

**CLEMSON UNIVERSITY
COLLEGE OF ENGINEERING AND SCIENCE**

TO THE SOUTH CAROLINA COMMISSION ON HIGHER EDUCATION

PROGRAM MODIFICATION PROPOSAL

**REQUEST APPROVAL TO OFFER ENGINEERING AND COMPUTER SCIENCE
PROGRAMS AT THE CLEMSON UNIVERSITY RESTORATION INSTITUTE (CURI)**

Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) in:

Civil Engineering, Computer Engineering, Computer Science, Electrical Engineering,
Environmental Engineering and Science, Industrial Engineering, Materials Science and
Engineering, and Mechanical Engineering

Master of Fine Arts (MFA) in:

Digital Production Arts

Master of Engineering (M.ENGR.) in:

Electrical Engineering, Industrial Engineering, and Systems Engineering

Dr. James P. Clements, President
September 15, 2014

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2. CLASSIFICATION

Program Titles and Degrees:

Civil Engineering: M.S. and PhD
CIP Code: 140801

Computer Engineering: M.S. and PhD
CIP Code: 140901

Computer Science: M.S. and PhD in Computer Science
CIP Code: 110101

Digital Production Arts: MFA
CIP Code: 110201

Electrical Engineering: M.ENGR., M.S., and PhD
CIP Code: 141001

Environmental Engineering and Science: M.S. and PhD
CIP Code: 141401

Industrial Engineering: M.S. and PhD
Industrial Engineering: M.ENGR., including Supply Chain and Logistics concentration.
CIP Code: 143501

Materials Science and Engineering: M.S. and PhD
CIP Code: 141801

Mechanical Engineering: M.S., and PhD
CIP Code: 141901

Systems Engineering: M.ENGR.
CIP Code: 142701

Academic Unit: College of Engineering and Science

Site: Clemson University Restoration Institute (CURI), North Charleston, SC; and Low Country Graduate Center (until the Zucker Family GED Building opens, date anticipated Fall 2016).

Modes: Traditional and Blended (online and distance education)

3. INSTITUTIONAL APPROVAL

Dr. James P. Clements, President; July 14, 2014.

Dr. Nadim Aziz, Interim Provost; July 14, 2014.

Clemson University Board of Trustees; July 18, 2014.

4. PURPOSE

This proposal seeks approval to establish an additional instructional site at the Clemson University Restoration Institute (CURI) in North Charleston, SC for many of the currently-approved graduate programs in Clemson's College of Engineering and Science (CES). The modes of delivery will be traditional and blended education. Several of these programs are currently approved for teaching at other sites in Charleston (e.g., the Citadel) and/or via distance education. An explanation and justification of the proposed program modifications follow below.

Since 2009, the State of South Carolina has invested significantly in Clemson University at the Restoration Institute in North Charleston. As a result of these state funds plus significant competitively awards, grants, gifts, and gifts-in-kind, world-class facilities and research capabilities have been developed in energy, advanced materials, and water resources. These include:

