ACAP
9/29/16
Agenda Item 5d

Name of Institution

University of South Carolina

Name of Program (include concentrations, options, and tracks)

Master of Science in Computer Science and Engineering is being modified to Master of Science in Computer Science, and Master of Engineering in Computer Science and Engineering is being modified to Master of Science in Computer Engineering.

Program Designation

- ☐ Associate's Degree
- ☒ Master's Degree
- ☐ Bachelor's Degree: 4 Year
- ☐ Specialist
- ☐ Bachelor's Degree: 5 Year
- ☐ Doctoral Degree: Research/Scholarship (e.g., Ph.D. and DMA)
- ☐ Doctoral Degree: Professional Practice (e.g., Ed.D., D.N.P., J.D., Pharm.D., and M.D.)

Does the program qualify for supplemental Palmetto Fellows and LIFE Scholarship awards?

- ☐ Yes
- ☒ No

Proposed Date of Implementation

Fall 2016

CIP Code

11.0701 for M.S. in Computer Science
14.0901 for M.S. in Computer Engineering

Delivery Site(s)

Delivery Mode

- ☒ Traditional/face-to-face*
  *select if less than 50% online
- ☐ Distance Education
  - ☐ 100% online
  - ☐ Blended (more than 50% online)
  - ☐ Other distance education

Program Contact Information (name, title, telephone number, and email address)

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Institutional Approvals and Dates of Approval

Graduate Council at USC, Oct 26, 2015 for M.S. in CS and Nov 23, 2015 for M.S. in CE.
USC Board of Trustees, June 24, 2016

Background Information

The University of South Carolina requests approval to modify the Master of Science program in Computer Science and Engineering, and Master of Engineering program in Computer Science and Engineering, and rename them as Master of Science in Computer Science and Master of Science in Computer Engineering respectively.

The Department of Computer Science and Engineering in the College of Engineering and Computing was formed in 2000 by merging parts of two separate departments, Electrical and Computer Engineering in College of Engineering and Mathematics and Computer Science in College of Arts and Sciences. Prior to the merger, there were two separate M.S. programs in each of these departments: a M.S. in Computer Science and a M.S. in Computer Engineering. At the time of the merger, it was decided to offer an M.S. program and an M.E. program, both in Computer Science and Engineering. This request would revert to that prior organization.

Program Objectives

The Master of Science degree in Computer Science aims to provide students with both breadth and depth in advanced topics in computer science. The graduates of this program:

- should have a strong foundation in formal languages and compilers.
- should have a strong foundation in computer architecture and the performance of computing systems.
- should have a strong foundation in analysis of algorithms.
- should have demonstrated the ability to develop large software systems.

The Master of Science degree in Computer Engineering aims to provide students with both breadth and depth in advanced topics in computer engineering. The graduates of this program:

- should have a strong foundation in digital electronics systems design.
- should have a strong foundation in computer architecture and the performance of computing systems.
- should have a strong foundation in analysis of algorithms.
- should have demonstrated the ability to integrate hardware and software components to form a coherent well designed system.

We will measure whether these objectives are achieved through the assessment of learning outcomes that are described in the Evaluation and Assessment section of this proposal.

Assessment of Need

There are several reasons for the proposed modification, which are enumerated below.

- The areas of focus and the required coursework for Computer Science (CS) and Computer Engineering (CE) programs are quite different. CE is more hardware-oriented, whereas CS is software-oriented. Students in the CE program focus on areas such as computer architecture, VLSI, robotics, networking, and systems performance evaluation, whereas students in CS program focus on bioinformatics, multi-agent systems, computer security, algorithms, databases, machine learning, etc.
- Offering two separate M.S. programs clearly delineates the discipline of CE from CS. It allows students to choose the program that matches their academic and career objectives and to earn credentials that precisely reflect the distinct skills they acquire.
- It is a common practice in peer institutions to offer separate M.S. programs in CS and CE. In addition to Clemson University, several universities such as Boston University, University of Virginia, Northwestern University, University of California, San Diego, and Washington University, St Louis, offer separate M.S. programs in CS and CE.
- The Department of Computer Science and Engineering currently offers a B.S. in Computer Science and a B.S. in Computer Engineering. By offering an M.S. program also in Computer Engineering in addition to the M.S. in Computer Science, we would provide a path towards advanced degrees for our Computer Engineering students.
- The career opportunities for graduates of Computer Science and Computer Engineering programs are different. The Bureau of Labor Statistics also tracks them separately.
- Apart from providing a path towards a Ph.D. program, graduates with a Master's degree in CE are expected to receive attractive offers from companies such as Intel, Texas Instruments, AMD, Cisco, Juniper Networks, iRobot, whereas CS graduates are expected receive offers from Google, Microsoft, Amazon, Apple, Facebook, etc.

