

PROGRAM MODIFICATION PROPOSAL FORM

Name of Institution: **Clemson University**

Briefly state the nature of the proposed modification (e.g., adding a new concentration, extending the program to a new site, curriculum change, etc.):

We request extending our currently approved MS Computer Science program to the Campbell Graduate Engineering Center (CU-International Center for Automotive Research) instructional site in Greenville.

Current Name of Program (include degree designation and all concentrations, options, and tracks):

MS Computer Science

Proposed Name of Program (include degree designation and all concentrations, options, and tracks):

MS Computer Science

Program Designation:

- | | |
|---|--|
| <input type="checkbox"/> Associate's Degree | <input checked="" type="checkbox"/> Master's Degree |
| <input type="checkbox"/> Bachelor's Degree: 4 Year | <input type="checkbox"/> Specialist |
| <input type="checkbox"/> Bachelor's Degree: 5 Year | <input type="checkbox"/> Doctoral Degree: Research/Scholarship (e.g., Ph.D. and DMA) |
| <input type="checkbox"/> Doctoral Degree: Professional Practice (e.g., Ed.D., D.N.P., J.D., Pharm.D., and M.D.) | |

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

- Yes
 No

If No, should the program be considered for supplemental Palmetto Fellows and LIFE Scholarship awards?

- Yes
 No

Proposed Date of Implementation: **15 August 2019**

CIP Code: **11.0101**

Current delivery site(s) and modes: **Clemson University Main Campus (50104), Clemson University Restoration Institute (80401), Lowcountry Graduate Center (40149), Blended Distance Education (85500)**

Proposed delivery site(s) and modes: **50116, Clemson University-Campbell Graduate Engineering Center (Clemson University International Center for Automotive Research)**

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

Dr. Mark Smotherman, MS Computer Science graduate coordinator; 864.656.5878; mark@clermson.edu

Dr. Jeremy King, Assoc Provost Instl Effectiveness; 864.934.3554; jking2@clermson.edu

Dr. Christopher Kitchens, Assistant to the Dean for Academic Initiatives; 864.656.2131; ckitche@clermson.edu

Institutional Approvals and Dates of Approval:

University Graduate Curriculum Committee: 14 December 2018

Executive Vice President for Academic Affairs and Provost: 13 January 2019

Clemson University Board of Trustees: 20 July 2018

Background Information

Provide a detailed description of the proposed modification, including target audience, centrality to institutional mission, and relation to strategic plan.

The Clemson University College of Engineering, Computing and Applied Sciences (CECAS) will address industry demands, while leveraging its existing innovation campuses, by offering its Master of Science (MS) in Computer Science (CpSc) at the Clemson University International Center for Automotive Research (CU-ICAR) in Greenville. The MS CpSc program is already approved for delivery at the Clemson University Restoration Institute (CURI) located in North Charleston. The Greenville location approval at CU-ICAR would complete our ability to leverage instruction across three sites that serve our innovation and workforce development partners and initiatives. The MS CpSc at CU-ICAR will target current working industry professionals in order to meet Greenville-based industry partners' stated need. Offering this program at the CU-ICAR site will support Clemson University's *Clemson Forward* strategic plan by strengthening alliances with industry, growing the current MS CpSc program, and leveraging Clemson's CU-ICAR innovation facilities and culture to provide specialized workforce development to key economic sectors.

Assessment of Need

Provide an assessment of the need for the program modification for the institution, the state, the region, and beyond, if applicable.

The Upstate of South Carolina, and the state of South Carolina as a whole, has experienced a tremendous growth in technical jobs in recent years. The Greenville Area Development Corporation (GADC) lists seven target areas for economic development, including Automotive, Aviation/Aerospace, and Data Centers.¹ Each of these three target areas has need for advanced degrees in Computer Science, especially since automobiles and aircraft are becoming more and more reliant on software.² Furthermore, the use of software and the application of computer science expertise to increase productivity and quality impacts almost all industries.³ The Bureau of Labor Statistics states, "Employment of computer and information technology occupations is projected to grow 13 percent from 2016 to 2026, faster than the average for all occupations."⁴ Locally, as of late February 2019, indeed.com lists over 500 job postings in information technology for the 25-mile radius around Greenville, more than half of which have the top of their estimated salary ranges

¹ <http://www.greenvilleeconomicdevelopment.com/target-industries/>, accessed February 21, 2019.