- In 2009, a competitively awarded grant was received from the US Department of Energy for the Wind Turbine Drivetrain Testing Facility. The State of South Carolina provided substantial matching funds for this project. The test facility is the world's largest and most comprehensive facility for testing large wind turbines, facilitating research and development in many areas in the industry, and accelerating the time to market. This test facility will operate as a non-profit organization with a business model for sustainability while providing ongoing state-of-the-art testing to wind turbine manufacturers. While the facility's primary mission is to service the wind industry, its secondary mission is to promote industry/government/university collaboration in research and workforce education.
- In 2012, a \$2M gift from Duke Energy was received, plus a \$2M matching gift in 2013 from the State of SC to establish the Duke Energy Smart Grid Endowed Chair and two Distinguished Professorships as part of the SC SmartState Center for Smart Grid Technology. The center will address core research areas of smart grid technology, and the holder of the endowed chair will be an acknowledged leader in research in one of the areas. These technical areas include real-time power systems operation/control, renewable/distributed energy, energy storage technologies and grid integration for the electric grid. To ensure that the research is relevant and addresses problems important to economic development, the endowed chair and the associated team will collaborate with industrial partners to validate R&D concepts on the world's largest and most advanced hardware in the loop grid simulator currently under construction in Charleston. The SmartState/CURI collaboration framework will immediately provide (i) strong, complementary research and graduate education bases upon which to build, (ii) access to established interdisciplinary teams with shared interests, (iii) a vetted set of public and private partners, and (iv) shared management, administrative and facilities support to reduce Center startup costs.
- In 2012, CURI was awarded with the 15 MW Hardware-in-the-Loop Grid Simulator project, funded from the US Department of Energy with matching funds and gifts-in-kind from an array of power industry partners and laboratories. The Grid Simulator will serve as the cornerstone for a Center of Excellence in grid compatibility testing, modeling and certification and the Power Systems Program in the College of Engineering and Science at Clemson. This facility will operate as a non-profit entity under a business model for long term self-sustainability. An Industrial Advisory board consisting of the Founding Partners including utilities, certification organizations and technology

innovators will provide (1) technical oversight and guidance, (2) matching private funds and (3) technical expertise to build the facility.

- In 2012, an \$8M US Department of Commerce grant and a \$5M private gift have led to the building of a Graduate Education Center at the CURI site. The GEC will strengthen existing industry clusters through private-public collaboration and will provide a source of leading edge academic research, with a focus on industry-led programs. The core mission of the GEC is ongoing public-private collaboration for workforce development and sustainable economic development for the region. CURI is home to the Turbine Drive Train Testing Facility and Hardware-in-the-Loop Grid Simulator (a public-private project). This is the largest facility of its kind in the world. Industry partners planning to use this testing facility (including GE, Areva, and RePower) will connect with faculty, students, and incubator companies at the GEC. Companies committed to leasing incubator space include FEV, Savannah River National Lab, Teco, and UL LLC. The aim of the GEC is to provide highly skilled, industry driven research and training opportunities that will lead to job creation and long term private sector investment in the region. The GEC will enhance global competitiveness by providing on-site Research and Development opportunities with testing facilities unmatched anywhere else in the world. The GEC will create a bridge between industry use of the testing facilities and students, faculty, and incubator start-ups with potential for commercialized research, green technology development, and environmentally sustainable innovation.

Through its various departments and schools, the College of Engineering and Science offers a variety of graduate degrees, at the Master of Engineering, Master of Science, and PhD levels, plus a specialty Masters in Fine Arts for its Digital Production Arts program. The Master of Engineering degree is an applied degree often sought by working professionals, and is typically attained through coursework. The Master of Science and PhD are research degrees, and require a combination of coursework, examinations, and research, culminating in a thesis or dissertation. In some fields, the M.S. degree can be obtained through coursework only. The PhD can be obtained via direct entry after a baccalaureate degree or after a Masters degree, with the direct-entry requiring more coursework to fulfill the degree requirements.

Clemson's expansion of research and test facilities at the innovation campuses, including the Clemson University Restoration Institute (CURI) in North Charleston, provide a focal point of activities that students and faculty can use to enhance their research and education that cannot be replicated on the main campus. The recent anchor gift from the Zucker family to build the Zucker Graduate Education Center at CURI will provide a unique opportunity for Clemson's College of Engineering and Science to expand programs in Charleston, and offer an array of degrees to a population of students in the rapidly growing Charleston metropolitan area while taking advantage of the unique research facilities at the CURI campus.



Figure 1. The SCE&G Energy Innovation Center at the CURI campus in North Charleston, SC.

As mentioned above, the programs to be delivered at the CURI site are already approved and no modifications to the programs are being sought. Except for the M.S. in Computer Science, the programs do not overlap with any programs taught in the Charleston area by other institutions. These programs will offer residents in the Charleston area advanced degree options that are either otherwise unavailable or are only accessible via distance education. Additionally, these programs will serve students on the Clemson main campus whose research programs and faculty supervisors are located at CURI.