Will the proposed modification impact any existing programs and services at the institution?

☐ Yes

☒ No

List of Similar Programs in South Carolina

Program Name	Institution	Similarities	Differences
M.S. in Computer Science	Clemson University	The M.S. in Computer Science programs at Clemson and at USC require 30 hours of graduate credits post Baccalaureate degree. Both programs offer Thesis and Non-Thesis options.	At Clemson University, M.S. in Computer Science is offered by the Division of Computer Science in the School of Computing, whereas at USC this program is offered by the Department of Computer Science and Engineering in the College of Engineering and Computing. The core and breadth requirements of M.S. in CS at Clemson are quite different from the core and elective requirements of M.S. in CS at USC. At Clemson, each student must take at least three courses in one core area, and one course in three other core areas, whereas USC requires four core courses, without requiring any concentration of multiple courses in a single core area, allowing the students greater flexibility. The sets of graduate courses offered by these departments and thus available to students in these programs are also different. For instance, Clemson offers several courses on Computer Graphics and Human Computer Interaction, whereas USC offers a variety of courses on Information and Network Security.
M.S. in Computer Engineering	Clemson University	Both programs offer Thesis and Non-Thesis options. In both the programs, number of credit hours required for M.S. with Thesis option is 30.	At Clemson, M.S. in Computer Engineering is offered by the Department of Electrical and Computer Engineering, whereas at USC it is part of the Department of Computer Science and Engineering. The focus area requirements of M.S. in CE at Clemson are quite different from the core

Program Name	Institution	Similarities	Differences
			requirements of M.S. in CE at USC. The sets of graduate courses offered by these departments and thus available to students in these programs are also different. For instance, Clemson offers several courses on Power and Energy Systems, whereas USC offers courses regularly on Robotics and Pattern Recognition. The Non-Thesis option at Clemson requires a minimum of 33 credit hours, whereas at USC, this option requires 30 credit hours.
M.S. in Computer and Information Sciences	Jointly by College of Charleston of Charleston and The Citadel	This program offers four specializations. Among them the course requirements for Computer Science Specialization have some overlap with that of M.S. in Computer Science at USC.	The required and specialization courses for M.S. in CIS at CofC/Citadel are different from the core and elective requirements of M.S. in CS at USC. The sets of graduate courses available to the students in these programs are also different. For instance, USC offers courses in areas such as bioinformatics and robotics, whereas CofC/Citadel focus on Information Systems, Software Engineering, and Cybersecuirty. M.S. in CIS at CofC/Citadel requires a minimum of 33 credit hours. At USC, both Thesis and Non-Thesis options require 30 credit hours, which is the standard requirement for all Master's degrees in the College of Engineering and Computing.

Program Name	Institution	Similarities	Differences
M.S. in Computer Science	Charleston Southern University	Both programs offer Thesis and Non-Thesis options. Some of the core courses on architecture and algorithms are similar.	The program at Charleston Southern requires 18 credit hours of core courses, whereas the requirements of the M.S. in CS at USC include 10 credit hours of core courses. The smaller core at USC allows students to tailor their course selections more precisely to their areas of interest. The sets of graduate courses available to the students in these programs are also different. For instance, USC offers courses in areas such as bioinformatics and robotics, whereas the Charleston Southern program offers tracks on Security and Software Engineering. The M.S. in CS at Charleston Southern requires a minimum of 33 credit hours. At USC, both Thesis and Non-Thesis options require 30 credit hours, which is the standard requirement for all Master's degrees in the College of Engineering and Computing.

