than did private universities among U.S. CS departments, with more than 40 percent of the tenure-track vacancies unfilled at private universities. The increased number of retirements (89 this past year vs. 67 the previous year) bears watching as baby boomers hit their mid-60s and some retirement programs modify their rules to deal with financial issues exacerbated by the most recent recession. The baby boomer factor is contributing to the high percentage of unfilled positions, and the negative impact of this factor is expected to increase over the next several years while demand continues to increase.

Foundation courses for the proposed doctoral degree already exist in our two MS programs in Computer Science and in Geospatial Surveying Engineering. Additional coursework required could also serve the CMSS PhD program as well as our MS programs, generating additional enrollment to help sustain the program with state funding.

C. Enrollment Projections – Use this table to show the estimated cumulative headcount and full-time student equivalent (FTSE) enrollment for the first five years of the program. Provide an explanation of how headcount and FTSE numbers were determined.

| | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** |
|---|---|---|---|---|---|
| **New Students** | M - 2<br>D - 4 | M - 6<br>D – 4 | M - 9<br>D - 4 | M - 9<br>D - 4 | M - 8<br>D - 4 |
| **Cumulative Headcount** | M - 2<br>D - 4 | M - 8<br>D – 8 | M - 14<br>D - 12 | M - 16<br>D - 16 | M - 15<br>D - 20 |
| **FTSE** | M - 2<br>D - 4 | M - 8<br>D – 8 | M - 14<br>D - 12 | M - 16<br>D - 16 | M - 15<br>D - 20 |
| **Attrition** | 0 | 0 | M - 1<br>D - 1 | M - 1<br>D - 3 | M - 1<br>D - 2 |
| **Graduates** | | M – 2 | M - 5 | M - 8 | M - 8 |

| | | | | D - 4 | D - 5 |
|---|---|---|---|---|---|
| **Master's graduates going on to PhD** | | 1 | 3 | 6 | 4 |

The projections were determined based on the history of MS CS graduates who have proceeded to PhD programs in other universities and the requests by others for TAMUCC to have such a doctoral program. In addition, the national demand provides a solid basis for these enrollment projections.

## II. Resources

A. Degree Requirements – Use this table to show the degree requirements of the program. *(Modify the table as needed. If necessary, replicate the table to show more than one option.)*

| **Category** | **Semester Credit Hours** |
|---|---|
| Core Courses | 27 |
| Prescribed Electives | 15-30 |
| Free Electives | 0 – 9 |
| Dissertation | 6 – 21 |
| Total (Minimum) | 60 |

B. Curriculum

Identify the required courses and prescribed electives. Courses that would be added if the program is approved are marked with a *.

| **Prefix and Number** | **Required Courses** | **SCH** |
|---|---|---|
| | CORE | |
| COSC 5334 | Design and Analysis of Algorithms | 3 |
| COSC 5336 | Database Management Systems | 3 |
| COSC 5351 | Advanced Computer Architecture | 3 |
| COSC 5352 | Advanced Operating Systems | 3 |
| COSC 5393 | Research Methods and Design | 3 |
| GSCS 5321* | Geospatial Data Structures | 3 |
| GSCS 5331* | Advanced Geospatial Computing | 3 |
| GSCS 6102* | Graduate Seminar – 1 credit per semester enr | 3 |
| MATH 5344 | Spatial Statistics | 3 |
| | | |
| | RESEARCH AND DISSERTATION | |
| GCSE 6399* | Dissertation | 3 |
| GCSE 6999* | Research | 3 - 18 |

| **Prefix and Number** | **Prescribed Elective Courses** | **SCH** |
|---|---|---|
| | MINIMUM of 15 SCH from this list | |
| COSC 5327 | Introduction to Computer Graphics | 3 |
| COSC 5328 | Advanced Computer Graphics | 3 |
| COSC 5330 | Programming Languages | 3 |
| COSC 5340 | Human-Computer Interaction | 3 |
| COSC 5345 | Simulation and Modeling | 3 |
| COSC 5348 | Expert Systems | 3 |
| COSC 5350 | Advanced Topics in DBMS | 3 |
| COSC 5353 | Compiler Design and Construction | 3 |
| COSC 5354 | Artificial Intelligence | 3 |

| | | |
|---|---|---|
| COSC 5355 | Data Communications and Networking | 3 |
| COSC 5356 | Theory of Computation | 3 |
| COSC 5357 | Wireless Sensor Networks | 3 |
| COSC 5360 | Parallel Computing | 3 |
| COSC 5361 | Parallel Algorithms | 3 |
| COSC 5370 | Advanced Software Engineering | 3 |
| COSC 5374 | Computer Forensics | 3 |
| COSC 5375 | Information Assurance | 3 |
| COSC 5376 | Network Security | 3 |
| COSC 5377 | Applied Cryptography | 3 |
| COSC 5379 | Advanced Information Assurance | 3 |
| GSCS 6329* | Scientific Visualization | 3 |
| GSCS 6344 | Ubiquitous Positioning | 3 |
| GSEN 5355 | Design and Analysis of GIS Applications | 3 |
| GSEN 5365 | Spatial Database Design | 3 |
| GSEN 5381 | Cadastral Information Systems | 3 |
| GSEN 5382 | Policy and Legal Aspects of Spatial Information Systems | 3 |
| GSEN 5383 | Advanced Geospatial Analysis and Design | 3 |
| GSEN 5384 | Geospatial Visualization Design | 3 |
| GSEN 5385 | Analytical and Digital Photogrammetric Engineering | 3 |
| GSEN 5386 | Seminar Problems in Remote Sensing of the Environment | 3 |

| Prefix and Number | Free Elective Courses | SCH |
|---|---|---|
| | Any graduate courses outside of the program that meets the student's needs. Chosen with the Advisor | 0 - 9 |

Course Descriptions are included in Appendix A.