² "[T]he average share of software is expected to grow at a compound annual rate of 11 percent, to reach 30 percent of overall vehicle content (around \$5,200) in 2030." Ondrej Burkacky, Johannes Deichmann, Georg Doll, and Christian Knochenhauer, "Rethinking car software and electronics architecture," McKinsey & Company, 2018, <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/rethinking-car-software-and-electronics-architecture>

³ E.g., see Leon Hounshell, "The Industrial Internet Of Things, Digitalization And The Future Of Business," Forbes Tech Council posting, July 30, 2018, <https://www.forbes.com/sites/forbestechcouncil/2018/07/30/the-industrial-internet-of-things-digitalization-and-the-future-of-business/>

⁴ <https://www.bls.gov/ooh/computer-and-information-technology/>, accessed February 21, 2019.

exceeding \$70,000.⁵ Industry partners, including BMW, have clearly expressed to us the need for our MS in Computer Science program to robustly support the economic development of the state and the growth of the advanced manufacturing industry in the state.⁶ BMW has established an Information Technology Research Center (ITRC) at the CU-ICAR campus in Greenville,⁷ and BMW, Bosch, and Michelin each see “digitalization” playing a key role in their futures.^{8,9,10} We consider an instructional site for the MS in Computer Science at the CU-ICAR campus an integral step in providing for Greenville’s and the Upstate’s continued economic growth. We believe that the accessibility of a Greenville-based MS in Computer Science program will be viewed as a valuable resource for existing companies such as BMW, Bosch, and Michelin, and as an additional attraction to new companies.

Transfer and Articulation

Identify any special articulation agreements for the modified proposed program. Provide the articulation agreement or Memorandum of Agreement/Understanding.

There are no articulation agreements for this program.

Description of the Program

Projected Enrollment						
Year	Fall Headcount		Spring Headcount		Summer Headcount	
	New	Total	New	Total	New	Total
2020-2021	20	20	0	20	0	20
2021-2022	20	39	0	39	0	39
2022-2023	20	57	0	57	0	57
2024-2025	25	62	0	62	0	62
2025-2026	30	66	0	66	0	66

⁵ <https://www.indeed.com/q-Information-Technology-l-Greenville,-SC-jobs.html> , accessed February 21, 2019.

⁶ E.g., the importance of supporting advanced manufacturing in the Greenville area led to a new four-year degree program at Greenville Tech. See Haley Walters, “Greenville Tech offers its first 4-year degree to meet advanced manufacturing demand,” The Greenville News, Aug. 22, 2018.

⁷ <https://www.bmwusfactory.com/manufacturing/building-a-better-bmw/information-technology-research-center/> , accessed February 21, 2019

⁸ “At the BMW Group, the future has already begun,” <https://www.bmwgroup.com/en/innovation/innovation%20-%20company/industrie-4-0.html>, accessed February 26, 2019

⁹ “Bosch Connected Industry joins up with Bain & Company for digitalization,” Manufacturing Automation, October 2, 2018, available online: <https://www.automationmag.com/technology/software/8664-bosch-connected-industry-joins-up-with-bain-company-for-digitalization>

¹⁰ Shahrzad Pourriahi, “Michelin boss stresses focus on digitalization,” Tire Business, May 26, 2017, available online: <https://www.tirebusiness.com/article/20170526/NEWS/170529961/michelin-boss-stresses-focus-on-digitalization>

Explain how the enrollment projections were calculated.

Projected enrollment in the MS in Computer Science at the CU-ICAR innovation campus begins with a projection of 20 new, in-state students, increasing to an enrollment of 25 new students in year four and to an enrollment of 30 in year five. We did not take a survey, but we believe that 20 is a reasonable estimate for the initial enrollment.¹¹ Total CU-ICAR enrollment is expected to grow from 20 students in the first year to 66 students in year 5. The current business model anticipates new, in-state students each year, drawing from the immediate area, and a three-year completion time. The annual withdrawal rate is anticipated at a minimal seven percent, based on previous program history (this explains the slightly lowered program enrollment in years two and three of the program).