Description of the Program

Projected Enrollment												
Year	Fall				Spring				Summer			
	Headcount		Credit Hours		Headcount		Credit Hours		Headcount		Credit Hours	
	CS	CE	CS	CE	CS	CE	CS	CE	CS	CE	CS	CE
2016	40	20	360	180	40	20	360	180	40	20	40	20
2017	42	21	378	189	42	21	378	189	42	21	42	21
2018	44	22	396	198	44	22	396	198	44	22	44	22
2019	46	23	414	207	46	23	414	207	46	23	46	23
2020	46	23	414	207	46	23	414	207	46	23	46	23

These estimates are based on the current total of 60 students in the existing M.S. and M.E. programs in the CSE department and the 2:1 ratio of CS to CE majors in our B.S. programs. Also, approximately one third of our faculty conduct research in computer engineering and advise M.S. students. We expect the enrollment to grow by 5% in future years and in the steady state, we anticipate around 46 and 23 M.S. students in the CS and CE programs respectively.

Curriculum

Attach a curriculum sheet identifying the courses required for the program.

Curriculum Changes

Note: Complete this table only if there are changes to the curriculum.

Courses Eliminated from Program	Courses Added to Program

Degree Requirements for Master of Science in Computer Science

The Master of Science in Computer Science degree requires 30 credit hours beyond the B.S. Students in this program may elect either the Thesis or the Non-Thesis option. The course work must include the following.

Core (10 hours):

CSCE 513 - Computer Architecture
CSCE 531 - Compiler Construction
CSCE 750 - Analysis of Algorithms
CSCE 791 - Seminar in Advances in Computing

Electives (20 hours):

A maximum of six hours in non-CSCE courses and at most three hours of CSCE 798 may be applied toward the degree. CSCE 797 may not be applied toward the degree.

Thesis Option:

Students who choose the Thesis option may substitute 6 hours of Thesis Preparation (CSCE 799) for electives. In addition, students must complete at least 12 hours in CSCE courses numbered 700 and above, and defend the Thesis in a public presentation.

Non-Thesis Option:

Students who choose the Non-Thesis option must complete at least 15 hours in CSCE courses numbered 700 and above, and pass a written comprehensive examination offered at the end of Fall and Spring semesters.

Degree Requirements for Master of Science in Computer Engineering

The Master of Science in Computer Engineering degree requires 30 credit hours beyond the B.S. Students in this program may elect either the Thesis or the Non-Thesis option. The course work must include the following.

Core (10 hours):

CSCE 513 - Computer Architecture
CSCE 611 - Advanced Digital Design
CSCE 750 - Analysis of Algorithms
CSCE 791 - Seminar in Advances in Computing

Electives (20 hours):

A maximum of six hours in non-CSCE courses and at most three hours of CSCE 798 may be applied toward the degree. CSCE 797 may not be applied toward the degree.

Students who choose the Non-Thesis option must complete 6 hours from the following list.

CSCE 512 - System Performance Evaluation
CSCE 516 - Computer Networks
CSCE 569 - Parallel Computing
CSCE 574 - Robotics
CSCE 613 - Fundamentals of VLSI Chip Design

Thesis Option:

Students who choose the Thesis option must substitute 6 hours of Thesis Preparation (CSCE 799) for electives. In addition, students must complete at least 12 hours in CSCE courses (including core courses) numbered 700 and above, and defend the Thesis in a public presentation.

Non-Thesis Option:

Students who choose the Non-Thesis option must complete at least 15 hours in CSCE courses (including core courses) numbered 700 and above, and pass a written comprehensive examination administered at the end of Fall and Spring semesters.