C. Faculty – Use these tables to provide information about Core and Support faculty. Add an asterisk (*) before the name of the individual who will have direct administrative responsibilities for the program. Add a pound symbol (#) before the name of any individual who has directed doctoral dissertations or master's theses. Add and delete rows as needed. (*Core Faculty: Full-time tenured and tenure-track faculty who teach 50 percent or more in the doctoral program or other individuals integral to the doctoral program who can direct dissertation research. Support Faculty: Other full-time or part-time faculty affiliated with the doctoral program.*)

| Name of Core Faculty and Faculty Rank | Highest Degree and Awarding Institution | Courses Assigned in Program | % Time Assigned To Program |
|---|---|---|---|
| #Ruizhi Chen, Endowed Chair, Professor | Ph.D. University of Helsinki | GSCS 6344, GSCS 5331, GSCS 6102 | 90% (20% teaching, 70% research) |
| Luis Rodolfo Garcia Carrillo (starting Fall 2013) | Ph.D. University of Technology of Compi'egne – Compi'engne, France | | 90% (30% teaching, 60% research) |
| Lucy Huang, Assistant Professor | Ph.D. State University of New York at Buffalo | GSCS 5321, GSEN 5365, GSEN 5383 | 90% (30% teaching, 60% research) |
| #Lonzhuang Li, Associate Professor | Ph.D. University of Missouri-Columbia | COSC 5336, COSC 5350, COSC 5370 | 90% (30% teaching, 60% research) |
| #Ahmed Mahdy, Associate Professor | Ph.D. University of Nebraska | COSC 5357, COSC 5393, GSCS 6102 | 90% (20% teaching, |

| | | | |
|---|---|---|---|
| and Director of Innovation in Computing Research (iCORE) labs | | | 70% research) |
| Richard Smith, Assistant Professor | Ph.D. University of Georgia | GSEN 5355, GSEN 5384 | 90% (30% teaching, 60% research) |
| New Faculty #1 – Engineering (in negotiation) | | | 90% (30% teaching, 60% research) |
| New Faculty #2 & 3 – Computer Science (on going faculty search for Fall 2013 & 2014) | | | 90% (30% teaching, 60% research) |
| New Faculty #4 – GIS (search in progress for starting date in Fall 2013) | | GSEN 5385, GSEN 5386 | 90% (30% teaching, 60% research) |

| **Name of <u>Support</u> Faculty and Faculty Rank** | **Highest Degree and Awarding Institution** | **Courses or Other Support Activity (e.g., Research Supervision) Assigned in Program** | **% Time Assigned To Program** |
|---|---|---|---|
| #David Bridges, Associate Professor of Mechanical Engineering | Ph.D. California Institute of Technology | Developing UAS and AUV for conducting research in GSC | 50% (50% research) |
| #LD Chen, Director School of Engineering and Computing Sciences | Ph.D. Pennsylvania State University | Developing UAS and AUV for conducting research in GSC | 20% (20% research) |
| *#John Fernandez, Associate Director, School of Engineering and Computing Sciences | Ph.D. Texas A&M University | COSC 5340, COSC 5393, GSCS 6102 | 40% (20% teaching, 20% research) |
| #Mario Garcia, Professor | Ph.D. Texas A&M University | COSC 5348, COSC 5354, COSC 5370, COSC 5374, COSC 5375, COSC 5376, COSC 5379 | 90% (50% teaching, 40% research) |
| Gary Jeffress, Director, Conrad Blucher Institute | Ph.D. University of Maine | GSEN 5381, GSEN 5382 | 20% (20% research) |
| #Dulal Kar, Associate Professor | Ph.D. North Dakota State University | COSC 5334, COSC 5351, COSC 5377 | 90% (50% teaching, 40% research) |
| #Ajay Katangur, | Ph.D. Georgia State | COSC 5351, COSC | 90% |

| | | | |
|---|---|---|---|
| Associate Professor | University | 5352, COSC 5375 | (50% teaching, 40% research) |
| #Scott King, Associate Professor | Ph.D. Ohio State University | COSC 5351, COSC 5327, COSC 5353, GSCS 6329 | 90% (20% teaching, 50% administrative, 20% research) |
| Devanayagam (Pal) Palaniappan, Assistant Professor of Mathematics | Ph.D. University of Hyderabad | Mathematical modeling hydrodynamics | 20% (20% research) |
| #Alex Sadovski, Professor of Mathematics | Ph.D. Academy of Science of the USSR | | 20% (20% research) |
| Dugan Um, Assistant Professor | Ph.D. University of Wisconsin, Madison | | 20% (20% research) |

D. Student Recruitment – Describe general recruitment efforts, including plans to recruit and retain students from underrepresented groups.

Recruitment is a key component of our program to engage world-class students. We will aggressively pursue domestic students to ensure a higher percentage of such students enroll, as compared to other doctoral programs in computer science. We will pursue top-ranked international students as well. The following are critical elements which form the basis of our recruitment plan:

- We will entice our own top undergraduate and graduate students to pursue the Ph.D. by offering funding and an efficient track to completion.
- We will invite top students from the institutional members of the South Texas Engineering Alliance, of which TAMUCC is a charter member.
- We will pursue undergraduate and graduate students from the Computing Alliance of Hispanic Serving Institutions (CAHSI), of which TAMUCC is a founding member.
- We will expand our recruitment efforts to include computer science at the annual conference of the Society for the Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS), which hosts some 2000 plus undergraduate and graduate students and 2000 plus faculty and industry leaders from across the country.
- We will initiate annual recruitment efforts at the Grace Hopper Celebration of Women in Computing which attracted over 2000 attendees from 29 countries in 2012, with the focus of recruiting domestic and international female students.
- We will use the Louis Stokes Alliance for Minority Participation (LSAMP) and McNair Scholars Programs to communicate with research-oriented students from across the state and around the country.
- We will pursue top students from international academic career fairs in South and Central America in which computer science has participated previously.
- We will recruit from Eastern Europe and Asia through visits to universities associated with international research conferences, using TAMUCC faculty with links to universities abroad.
- We will partner with the English as a Second Language Institute (ESLI) which has been successful in recruiting top Master's students from South America, Europe and Asia.
- We will pursue international students from countries, such as Saudi Arabia, which provide full funding to students studying in the U.S., potentially using the Texas A&M University location in

Qatar as a launching point for recruitment in that region. Some efforts are ongoing with ESLI and consultant international recruiters.