Note Regarding Financials: Program costs are relatively flat over the 5-year budget period presented below. On top of these flat costs, however, are initially low revenues that increase in a measured fashion as program enrollment grows in an intentional, measured fashion according to the above table. The measured increase in enrollment, and thus tuition revenue, leads to a financial loss in the first two years of the program. That loss disappears in year 3, and the program more than covers its costs over the 5 year period—and going forward thereafter.

Curriculum

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

See last page.

Curriculum Changes

There will be no curriculum changes. Clemson will be offering the same curriculum at an additional location.

Courses Eliminated from Program	Courses Added to Program	Core Courses Modified

New Courses

List and provide course descriptions for new courses.

No new courses are proposed or needed.

¹¹ As points of comparison: USC Upstate in Spartanburg, SC, enrolled 215 students across five Master’s degree programs in Fall 2018, see <http://ipr.sc.edu/enrollment/prel2018/fall/pr101818.pdf> and <https://www.uscupstate.edu/admissions-and-financial-aid/graduate/>; Clemson enrolled 3,920 students across 65 Master’s degree programs in Fall 2018, including 77 MS Computer Science students, see <https://www.clemson.edu/institutional-effectiveness/oir/factbook/> and <https://www.clemson.edu/graduate/academics/>.

Similar Programs in South Carolina offered by Public and Independent Institutions

Identify the similar programs offered and describe the similarities and differences for each program.

Program Name and Designation	Total Credit Hours	Institution	Similarities	Differences
Master of Science in Computer Science	30	USC Columbia	Both are Master of Science degrees in Computer Science with thesis and non-thesis options.	USC offers the degree on the main campus in Columbia and by distance education through the APOGEE program. There is no Greenville physical site. The non-thesis option at USC requires 10 credit hours from four specific courses (algorithms, computer architecture, compilers, and a seminar in advances in computing) plus 20 credit hours from elective courses. The thesis option has the same required courses and replaces six credits of elective courses with thesis research credits. Clemson's program has no specific required courses.
Master of Science in Computer Science	33	Charleston Southern	Both are Master of Science degrees in Computer Science with thesis and non-thesis options.	CSU offers the program in Charleston. There is no Greenville site. 33 rather than 30 credit hours are required. The non-thesis option at CSU requires six specific courses (algorithms, computer architecture, database, networks, operating systems, and software testing) plus five elective courses. The thesis option has the same required courses and substitutes thesis research credits in place of two of the five elective courses. Clemson's program has no specific required courses.
Master of Science in Computer and Information Sciences	33	CofC & Citadel	Both are Master of Science degrees with thesis and non-thesis options.	The College of Charleston and the Citadel offer a joint program in Charleston, and at least 11 credit hours must be taken at each institution. There is no Greenville site. The non-thesis program requires four specific courses (database, distributed computers, object-oriented design, and software engineering), four courses in one of four emphasis areas (computer science, information systems, software engineering, or cybersecurity), and three elective courses. The thesis option has the same required courses and emphasis area requirements, and it replaces either one or two of the elective courses with thesis credits (a project thesis or a research thesis, respectively). Clemson's program has no specific required courses.
Master of Science in	30	USC Upstate	Both are Master of Science	USC Upstate offers the degree with traditional, online, and

Informatics			degrees with thesis and non-thesis options.	hybrid course formats. Students may attend live meetings in Spartanburg or Greenville. The non-thesis option at USC requires three specific courses (information resource management, management of innovation, and interoperability) plus four courses in one of two tracks (information resource management or health information management), and six credits of thesis research or independent study resulting in a survey paper. The USC Upstate program is oriented toward broad preparation in information technology, communication, and business theory. Clemson’s program is instead oriented toward computer science and provides greater flexibility with its absence of tracks.
Master of Science in Software Engineering	30	USC Columbia	Both are Master of Science degrees with thesis and non-thesis options. Both degrees can have five software engineering courses applied to the graduation requirements.	USC offers the degree on the main campus in Columbia. There is no Greenville site. The non-thesis option at USC requires 15 credit hours from five specific software engineering courses plus 15 credit hours from elective courses. The thesis option has the same required courses and replaces six credits of elective courses with thesis research credits. Clemson’s program has no specific required courses.

Faculty

State whether new faculty, staff or administrative personnel are needed to implement the program modification; if so, discuss the plan and timeline for hiring the personnel. Provide a brief explanation of any personnel reassignment as a result of the proposed program modification.