List of Graduate Level Courses in Computer Science and Engineering at USC

- CSCE 510 - System Programming
- CSCE 512 - System Performance Evaluation
- CSCE 513 - Computer Architecture
- CSCE 515 - Computer Network Programming
- CSCE 516 - Computer Networks
- CSCE 517 - Computer Crime and Forensics
- CSCE 520 - Database System Design
- CSCE 522 - Information Security Principles
- CSCE 526 - Service Oriented Computing
- CSCE 531 - Compiler Construction
- CSCE 547 - Windows Programming
- CSCE 548 - Building Secure Software
- CSCE 551 - Theory of Computation
- CSCE 552 - Computer Game Development
- CSCE 555 - Algorithms in Bioinformatics
- CSCE 557 - Introduction to Cryptography
- CSCE 561 - Numerical Analysis
- CSCE 563 - Systems Simulation
- CSCE 564 - Computational Science
- CSCE 565 - Introduction to Computer Graphics
- CSCE 567 - Visualization Tools
- CSCE 569 - Parallel Computing
- CSCE 571 - Critical Interactives
- CSCE 572 - Human-Computer Interaction
- CSCE 574 - Robotics
- CSCE 578 - Text Processing
- CSCE 580 - Artificial Intelligence
- CSCE 582 - Bayesian Networks and Decision Graphs
- CSCE 587 - Big Data Analytics
- CSCE 590 - Topics in Information Technology
- CSCE 611 - Advanced Digital Design
- CSCE 612 - VLSI System Design
- CSCE 613 - Fundamentals of VLSI Chip Design
- CSCE 711 - Advanced Operating Systems
- CSCE 713 - Advanced Computer Architecture
- CSCE 715 - Network Systems Security
- CSCE 716 - Design for Reliability
- CSCE 717 - Computer System Performance and Reliability Analysis
- CSCE 718 - Real-Time Computer Applications
- CSCE 719 - Security and Privacy for Wireless Networks
- CSCE 721 - Physical Database Design
- CSCE 723 - Advanced Database Design
- CSCE 725 - Information Retrieval: Algorithms and Models
- CSCE 727 - Information Warfare
- CSCE 730 - Programming Language Semantics
- CSCE 740 - Software Engineering
- CSCE 741 - Software Process
- CSCE 742 - Software Architectures

- CSCE 743 - Software Requirements
- CSCE 744 - Object-Oriented Analysis and Design
- CSCE 745 - Object-Oriented Programming Methods
- CSCE 747 - Software Testing and Quality Assurance
- CSCE 750 - Analysis of Algorithms
- CSCE 755 - Computability, Automata, and Formal Languages
- CSCE 758 - Probabilistic System Analysis
- CSCE 760 - Numerical Analysis I
- CSCE 761 - Numerical Analysis II
- CSCE 763 - Digital Image Processing
- CSCE 765 - Computer Graphics System Design
- CSCE 766 - Scientific Visualization
- CSCE 767 - Interactive Computer Systems
- CSCE 768 - Pattern Recognition and Classification
- CSCE 769 - Computational Structural Biology
- CSCE 771 - Computer Processing of Natural Language
- CSCE 772 - Computer Speech Processing
- CSCE 774 - Robotics Systems
- CSCE 780 - Knowledge Representation
- CSCE 781 - Knowledge Systems
- CSCE 782 - Multiagent systems
- CSCE 784 - Neural Information Processing
- CSCE 787 - Introduction to Fuzzy Logic
- CSCE 790 - Topics in Information Technology
- CSCE 791 - Seminar in Advances in Computing
- CSCE 793 - Internship in Software Engineering
- CSCE 797 - Individual Study and Research
- CSCE 798 - Directed Study and Research
- CSCE 799 - Thesis Preparation
- CSCE 813 - Internet Security
- CSCE 814 - Distributed Systems Security
- CSCE 815 - Computer Communications
- CSCE 818 - Top-Down VLSI Design
- CSCE 819 - Custom VLSI Design
- CSCE 821 - Distributed Database Design
- CSCE 822 - Data Mining and Warehousing
- CSCE 824 - Secure Database Systems
- CSCE 826 - Cooperative Information Systems
- CSCE 846 - Software Reliability and Safety
- CSCE 850 - Advanced Analysis of Algorithms
- CSCE 853 - Formal Methods in Computer Security
- CSCE 865 - Advanced Computer Graphics
- CSCE 867 - Computer Vision
- CSCE 868 - Advanced Pattern Recognition
- CSCE 883 - Machine Learning
- CSCE 895 - Ph.D. Seminar
- CSCE 899 - Dissertation Preparation

Faculty

Provide a brief explanation of any additional institutional changes in faculty and/or administrative assignment that may result from implementing the proposed program modification. (1000 characters)

This modification restructures two existing Masters programs, but does not entail additional teaching or administrative responsibilities beyond the current workload for faculty and staff. All of the courses required for these programs are already offered regularly. The responsibilities for the operation of these two M.S. programs will be distributed among the existing CSE faculty. Administration of the two programs will not differ substantially from the administration of the existing Masters programs.