To accomplish these objectives, we will implement several support strategies which include the following:

- Offer campus visits to top prospective applicants
- Offer competitive funding packages
- Create a highly interactive and engaging website, with other language versions as appropriate.
- Create a Twitter and Facebook presence to attract the digital age students
- Implement ongoing and timely communication with all inquiries using the graduate program administrative assistant who will ensure frequent email and letter correspondence
- Maintain good recruitment records to determine where successful students are from and how they found out about the program
- Create "campus visit" webinars throughout the year to reach students who are interested and would like more interaction, such as with a panel of graduate students and faculty

E. Student Financial Assistance – Identify the number of full-time and part-time students who would be funded (*e.g., teaching assistantships, research assistantships, scholarships, etc.*) and the anticipated amount of the stipends for the first five years. (*These costs should be reflected in the cost sheet as well.*)

| | | **20XX** | **20XX** | **20XX** | **20XX** | **20XX** |
|---|---|---|---|---|---|---|
| **Teaching Assistantships** | # of students | 0 | 2 | 3 | 4 | 4 |
| | Amount per student | Without a Masters - $1,500<br>With a Masters - $2,000<br>Candidate - $2,200 | | | | |
| **Research Assistantships** | # of students | 2 | 5 | 6 | 6 | 8 |
| | Amount per student | Without a Masters - $1,500<br>With a Masters - $2,000<br>Candidate - $2,200 | | | | |
| **Scholarships** | # of students | Competitive in COSE | same | same | same | same |
| | Amount per student | $1,000 | same | same | same | same |

F. Admissions Standards – Describe the institution's general graduate admissions standards and the program-specific admissions standards for applicants of the program. If relevant, include policies for accepting students transferring from other graduate programs.

A bachelor's degree in computer science, geographic information science, engineering, or mathematics is preferred, but not required. All applicants must have the necessary academic preparation to complete graduate level courses required for the Geospatial Computing Science PhD program. All US applicants must hold a bachelor's degree from an accredited college or university. The applicants must be able to score competitively on the GRE test. Non-native English speakers must show proficiency in English. TAMUCC accepts both TOEFL and IELTS test results.

The most competitive applicants have at least a 3.50 GPA (on a 4.00 scale) of the applicant's last 60 SCH of undergraduate degree study, and at least a 3.25 GPA (on a 4.00 scale) in any graduate study.

The grades and test scores are important components in evaluation of applicants for admission. Letters of recommendation, essay, research experience and achievements, and other accomplishments that would lend promise to excellence in graduate study are also important components in evaluation.

G. Teaching Load – Indicate the targeted teaching load for core faculty supporting the program. *(Teaching load: Total number of semester credit hours in organized teaching courses taught per academic year by core faculty divided by the number of core faculty in the prior year.)*

Faculty Handbook of the College of Science and Engineering specifies nominal teaching loads of the tenure-line faculty. Within the ranks of the tenure-line faculty there are three recognizable groups – those faculty primarily supporting undergraduate programs (generally with a 4/4 teaching assignment), graduate faculty primarily supporting Master of Science programs (generally with a 3/3 teaching assignment), and graduate faculty supporting PhD programs (generally with a 1/2 teaching assignment). The Geospatial Computing Science core faculty will have the 1/2 teaching assignment. The support faculty will have the teaching assignment ranging from 1/2 to 3/3, depending on the roles of individual faculty, and will be negotiated with the department chair/school director with the dean's approval. The nominal effort allocation for faculty of each respective group is summarized in Table 2.

Table 2. Nominal Effort Allocation

| | *Effort Allocation (%)* | | |
|---|---|---|---|
| *Teaching Load** | *Teaching* | *Research* | *Service* |
| *4/4* | *80* | *10* | *10* |
| *3/3* | *60* | *30* | *10* |
| *1/2* | *30* | *60* | *10* |

*Based on 3-SCH course load

H. Candidacy/Dissertation – If the program requires a dissertation, describe the process leading to candidacy and completion of the dissertation.

To be admitted to candidacy, a student must have entered upon a dissertation research course approved by his or her dissertation adviser, and have passed a comprehensive exam. The comprehensive exam is composed of a written dissertation proposal and an oral examination. The comprehensive exam is administered by the student's dissertation committee that is chaired by the student's adviser with four additional faculty members (including the Graduate College representative) on the committee.

To facilitate close supervision and a highly research-oriented environment, students are expected to find an advisor and to start their research within the first year of their study. A degree plan is determined in consultation with, and approved by, the adviser and through the Graduate College.

Students are expected to meet regularly with their advisers and are encouraged to do the same with other members of the faculty.

A final oral examination will be scheduled and given after the PhD dissertation has been submitted for review to the student's adviser and other members of the dissertation committee. The dissertation examination is a defense of the dissertation research, an examination of the student's original contributions to the field of study, and a test of the candidate's knowledge in his or her specialized fields.

All TAMUCC policies that govern the degree requirements, including GPA requirements, residency, recency of credit, scheduling of the exams, etc., apply.

In addition, we propose a schedule toward the degree similar to the guidelines established by the Computer Science and Engineering Department of Texas A&M University, http://www.cs.tamu.edu/academics/graduate/PhD-Review-Procedures (April 19, 2013). For full-time students, the guidelines are listed below for B.S. to Ph.D. and M.S. to Ph.D. degree studies, respectively. For part-time Ph.D. students a similar and scaled schedule is recommended. Students coming in with an MS degree in Computer Science, Geographic Information Science or in a related engineering or science field may have an accelerated schedule.

**B.S. to Ph.D. Satisfactory Progress Guidelines**

| | |
|---|---|
| Year* B+1 | The student is expected to find an advisor, to complete several core courses, to start their research. The student may file a degree plan. |
| Year B+2 | The student is required to file a degree plan (by the end of their third semester). The student is expected to complete most of their course requirements. Some progress in research should be documented (for instance, submission of a paper to a conference or journal). |
| Year B+3 | The student is expected to complete their course work. The student should have tangible research results, such as refereed publications in recognized outlets. The student is expected to complete their Ph.D. proposal and pass the comprehensive exam. |
| Year B+4 | The student is strongly expected to complete their Ph.D. proposal and pass the comprehensive exam. The student must have made substantial progress towards the completion of the Ph.D. dissertation. There should be evidence that the candidate has produced original, significant research contributions. Lack of publications will be an indicator of inadequate progress. |
| Year B+5 | The student should plan to complete and successfully defend the dissertation. |
| Year B+6 | The student should complete and successfully defend the dissertation no later than B+6 year.. |

*The notation "B+i" means the i-th year after the B.S. degree.