Clemson is committed to collaborate with the state's institutions, where appropriate, to deliver these degree programs and support other complimentary programs offered by South Carolina's other institutions. We understand that other institutions may develop new programs in the same degrees and we encourage and support their efforts. For example, Clemson is currently working with the University of South Carolina and the Citadel to develop a consortium where a common pool of courses from the member institutions can be used to meet degree requirements through a master articulation agreement. Clemson has a close relationship with the Medical University of South Carolina (MUSC) in Bioengineering, and is collaborating with MUSC in both education and research, plus exploring articulated programs leading to degrees at both institutions. Clemson and the College of Charleston offer a joint MS in Historical Preservation. Discussions are currently underway with the College of Charleston to refine the scope of Clemson's M.S. in Computer Science to ensure it is complementary to the existing M.S. in Computer and Information Sciences offered jointly by the College of Charleston and the Citadel. Clemson anticipates the lower-level graduate courses will be available to the Citadel to supplement their degree programs (currently undergraduate engineering programs and M.S. in project management, but to include future programs that they might offer). Additionally, Clemson anticipates that courses offered by the Citadel, the College of Charleston, MUSC, and USC (with possible additions) may be used in Clemson's programs. For example, certain courses taught in the Citadel's project management program or USC's engineering management program might be used in one or more of Clemson's programs, or vice versa.

The programs will be accelerated to full implementation over a six-year period. Because of the sequential nature of curricula, all courses need not be available initially, nor offered each term

or originated entirely from CURI. Consequently, the number of full-time equivalent (FTE) faculty located at CURI (either permanently or on a rotating basis) can start with a small core group and increased over time.

Twelve FTE faculty are available for the CURI programs at full implementation, with nine of these positions newly allocated to manage this growth in these programs. One of these positions will be the Duke Energy Smart Grid Chair, with two of these new positions linked to this chair. The remaining faculty positions will be underwritten by three million in recurring funding (including start-up costs). Tuition generated by the programs' graduate students will provide the additional needed revenues.



5. JUSTIFICATION

Long enjoying an economy fueled by the defense industry and tourism, the city of Charleston (and by extension, the State of South Carolina) has been propelled by the recent explosion in growth by Boeing and related industries, a growing demand in IT and health, the expansion of the port, plus nearby energy producers such as Santee Cooper. In addition, Charleston is now becoming the center of a burgeoning film and media industry, and it is expected that Clemson, through its digital production arts program will provide the employees needed for this industry. The influx of engineers and other technical professionals has created a demand for continued technical education by the incumbent workforce. Additionally, industry seeks a close relationship with Clemson University for collaboration, research partnerships and workforce

development in the engineering and science disciplines which is possible through a stable physical presence of Clemson in the Charleston area.

The Clemson University Restoration Institute (CURI) campus was established in 2004 to drive economic growth in the natural, built, and socioeconomic restoration economy by developing and fostering restoration industries and environmentally sustainable technologies in South Carolina. The initial efforts were in the discipline of materials science, where Clemson researchers from the CES Materials Science and Engineering (MS&E) department were engaged in research within the Warren Lasch Laboratory to restore the submarine H.L. Hunley. Both faculty and graduate students have benefited greatly from the research related to this restoration project, which was made possible by the presence of the laboratory and facilities placed near that of the submarine. Although both students and faculty work on-site at the lab, the graduate degrees are anchored at the main Clemson campus, making it difficult for students and faculty to navigate a curriculum of some courses based in Clemson while performing research at the North Charleston innovation campus. Expanding upon this well-established research, the intent is to now expand the degree programs in MS&E so that graduate students may complete their studies at the CURI campus.