There are minimal course delivery costs related to the addition of the new site location. These include: an on-site graduate teaching assistant to interact with and support students; an on-site program director to recruit, support students, advise them and lecture as needed. Additional administrative support costs include audio-visual and information technology support personnel.

Resources

Identify new library, instructional equipment and facilities needed to support the modified program.

Library Resources: none

Equipment: Partial cost for video conferencing technology installed in classrooms will be shared with multiple programs that will use the classrooms.

Facilities: This program location will be at CU-ICAR, utilizing the One Research Drive building.

Impact on Existing Programs

Will the proposed program impact existing degree programs or services at the institution (e.g., course offerings or enrollment)? If yes, explain

Yes

No

Financial Support

Sources of Financing by Year						
Category	1st	2nd	3rd	4th	5th	Total
Tuition Funding	\$ 131,016	\$ 263,146	\$ 396,135	\$ 443,811	\$ 486,617	\$ 1,720,725
Other Funding						\$ -
Reallocation of Existing Funds	\$ 33,657	\$ 34,827	\$ 36,043	\$ 37,307	\$ 38,620	\$ 180,453
Total	\$ 164,673	\$ 297,972	\$ 432,178	\$ 481,117	\$ 525,237	\$ 1,901,178
Estimated Costs Associated with Implementing the Program by Year						
Category	1st	2nd	3rd	4th	5th	Total
Program Administration and Faculty and Staff Salaries	\$ 242,690	\$ 255,810	\$ 269,292	\$ 280,050	\$ 290,993	\$ 1,338,836
Operational Costs	\$ 72,000	\$ 16,878	\$ 17,384	\$ 17,905	\$ 18,442	\$ 142,609
Library Resources						\$ -
Administrative Overhead	\$ 37,635	\$ 59,259	\$ 83,836	\$ 92,918	\$ 101,132	\$ 374,780
Total	\$ 352,325	\$ 331,947	\$ 370,512	\$ 390,873	\$ 410,567	\$ 1,856,225
Net Total (i.e., Sources of Financing Minus Estimated Costs)	\$ (187,652)	\$ (33,974)	\$ 61,666	\$ 90,244	\$ 114,670	\$ 44,953

Budget Justification:

The request for an additional site location creates minimal additional costs that include an on-site program director and staff to oversee the remote delivery of courses. The program will take advantage of the extant approved curriculum, and leverage technology in classes currently taught on the Clemson campus to allow students to take coursework at CUICAR.

Revenue Highlights:

- **Academic Tuition and Fees:** A Graduate in-state/resident, Tier 2, part-time tuition rate of \$636 per credit hour is planned. No out of state students are planned for the program. The additional site location is targeting the local, Greenville area population of working professionals. The 30 credit hour program length is three years based on an average annual course load of 10 credit hours. Proposed tuition rates are based on current, fiscal year 2018, part-time Tier 2 rates with three percent inflation. Rates are subject to tuition increase and Board-approved changes.
- **Reallocation of Resources:** The teaching cost is shown as a reallocated expense since the faculty are already in place (i.e., the instructional faculty neither represent new incremental revenues nor costs)

Expense Highlights:

- **Personnel Expenses:**
 - There are minimal course delivery costs related to the addition of the new site location. The cost of teaching the courses is shown in the total expenses, but a portion is offset by a corresponding income line for salary expenses already in place (reallocation of existing funds).
 - Administrative Program Costs: The program will require an on-site graduate teaching assistant to interact and support students; an on-site program director needed to recruit, support students, advise them and lecture as needed; and audio-visual and IT support.
- **Operational Costs:** Initial program costs will include the installation of an electronic course delivery system, including course delivery software and annual license fees. This system can be used by multiple programs as new degrees are added to the CU-ICAR site. Higher advertising costs are included in the first year to promote the program to the Greenville area, while regular advertising costs are included in subsequent years. Support for on-campus lecturers who may need to travel to the CUICAR campus are included, as are minimal operating supplies.
- **Administrative Overhead:** Intended to represent general and administrative costs, as well as college-level administration costs related to the program.

Challenges & Mitigation Strategy:

The department is aware that enrollment may vary from the projections embedded in the business plan. Incremental expenses will be managed based on enrollment.