**M.S. to Ph.D. Satisfactory Progress Guidelines**

| | |
|---|---|
| Year* M+1 | The student should be familiar with the GCS faculty and their research activities such that agreement with an advisor can be finalized quickly. The student should (nearly) complete course work, start their research, and is expected to file a degree plan. Progress in research should be documented (for instance, submission of a paper to a conference or journal). A student may engage in more research and correspondingly less course work. |
| Year M+2 | The student must file a degree plan (by the end of the third semester). The student should complete all course work. The student must have tangible research results, such as refereed publications in recognized outlets. The student should submit their dissertation proposal and |

| | |
|---|---|
| | pass the comprehensive exam. |
| Year M+3 | The student must have made substantial progress towards completion of the Ph.D. dissertation. There should be evidence that the candidate has produced original, significant research contributions. Lack of publications will be an indicator of inadequate progress. |
| Year M+4 | The student should plan to complete and successfully defend the dissertation. |
| Year M+5 | The student should complete and successfully defend the dissertation no later than M+5 year. |

*The notation "M+i" means the i-th year after completing the Master's Degree.

I. Use of Distance Technologies – If applicable, describe the use of any distance technologies in the program.

While there might be a course or two offered on-line at some point, there is no current intent to offer the program or a significant part of the program on-line. This is a very research-oriented Ph.D. program. Doctoral students will be working closely with faculty in their labs on complex research topics related to geospatial computing sciences. On the other hand, while this will not be an online program, there will be high-end technology available for both students and faculty. Access to the technology is essential for research and instruction in this discipline.

J. Library Resources – Provide the library director's assessment of both paper and electronic library resources for the program. Describe plans to build the library holdings to support the program.

The Library Director, Christine Shupala, has been very supportive of the all programs in the School of Engineering and Computing Sciences (ENCS). As such, ENCS has the following resources to support the proposed doctoral program:

- Science Direct, a database that offers access to the full text of over 1,200 journal titles, from 1995 to the present. Fields covered by the database include biochemistry, biological science, business & management science, chemistry, clinical medicine, earth sciences, economics, engineering & technology, environmental science, materials science, mathematics & computer science, microbiology & immunology, neurosciences, pharmacology & toxicology, physics, and the social sciences.
- SpringerLink, a database containing full text from publishers such as Springer-Verlag, Urban and Vogel, Steinkopff, and Birkhauser. SpringerLink currently offers over 500 fully peer reviewed journals. This database also includes the content formerly found in Kluwer Online, a full-text collection that provided access to the complete contents of more than 700 Kluwer journals and covers a wide array of subjects, including science, technology, medicine, humanities and law.
- Taylor and Francis, a full text resource containing information from more than 1,000 journals and covering topics such as agriculture, anthropology, biology, business, chemistry, communication, computer science, criminology, earth sciences, economics, education, engineering, environmental science, geography, health science, mathematics, physics, psychology and social science. This database also includes the content formerly found in Dekker Publications, a full-text collection of authoritative scientific, technical, & medical journals published in print and online by Dekker.
- Wiley InterScience, from John Wiley & Sons, includes full text from over 300 scientific, technical, medical, and professional journals, plus major reference works, Current Protocols laboratory manuals, and full text of select Wiley print books online.
- IEEE Explore, from the Institute of Electrical and Electronics Engineers, Inc. provides IEEE transactions, journals, magazines, and conference proceedings and IEEE standards. Topics

covered include: aerospace, circuitry, communications, computers, electronics, engineering, magnetics, manufacturing engineering, quantum electronics, robotics, superconductivity, signal processing, and many other engineering topics.
- ACM Digital Library, a collection of citations and full text from the Association for Computing Machinery (ACM) journal, magazine, and newsletter articles, and conference proceedings. ACM is the world's largest educational and scientific computing society, which delivers resources that advance computing as a science and a profession.

Additional available resources are included in the appendix. Funds are being requested to acquire new monographic and serial resources that will support this program directly.

K. Facilities and Equipment – Describe the availability and adequacy of facilities and equipment to support the program. Describe plans for facility and equipment improvement or additions.

The School of Engineering and Computing Sciences has a strong level of equipment and facilities to support the proposed PhD program in Geospatial Computing Sciences. Five laboratories/facilities that are key components of the program are: the Innovation in Computing Research Labs (iCORE); the Graphics and Visualization Laboratory; the Unmanned Aerial System (UAS) and Laboratory; the Conrad Blucher Institute for Surveying and Science (CBI); and the Network, Security and Cluster Laboratory.

**Conrad Blucher Institute for Surveying and Science (CBI)**
The Conrad Blucher Institute for Surveying and Science (CBI) has a national reputation for developing innovative geospatial science research and serves as a focused resource area for geospatial datasets relevant to the coastal environment. CBI has two strategic research areas: Geospatial Computing and Coastal Dynamics. For Geospatial Computing, CBI supports two research entities utilizing Geometrics and Geographic Information Science as a critical portion to their research projects focusing on mobile geospatial computing, automated cartography and smart GIS applications. CBI is a designated ESRI Development Center allowing student access to all state-of-the-art GIS software and to the development platforms for developing mobile-, web- and cloud-based GIS applications. In 2007, the Texas Legislature established the TAMUCC Texas Spatial Reference Center (http://tsrc.cbi.tamucc.edu/) with the goal of conducting geodetic surveying and mapping research. Furthermore, the CBI has projects that include mapping shorelines for beach erosion, hydrographic mapping using new sensors designed at CBI and other related sciences. For Coastal Dynamics, CBI operates more than 50 ocean observing stations built and operated to National Ocean Service standards for several agencies historically spanning the Gulf Coast from Mississippi to South Texas including the Texas Coastal Ocean Observation Network (TCOON). The TCOON network and associated information technology and communications infrastructure provides in real-time water level, meteorological, and water quality data. CBI resources include office space, electronics and calibration laboratory, other various laboratory and information technology space in its own building (about 8,000 sf) and in the Natural Resources Center building (approximately 10,000 sf.). CBI owns six field operations vehicles, four small boats, various oceanographic sensors, electronics, large-format scanner and plotter, surveying equipment, and state-of-the-art, precise GPS equipment. CBI owns a range of workstations, servers, tablets, smartphones, and data storage devices to run the information technology component of its observation network and to conduct research projects.