Resources

Identify any new library/learning resources, new instructional equipment, and new facilities or modifications to existing facilities needed to support the modified program. (2000 characters)

The existing library resources, instructional equipment, and lab space satisfy most of the teaching and research requirements of the two M.S. programs. In addition, to support the operation of the two M.S. programs, the CSE department plans to allocate a recurring budget of $2000 per year for library collections and $5000 per year for equipment upgrades.

Financial Support

Estimated New Costs by Year						
Category	**1st**	**2nd**	**3rd**	**4th**	**5th**	**Total**
Program Administration	5,082	5,235	5,392	5,553	5,720	26,982
Faculty and Staff Salaries	527,500	543,325	559,625	576,413	593,706	2,800,569
Graduate Assistants						
Equipment	5,000	5,000	5,000	5,000	5,000	25,000
Facilities						
Supplies and Materials						
Library Resources	2,000	2,000	2,000	2,000	2,000	10,000
Other*						
Total	539,582	555,560	572,017	588,966	606,426	2,862,551
Sources of Financing						
Category	**1st**	**2nd**	**3rd**	**4th**	**5th**	**Total**
Tuition Funding						
Program-Specific Fees						
State Funding (i.e., Special State Appropriation)*						
Reallocation of Existing Funds*	812,250	878,448	947,888	1,020,703	1,051,324	4,710,613
Federal Funding*						
Other Funding*						
Total	812,250	878,448	947,888	1,020,703	1,051,324	4,710,613
Net Total (i.e., Sources of Financing Minus Estimated New Costs)	272,668	322,888	375,871	431,737	444,898	1,848,062

*Provide an explanation for these costs and sources of financing in the budget justification.

Budget Justification

Provide a brief explanation for the other new costs and any special sources of financing (state funding, reallocation of existing funds, federal funding, or other funding) identified in the Financial Support table. (1000 characters)

Note: Institutions need to complete this budget justification *only* if any other new costs, state funding, reallocation of existing funds, federal funding, or other funding are included in the Financial Support table.

There are no other new costs, state funding, reallocation of existing funds, federal funding, or other funding included in the financial support table. However, in the following, we provide a brief explanation of the budget.

For the program administration, the graduate director is paid an amount equivalent to 40% of his/her salary for one month. The cost for faculty and staff salaries is estimated considering that 20% of the effort of the department's faculty and staff goes towards the M.S. programs (30% for Ph.D. and 50% for Bachelors). The tuition funding is calculated based on 60 M.S. students in the first year, of which 20 (~33%) pay out-of-state tuition fees, each taking 19 credits per year.

Evaluation and Assessment

Will any the proposed modification impact the way the program is evaluated and assessed?

☒ Yes

☐ No

If yes, explain. (1000 characters)

There will be a separate evaluation and assessment for the M.S. in CS and the M.S. in CE. While the programmatic assessment will be similar for these programs, assessment of student learning outcomes for CS program will be different from that of CE program.

Evaluation and Assessment

Programmatic Assessment: The assessment of the modification will be performed by the assessment of the learning outcomes and the assessment of the program's success.

We will periodically measure the success of the two M.S. programs to ensure continuous quality improvement and that the programs meet the changing demands. Initially, we plan to perform yearly assessment on the programs, followed by a full assessment of the programs and the learning outcomes in the 5th year. We plan full assessment every 5 years afterwards.

The assessment of the programs will be based on the 1) rate of recruitment, 2) rate of retention, 3) satisfactory offering of the core and elective courses, and 4) the placement of the graduates.

Recruitment: We anticipate a steady enrollment after the first five years. We will compare enrollment demographics (e.g., field of undergraduate studies, transfer information, GRE score, etc.) of the M.S. in CS and M.S. in CE students with other programs.

Retention: We will collect and analyze data about the rate of successful completion of the programs. We will also collect data for identifying the characteristics of students who dropped out of the programs. We aim to use these characteristics to provide intervention and reduce the number of students who transfer out or drop out of the programs.