The program will be evaluated annually by the college to determine its value and sustainability. If at any time the program does not meet enrollment targets and the incremental expenses are deemed a financial burden to CECAS, the program may be phased out or restructured.

Evaluation and Assessment

Program Objectives	Student Learning Outcomes Aligned to Program Objectives	Methods of Assessment
The Clemson Computer Science MS degree should be a strong academic program and should prepare students for success in the profession.	SLO 1: Students can frame a real-world problem such that it can be addressed computationally.	ePortfolio: A student must submit an artifact from his or her coursework, typically a written report prepared as a course assignment, that best demonstrates the student’s ability to frame a real-world problem such that it can be addressed computationally and must answer several self-reflection questions regarding the artifact. For students in the thesis option, an artifact from the thesis is also acceptable.
	SLO 2: Students can evaluate multiple computational approaches to a problem and choose the most effective one. The different approaches may involve different algorithms and/or different software tools.	ePortfolio: A student must submit an artifact from his or her coursework, typically a written report prepared as a course assignment, that best demonstrates the student’s ability to evaluate multiple computational approaches to a problem and must answer several self-reflection questions regarding the artifact. For students in the thesis option, an artifact from the thesis is also acceptable.
	SLO 3: Students can apply reasoning and technical skills to solve a computational problem with minimal guidance.	ePortfolio: A student must submit an artifact from his or her coursework, typically a program submitted as the solution to a programming assignment, that best demonstrates the student’s ability to apply reasoning and technical skills to solve a computational problem with minimal guidance and must answer several self-reflection questions regarding the artifact. For students in the thesis option, an artifact from the thesis is also acceptable.

Will any the proposed modification impact the way the program is evaluated and assessed? If yes, explain.

- Yes
- No

Will the proposed modification affect or result in program-specific accreditation? If yes, explain; and, if the modification will result in the program seeking program-specific accreditation, provide the institution’s plans to seek accreditation, including the expected timeline.

- Yes
- No

Will the proposed modification affect or lead to licensure or certification? If yes, identify the licensure or certification.

Yes

No

Explain how the program will prepare students for this licensure or certification.

N/A

If the program is an Educator Preparation Program, does the proposed certification area require national recognition from a Specialized Professional Association (SPA)? If yes, describe the institution's plans to seek national recognition, including the expected timeline.

Yes

No

CURRICULUM
Master of Science in Computer Science
Clemson University

A candidate for the Master of Science degree in Computer Science must satisfactorily complete an approved program of at least 30 graduate credit hours. Students may elect one of two options to satisfy the degree requirements: a coursework-only option or a thesis option. The thesis option requires six credit hours of research credit as part of the 30-hour requirement.

There are no specific required courses. Each CPSC and human-centered computing graduate course offered by the School of Computing is associated with one or more of six core areas within computing. Students in either option are expected to take at least three courses having the same core area designation to provide depth of study and to take courses with designations from at least three other core areas to provide breadth of study.

At least 21 of the 30 credit hours must be at the 8000-level for the coursework-only option. At least 24 of the 30 credit hours must be at the 8000-level for the thesis option; these 24 credit hours include the six credit hours of thesis research. Students in either option may include up to six credit hours of approved courses from outside the School of Computing; these six credit hours of approved courses may include courses transferred from another university.

Of the 30 credit hours of approved courses required for graduation, only six credit hours of CPSC 6820 (Special Topics in Computing), CPSC 8810 (Special Topics), or HCC 8810 (Special Topics) can be included. The student may not include credit for the following courses:

- CPSC 6810 (Independent Study),
- CPSC 6890 (Programming Team Training Seminar),
- CPSC 8880 (Directed Projects in Computer Science),
- CPSC 9500 seminars (Selected Topics in Computer Science),
- DPA 6000 (Technical Foundations of Digital Production I),
- DPA 6010 (Technical Foundations of Digital Production II),
- DPA 6020 (Visual Foundations of Digital Production I),
- DPA 6030 (Visual Foundations of Digital Production II),
- DPA 6810 (Independent Study),
- DPA 6820 (Special Topics in Digital Production Arts),
- DPA 6830 (Special Studio Topics in Digital Production Arts),
- DPA 8600 (Digital Production Studio),
- DPA 8800 (Graduate Research Studio).