**Innovation in Computing Research Labs (iCORE)**
The Innovation in Computing Research Labs (iCORE) is a research, development, and commercialization group that promotes excellence, innovation, and entrepreneurship in computing and related fields. The mission of iCORE is to discover new knowledge, sciences, and technologies that enhance the quality of life. With its sponsored basic and applied research, iCORE creates innovative solutions for a smarter global community. Dr. Mahdy and his multidisciplinary group

continue to establish partnerships with industry, education, and public entities promoting business development and creating job opportunities.

iCORE is actively engaging in

1) Discovering and disseminating new knowledge and sciences related to computing
2) Engineering and developing novel technologies
3) Promoting business development and creating job opportunities
4) Advancing and nurturing the research environment
5) Promoting innovation and creativity in computing
6) Seeking excellence in education and training in related fields
7) Serving as a catalyst for curriculum development and student recruitment in computing fields

Ongoing research projects include virtual cloning, situation-aware mobile computing, real-time integrated aerial, terrestrial, and underwater sensing, gesture-based and brain human-computer interaction, and agile knowledge sharing-based software development process. In addition to software development supporting the aforementioned research, iCORE is also sponsored on large software projects including mobile and web application development.

This innovative research and development work is enabled by its dedicated facility that includes office space, work stations, and a conference room. iCORE is equipped with a state-of-the-art computing infrastructure. This includes high performance server and computers, mobile devices, wireless sensor networks, robots, unmanned aerial, ground, and underwater vehicles, software RF and communication transceivers…etc.

A list of key equipment follows below:

| Item | Approximate Cost |
|---|---|
| Apple Desktops and Laptops | $25,000 |
| Alienware Desktops | $22,000 |
| Dell Laptops | $15,000 |
| WSN and BSN Boards, Kits…etc. | $35,000 |
| Remote-Controlled Sensing: Hex ArduCopter, DJI Copter UAV, UGV, Open ROV, GoPro HD | $15,000 |
| Touch Surface: Samsung SUR 40 with PixelSense | $9,800 |
| Software RF: NI USRP…etc. | $5,000 |
| Brain HCI: Emotiv Kits | $5,000 |
| Gesture HCI: GestureTek FX, Leap Motion, Myo Armband…etc. | $15,000 |
| Mobile Devices | $10,000 |
| Development Boards, Kits…etc. | $5,000 |
| eKo Weather Stations | $9,000 |
| Humanoid Robot: NAO Next Gen | $16,000 |
| Software Development Infrastructure: Dazzler SDK, Ouya, Adobe Web and Design Suites, Antetype, Balsamiq…etc. | $7,000 |

**Graphics and Visualization Laboratory (Pixel Island)**

Pixel Island is a multidisciplinary laboratory that includes the areas of computer graphics, visualization, game design, game development, human computer interaction, GPGPU, motion capture and digitization, robotics, mobile computing and related research areas. Pixel Island is also used for teaching courses in the above topics. The following list of equipment supports all the work conducted by faculty and students:

4x 2009 Dell XPS core i7 (1st gen)
3x 2008 Dell XPS core2 duo
2008 Dell Precision 4 core Xeon Processor
2010 iMac
2011 Alienware corei7 (2nd gen) 4 core
2010 Dell Server for data storage
37inch TV
32inch TV
32inch touchscreen TV
2x ActivMedia Robotics robots
Lego Mindstorms robot
Parrot ArDrone
Lab designed 4 wheeled robot, Kinect sensor, control software can control with gamepad.
3x DLP projector
3D projection system
2x 37inch mountable plasma TV
Xbox 360s for XNA development
Motion capture system (Motion Analysis) 8 Eagle- 4 10 Hawk-I cameras
GPUs for Dell systems are GTX 680, GTX 460, and GTX 280
10 Kinects
20 various android mobile devices (phones and tablets)

**Unmanned Aerial System (UAS) Laboratory**

The aircraft is an Arcturus RS-16 which has been modified by American Aerospace Advisors, Inc. (AAAI). AAAI also performed the integration of the scientific payload into the aircraft, and the assembly of the ground control station and aircraft launcher. The aircraft is approximately 7 ft long and has a 12.9-ft wingspan. It has a maximum gross take-off weight of 85 lbs and a maximum airspeed of 65 kts. It can carry a 25-lb payload and stay in the air for a maximum of 12 hours. The plane is controlled by a Piccolo autopilot manufactured by Cloud Cap. It is operated by a computer through a ground station which has a radio link with the aircraft. The aircraft is launched by a pneumatic piston launcher which operates off compressed air.

The payload on the RS-16 is a multi-spectral camera system consisting of a high-definition video (HDV) camera, an infrared (IR) camera, and an ultraviolet (UV) camera. The spectral wavelength range for the HDV camera is 0.45 to 0.65 microns; for the IR camera, 8 to 12 microns; and for the UV camera, 0.3 to 0.4 microns. The IR and UV cameras each have a resolution of 0.5 ft per pixel at an altitude of 1,000 ft and the HDV camera has a resolution of 0.167 ft at an altitude of 1,000 ft.
Capital Equipment Purchases – UAS

| | |
|---|---|
| RS-16A Unmanned Aerial Vehicle, with launcher and ground control station: | $200,000 |
| Multi-spectral camera payload (including supporting electronics and systems) | 46,355 |
| Trailer-based Mobile Operations Center | 64,250 |
| High-gain tracking antenna | 17,500 |
| Launcher pressurization system | 6,575 |
| RS-16 shipping case | 1,050 |
| External pilot communication system – intercom cables | 1,250 |
| Total | $336,980 |

**Network, Security and Cluster Laboratory**

The Network, Security and Cluster Laboratory serves multiple research and teaching purposes. Theoretical network architectures can be explored and simulated in the lab environment which is isolated from the campus infrastructure. Students can exercise book concepts in a real-world environment using lab resources. Security profiles and exercises can be executed in a virtual machine environment to research algorithms or protocols and to provide hands-on exercises for students. In addition, the cluster infrastructure provides a research and teaching environment for parallel computing and cloud computing applications.