Job placement: We will track the job placement of the graduates of these programs. We will analyze the data on the employment of graduates these programs immediately after graduation and after more than 5 years after graduation. We will gather information about the position title, rank, size of the organization, and primary responsibilities. It is anticipated, that near graduation employment will be primarily in the technical areas of computer science and computer engineering. However, after 5 years, graduates are expected to move into leadership positions.

Student Learning Assessment For M.S. in Computer Science

Expected Student Learning Outcomes	Methods of/Criteria for Assessment
At the time of graduation, a Master of Science in Computer Science student should have a strong foundation in formal languages and compilers.	On assignments and assigns, students will formally define the grammar and semantics of a language, design and implement finite state machines appropriate for use as a lexical scanner, design either a bottom-up or top-down parser for the given context-free grammar, implement the semantic routines for a top-down or bottom-up parser for the given the semantic definitions of a language, and perform code generation at the tuple level. 75% of students will score at least 70% on the assignments/exam questions related to this outcome.
At the time of graduation, a Master of Science in Computer Science student should have a strong foundation in computer architecture and the performance of computing systems.	On assignments and exams, students will describe the principles of computer architecture, techniques and principles for the development of high performance computer systems, details of extant computer architectures, and quantitatively analyze aspects of computer architecture and draw conclusions about their performance. 75% of students will score at least 70% on the assignments/exam questions related to this outcome.
At the time of graduation, a Master of Science in Computer Science student should have a strong foundation in analysis of algorithms.	On assignments and exams, students will solve recurrence relations, analyze complex algorithms for their correctness and use of resources, use high-order principles of algorithm construction, e.g., divide-and-conquer, dynamic programming, simulate and answer basic questions about the most common graph algorithms. 75% of students will score at least 70% on the assignments/exam questions related to this outcome.
At the time of graduation, a Master of Science in Computer Science student should have demonstrated the ability to develop large software systems.	For evaluating the performance of graduates on this learning outcome, we use the project in the course on Complier Construction. 75% of the students should score at least 70% on the project.

Student Learning Assessment For M.S. in Computer Engineering

Expected Student Learning Outcomes	Methods of/Criteria for Assessment
At the time of graduation, a Master of Science in Computer Engineering student should have a strong foundation in digital electronics systems design.	On assignments and exams, students will design large-scale digital systems using VHDL, perform behavioral verification using test benches and simulation, design a pipelined microprocessor, design a system bus architecture with CPU, memory, and I/O interfaces, synthesize, place-and-route, and implement a computer system on a programmable hardware platform. 75% of students will score at least 70% on the assignments/exam questions related to this outcome.
At the time of graduation, a Master of Science in Computer Engineering student should have a strong foundation in computer architecture and the performance of computing systems.	On assignments and exams, students will describe the principles of computer architecture, techniques and principles for the development of high performance computer systems, details of extant computer architectures, and quantitatively analyze aspects of computer architecture and draw conclusions about their performance. 75% of students will score at least 70% on the assignments/exam questions related to this outcome.
At the time of graduation, a Master of Science in Computer Engineering student should have a strong foundation in analysis of algorithms.	On assignments and exams, students will solve recurrence relations, analyze complex algorithms for their correctness and use of resources, use high-order principles of algorithm construction, e.g., divide-and-conquer, dynamic programming, simulate and answer basic questions about the most common graph algorithms. 75% of students will score at least 70% on the assignments/exam questions related to this outcome.
At the time of graduation, a Master of Science in Computer Engineering student should have demonstrated the ability to develop large software systems.	For evaluating the performance of graduates on this learning outcome, we use the project in the course on Advanced Digital Design. 75% of the students should score at least 70% on the project.

Will the proposed modification affect or result in program-specific accreditation?

☐ Yes

☒ No

If yes, explain; if the modification will result in the program seeking program-specific accreditation, provide the institution's plans to seek accreditation, including the expected timeline for accreditation. (500 characters)

Will the proposed modification affect or lead to licensure or certification?

☐ Yes

☒ No

If yes, explain how the program will prepare students for licensure or certification. (500 characters)

Teacher or School Professional Preparation Programs

Is the proposed modified program a teacher or school professional preparation program?

☐ Yes

☒ No

If yes, complete the following components.

Area of Certification

Attach a document addressing the South Carolina Department of Education Requirements and SPA or Other National Specialized and/or Professional Association Standards.