| **Product** | **Quantity** | **Description** |
|---|---|---|
| Dell OptiPlex 990 Desktops | 25 | For computing needs |
| Dell PowerEdge 6600 server | 1 | Server for holding files, software patches, security updates, VMware images |
| Cisco Catalyst 2950 series 24-port switch | 2 | Provides Ethernet connectivity among the computers, storage, modems, printers in the lab |
| Cisco VPN 3000 series concentrator | 1 | Provides remote connectivity securely |
| Cisco PIX 515E Firewall | 1 | Provides security for small to medium-sized networks, and supports DMZ |
| Cisco 2600 Series Router | 2 | Provides LAN and WAN connectivity. It features several security options that can be configured as needed |
| Cisco IDS-4235-K9 | 1 | Provides the capability of detecting any intrusions, attacks on the network |
| 3Com 3300 24-port switch | 5 | Provides Ethernet connectivity among the computers, storage, modems, printers in the lab |
| 3Com Link Builder FMS II 24-port Hub | 1 | Provides connectivity among computers |
| 3Com Super Stack II Hub 10 24-port | 2 | Provides connectivity among computers |
| 3Com Super Stack II PS Hub 40 24-port | 1 | Provides connectivity among computers |
| Netgear 4-port Hub | 1 | Provides connectivity among computers |
| Linksys 10/100 16-port workgroup switch | 4 | Provides Ethernet connectivity among the computers, storage, modems, printers in the lab |
| Linksys 10/100 8-port workgroup switch | 3 | Provides Ethernet connectivity among the computers, storage, modems, printers in the lab |
| Linksys Gigabit 5-port workgroup switch | 4 | Provides Gigabit Ethernet connectivity among the computers, storage, modems, printers in the lab |
| Linksys 10/100 4-port VPN router | 5 | Provides connectivity among computers by acting as a switch, and supports remote connectivity securely |
| Linksys Broadband firewall router with 4-port switch/VPN end point | 3 | Provides connectivity among computers by acting as a switch, and supports remote connectivity securely |
| Belkin OmniView Pro 8-port KVM switch | | For controlling up to 8 computers from a single console |
| Philips projector | 1 | Projector |
| HP Laserjet 4000N | 1 | Printer |

The cluster consists of a file server and 16 compute nodes connected by a Dell 1Gbit Ethernet switch. The file server, Dell PowerEdge contains a 8 core CPU of 3.0Ghz, 16 GB RAM, and 320 GB hard disk, while each compute node, Dell PowerEdge R300, has a dual core Intel Xeon processor of 4GB RAM, and 140 GB hard disk. Rocks Clusters software is used for the operating system as well as for management of the cluster. The existing computer cluster is being used to construct a Cloud Computing Infrastructure.

L. <u>Accreditation</u> – If the discipline has a national accrediting body, describe plans to obtain accreditation or provide a rationale for not pursuing accreditation.

There is no national body that accredits doctoral programs in this area. The university's B.S. program in Computer Science – Systems Programming option is accredited by the Computing Accreditation Commission (CAC) of ABET. The B.S. in Geographic Information Science, the BS in Electrical Engineering Technology, and the B.S. in Mechanical Engineering Technology are accredited by the Applied Science Accreditation Commission of ABET. The B.S. in Mechanical Engineering program received its first ABET visit in fall of 2012, and accreditation is expected by August 2013.

M. <u>Program Evaluation</u> – Describe how the program will be evaluated.

Annual evaluation of program performance will be conducted. The program evaluation will follow the assessment method adopted by the National Research Council detailed in the NAP publication entitled "A data-based assessment of research-doctorate programs in the United States" (2010). The assessment will include the following metrics:

1. Publications per allocated faculty member
2. Citations per publication
3. Percent faculty with grants
4. Awards per allocated faculty member
5. Percent interdisciplinary faculty
6. Percent non-Asian minority faculty
7. Percent female faculty
8. Average GRE scores
9. Percent 1st-yr. students with full support
10. Percent 1st-yr. students with external funding
11. Percent non-Asian minority students
12. Percent female students
13. Percent international students
14. Average PhDs (5-year degree productivity)
15. Average completion percentage
16. Median time to degree
17. Percent students with academic plans
18. Student work space
19. Student health insurance
20. Number of student activities offered

N. <u>Related and Supporting Programs</u> – Use this table to list all undergraduate and graduate programs within the same 2-digit CIP code that would undergird the proposed program. Include enrollment, number of graduates, graduation rate, and average time to degree for the last five years. Calculate the program graduation rate starting at the time a student takes the first course in his or her major outside the core curriculum. (*Add and delete rows as needed.*)

| | | **2008** | **2009** | **2010** | **2011** | **2012** |
|---|---|---|---|---|---|---|
| **PhD in Coastal & Marine System Science** | Fall Enrollment | 23 | 19 | 18 | 18 | 19 |
| | # of Graduates | | 2 | 2 | 1 | 4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Graduation Rate | N/A* | N/A* | N/A* | N/A* | N/A* |
| | Average time to degree | | 3.66 years | 3.66 years | 5.50 years | |
| **MS in Computer Science** | Enrollment | 78 | 83 | 97 | 88 | 55 |
| | # of Graduates | 13 | 24 | 17 | 37 | 36 |
| | Graduation Rate | 68.75 | 60.00 | 70.59 | 80.00 | 65.22 |
| | Average time to degree | 3.50 | 2.81 | 2.56 | 2.28 | 2.11 |
| **MS in Geospatial Surveying Engineering** | Enrollment | 14 | 28 | 20 | 21 | 32 |
| | # of Graduates | | 7 | 9 | 6 | 2 |
| | Graduation Rate | NA | NA | NA | 58.33 | 71.43 |
| | Average time to degree | | | | 1.76 | 1.46 |

*The program began in 2004. Not enough years of data to establish a standard graduation rate which is calculated over 10 years.

O. Graduation Rates – Use this table to show the institution's total number of graduates and comprehensive graduation rates from undergraduate and graduate programs in each of the last five years.

| | **2008** | **2009** | **2010** | **2011** | **2012** |
|---|---|---|---|---|---|
| **All Undergraduate Programs** | | | | | |
| No. of Graduates | 1340 | 1424 | 1335 | 1315 | 1515 |
| Graduation Rate: 4-year | 22.1% | 21.6% | 23.5% | 26.4% | 27.8% |
| (cohort year) | 2003 | 2004 | 2005 | 2006 | 2007 |
| Graduation Rate: 6-year | 49.8% | 52.9% | 53.4% | 50.3% | 51.1% |
| (cohort year) | 2001 | 2002 | 2003 | 2004 | 2005 |
| **All Masters Programs** | | | | | |
| No. of Graduates | 400 | 469 | 445 | 532 | 527 |

| | | | | | |
|---|---|---|---|---|---|
| Graduation Rate | 49.1%<br>2003 | 54.3%<br>2004 | 56.6%<br>2005 | 65.2%<br>2006 | 64.3%<br>2007 |
| **All Doctoral Programs** | | | | | |
| No. of Graduates | 32 | 27 | 21 | 30 | 29 |
| Graduation Rate | | 75%<br>1999 | 78.9%<br>2000 | 66.7%<br>2001 | 92.3%<br>2002 |

Graduation rates given for undergraduate programs are Texas Higher Education Coordinating Board Accountability System rates of graduating from the same or another Texas institution. Master's Program and Doctoral Program graduation rates are also from the Accountability System.

P. Existing Doctoral Programs – (a) Provide the web link(s) for the *18 Characteristics of Doctoral Programs* for each of the institution's existing doctoral programs. (b) Describe how the data represent the current quality of the institution's existing doctoral programs. (c) Describe how existing closely-related doctoral programs would enhance and complement the proposed program.

http://gradschool.tamucc.edu/docs/CTPDP/ctpdp.php

Q. Describe how the proposed doctoral program fits into the institution's overall strategic plan, and provide the Web link to the institution's strategic plan.

The proposed Ph.D. in Geospatial Computing Sciences will make a crucial contribution to the university's strategic plan, *Momentum 2015*. It advances Imperative IV: Establish Targeted Areas of State, Regional, and National Recognition and Distinction. In the geospatial computing sciences area, the university has the opportunity to achieve national and international prominence. We have special strengths as represented by our faculty in computer science, our researchers who work with unmanned aerial and underwater vehicles, and our faculty and researches in the Blucher and Harte Institutes. The Higher Education Coordinating Board is increasingly expecting universities requesting new doctoral programs to focus on areas where they can demonstrate national or international distinction. This is one of those areas for Texas A&M University-Corpus Christi. One indication of the high quality of our programs in this area is their ability to attract international students and international institutions interested in forming academic partnerships. Evidence of our success in this area is the agreement we are close to finalizing with Hubei University in China for a 3 plus 2 program that will result in students getting their bachelor's degree from Hubei and our master's degree in geospatial surveying engineering. Hubei is the one of the top Chinese universities in the geospatial area.

A Ph.D. in Geospatial Computing Sciences also contributes in a critical way to Imperative V: the university's aspiration to Achieving Doctoral Comprehensive Status and Emerging Research Designation. To meet this goal, the university needs to generate more externally funded research, to produce more doctoral graduates and to have more doctoral programs. The Coordinating Board has been reviewing and considering revisions to its requirements for Emerging Research Status. Under those proposed revisions, research PhD degrees like the proposed program would "count" toward Emerging Research Status, but EdD's and professional doctorates would not. A Ph.D. in Geospatial Computing Sciences would contribute significantly to our ability to increase externally funded research.
Link to strategic plan: http://www.tamucc.edu/about/momentum2015/stratplan.html

## III. Costs and Funding

Five-Year Costs and Funding Sources – On the attached forms, provide estimates of new costs to the institution related to the proposed program and provide information regarding sources of the funding that would defray those costs.

## IV. Required Appendices

A. Course Descriptions and Prescribed Sequence of Courses, if Applicable
B. Curricula Vitae for Core Faculty
C. Curricula Vitae for Support Faculty
D. Five-Year Faculty Recruitment Plan/Hiring Schedule
E. Institution's Policy on Faculty Teaching Load
F. Itemized List of Capital Equipment[1] Purchases during the past five years
G. Librarian's Statement of Adequate Resources

## V. Recommended Appendices (as applicable)

A. List of Specific Clinical or In-Service Sites to Support the Program
B. Letters of Support

[1] "Equipment" has the meaning established in the Texas Administrative Code as items and components whose cost are over $5,000 and have a useful life of at least one year. (See TAC §252.7(3))

## Signature Page

1. Adequacy of Funding – The chief executive officer shall sign the following statement:

*I certify that the institution has adequate funds to cover the costs of the new program. Furthermore, the new program will not reduce the effectiveness or quality of existing programs at the institution.*

___________________________________________________

Chief Executive Officer Date

. Board of Regents Approval – A member of the Board of Regents or designee shall sign the following statement:

*On behalf of the Board of Regents, I certify that the Board of Regents has approved the program.*

___________________________________________________

Board of Regents (Designee) Date of Approval

3. Board of Regents Certification of Criteria for Commissioner or Assistant Commissioner Approval – For a program to be approved by the Commissioner or the Assistant Commissioner for Academic Affairs and Research, the Board of Regents or designee must certify that the new program meets the criteria under Texas Administrative Code (TAC) Section 5.50 (b) and (c). The criteria are:

TAC §5.50(b):

(1) be within the institution's current Table of Programs;
(2) have a curriculum, faculty, resources, support services, and other components of a degree program that are comparable to those of high quality programs in the same or similar disciplines at other institutions;
(3) have sufficient clinical or in-service sites, if applicable, to support the program;
(4) be consistent with the standards of the Commission of Colleges of the Southern Association of Colleges and Schools and, if applicable, with the standards or discipline-specific accrediting agencies and licensing agencies;
(5) attract students on a long-term basis and produce graduates who would have opportunities for employment; or the program is appropriate for the development of a well-rounded array of basic baccalaureate degree programs at the institution;
(6) not unnecessarily duplicate existing programs at other institutions;
(7) not be dependent on future Special Item funding;
(8) have new five-year costs that would not exceed $2 million;

TAC §5.50 (c)

(1-2) be in a closely related discipline to an already existing doctoral program(s) which is productive and of high quality;
(3) have core faculty that are already active and productive in an existing doctoral program;
(4) have received no objections from other institutions during the 30-day comment period; and
(5) have a strong link with workforce needs or the economic development of the state.

*On behalf of the Board of Regents, I certify that the new program meets the criteria specified under TAC Section 5.50 (a and b).*

___________________________________________________

Board of Regents (Designee) Date

## COSTS TO THE INSTITUTION OF THE PROGRAM/ADMINISTRATIVE CHANGE

*Note:* Use this chart to indicate the dollar costs to the institution that are anticipated from the change requested.

| Cost Category | Cost Sub-Category | Before Approval Year* | 1st Year | 2nd Year | 3rd Year | 4th Year | 5th Year | TOTALS |
|---|---|---|---|---|---|---|---|---|
| **Faculty Salaries** | **(New)** | | | | | | | |
| | **(Reallocated)** | | **115,000** | **287,500** | **504,000** | **552,000** | **662,500** | **2,121,000** |
| **Program Administration** | **(New)** | | | | | | | |
| | **(Reassignments)** | | | | | | | |
| **Graduate Assistants** | **(New)** | | **19,440** | **129,600** | **174,960** | 200,880 | 239,760 | 764,640 |
| | **(Reallocated)** | | **18,000** | **18,000** | **18,000** | 18,000 | 18,000 | 90,000 |
| **Clerical/Staff** | **(New)** | | | **21,533** | **21,533** | 21,533 | 21,533 | 86,134 |
| | **(Reallocated)** | | | | | | | |
| **Supplies & Materials** | | | | | | | | |
| **Library & IT Resources**** | | | **52,500** | **56,000** | 59,850 | 64,085 | 68,744 | 301,179 |
| **Equipment** | | | | | | | | |
| **Facilities** | | | | | | | | |
| **Other (Post Doc)** | | | **75,000** | **75,000** | | | | 150,000 |
| **TOTALS** | | | **279,940** | **587,633** | **778,343** | 856,498 | 1,010,537 | 3,512,953 |

* Include costs incurred for three years before the proposal is approved by the Board (e.g., new faculty, library resources, equipment, facilities remodeling, etc.).

** IT = Instructional Technology

**Explanations:**

## ANTICIPATED SOURCES OF FUNDING

*Note:* Use this chart to indicate the dollar amounts anticipated from various sources. Use the reverse side of this form to specify as completely as possible each non-formula funding source.

| Funding Category | 1st Year | 2nd Year | 3rd Year | 4th Year | 5th Year | TOTALS |
|---|---|---|---|---|---|---|
| **I. Formula Income*** | | | $282,934 | $358,095 | $418,892 | $1,059,921 |
| **II. Other State Funding* (Statutory Tuition)** | $6,856 | $18,283 | $29,710 | $36,566 | $41,137 | $132,552 |
| **III. Reallocation of Existing Resources*** | $208,000 | $380,500 | $432,000 | $570,000 | $650,500 | $2,241,000 |
| **IV. Federal Funding* (In-hand only)** | $0 | $0 | $0 | $0 | $0 | $0 |
| **V. Other Funding* (Designated Tuition)** | $8,950 | $120,954 | $184,133 | $241,534 | $247,500 | $803,071 |
| **TOTALS** | $223,806 | $519,737 | $928,778 | $1,206,195 | $1,358,029 | $4,236,544 |
| **Funding Category** | **1st Year** | **2nd Year** | **3rd Year** | **4th Year** | **5th Year** | **TOTALS** |
| **I. Formula Income*** | | | | | | |

*For more information, please refer to the accompanying *Anticipated Sources of Funding: Explanatory Notes and Examples.*

## NON-FORMULA SOURCES OF FUNDING

*Note:* Use this form to specify as completely as possible each of the non-formula funding sources for the dollar amounts listed on the reverse side of this form.

| Funding Category | Non-Formula Funding Sources |
|---|---|
| **II. Other State Funding*** | **#1** |
| | |
| | **#2** |
| | |
| **III. Reallocation of Existing Resources*** | **#1** |
| | |
| | **#2** |
| | |
| **IV. Federal Funding*** | **#1** |
| | |
| | **#2** |
| | |
| **V. Other Funding*** | **#1** |
| | |
| | **#2** |
| | |

*For more information, please refer to the accompanying *Anticipated Sources of Funding: Explanatory Notes and Examples.*

Explanations:

## ANTICIPATED SOURCES OF FUNDING: EXPLANATORY NOTES AND EXAMPLES

### I. Formula Income

A. The first two years of any new program should not draw upon formula income to pay for the program.

B. For each of years three through five, enter the smaller of:
   1. the new formula income you estimate the program would generate, based on projected enrollments and formula funding rates; or
   2. half of the estimated program cost for that year.

C. Because enrollments are uncertain and programs need institutional support during their start-up phase, it is the Coordinating Board's policy to require institutions to demonstrate that they can provide:
   1. sufficient funds to support **all** the costs of the proposed program for the first two years (when no **new** formula funding will be generated); and
   2. half of the costs of the new program during years three through five from sources other than state formula funding.

D. When estimating new formula income, institutions should take into account the fact that students switching programs do not generate additional formula funding to the institution. For example, if a new master's program has ten students, but five of them switched into the program from existing master's programs at the institution, only five of the students will generate new formula income to help defray the costs of the program.

### II. Other State Funding

This category could include special item funding appropriated by the legislature, or other sources of funding from the state that do not include formula-generated funds (e.g., HEAF, PUF, etc.).

### III. Reallocation of Existing Resources:

If faculty in existing, previously budgeted positions are to be partially or wholly reallocated to the new program, you should explain in the text of your proposal how the institution will fulfill the current teaching obligations of those faculty and include any faculty replacement costs as program costs in the budget.

### IV. Federal Funding

Only federal monies from grants or other sources currently ***in hand*** may be included. Do not include federal funding sought but not secured. If anticipated federal funding is obtained, at that time it can be substituted for funds designated in other funding categories. Make note within the text of the proposal of any anticipated federal funding.

### V. Other Funding

This category could include Auxiliary Enterprises, special endowment income, or other extramural funding.

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