The recent \$50M award from the US Department of Energy has been used to substantially expand the research and testing capabilities at CURI. This grant, together with other matching and gift monies, has been used to expand the 82,000 square foot SCE&G/SCANA Energy Innovation Center (EIC), a world-class research-and-development facility which houses the Wind Turbine Drivetrain Test Facility (WTTF) and the Duke Energy eGRID facility (a singularly unique advanced electric power grid simulator). The SCE&G EIC was dedicated on November 21, 2013 with keynote addresses from the US Department of Energy deputy secretary Daniel Poneman and the now-retired chairman and CEO of Duke Energy James Rogers.



Figure 2. The keynote address by the US Deputy Secretary of Energy Daniel Poneman to a thousand plus audience during November 21, 2013 dedication of the SCE&G Energy Innovation Center at CURI.

These new facilities provide unparalleled research and development opportunities for faculty and students in energy and computing disciplines, which include many existing programs in the College of Engineering and Science at Clemson. Most importantly, industry has substantial

access to all these CURI facilities, which will promote significant interactions between students, faculty, and industry to foster translational research that promotes economic development.

To ensure that faculty and students have greatest possible access to CURI facilities, Clemson University and the College of Engineering and Science are committed to providing to them semester or year-long rotations, sabbaticals, and even permanent placement. These faculty members will be actively engaged in fulfilling the Clemson mission, which includes educating both graduates and undergraduates. The Zucker Family Graduate Education Center (ZF-GEC) at CURI, which will house faculty and graduate student offices, classrooms and technology-enhanced distance educational facilities, and laboratories, will be instrumental to enable this educational initiative. Both graduate and undergraduate students will have the opportunity to spend a semester or summer at CURI on an internship or co-operative education assignment while enrolled in courses towards their respective degrees. Faculty located at CURI will also have the option to teach courses at CURI via internet for students at the main Clemson and previously approved instructional sites. Details of the Zucker Family GEC are discussed below.

To ensure the widest possible dissemination of these new faculty and new program offerings, the Clemson College of Engineering and Science proposes to invest substantially in establishing an academic presence at CURI. Faculty cannot be effectively recruited to an outpost remote from the main campus without students even with CURI's impressive facilities, and students need to make progress toward their degrees with local instruction and faculty support. As a result, we seek approval for a comprehensive package of synergistic degree programs in engineering and the computing sciences. There is considerable overlap in the coursework required for these degree programs, and the number of courses that needed to offer the complete array is not the sum of the courses for each of the individual degrees. In fact, cross-purpose courses not only will enable economies where duplication would otherwise exist, but create opportunities for multidisciplinary programs (e.g., systems integration and wind energy) and increase the diversity of students within the classes themselves. The coursework used for the non-thesis and research master's degrees comes from the same set of courses, as do part of the direct-entry PhD programs. For example, approximately two-thirds of the direct entry PhD programs use the same coursework as the post-M.S. PhD programs. Thus, the courses offered will serve a variety of purposes, and enable considerable efficiencies of scale.

OBJECTIVES OF THE MODIFICATION

The objectives of adding the CURI as a site for delivering the aforementioned graduate programs include:

- These research-based degree programs in engineering and science will provide significant benefit to the citizens in the Charleston/Low Country region of South Carolina, as well as the entire state.
- Industry and economic development will be enhanced by providing an educated workforce with advanced degrees in high-technology subjects, as well as applied research that will advance technologies used by the state's industry.
- An infrastructure of more than \$200M that is at the forefront of technology will be leveraged.
- The State of South Carolina has invested substantially at CURI and in the endowed chairs program. Industry has invested in the endowed chairs program. Expanding the graduate programs to CURI ties these investments together and provides an unparalleled leveraging opportunity for the state and its constituents.

- Students and faculty will be present at CURI working on research projects; these students will be able to earn a degree without having to return to the main campus and can be located near their research and faculty advisors.
- The degree programs, in conjunction with the CURI facilities and researchers, will open collaboration opportunities for universities around the state.

IMPACT ON CAMPUS PROGRAMS

Clemson University expects a positive impact on its main campus programs due to the significant research and educational opportunities at CURI. Enrollments in the main campus programs are not expected to be diluted by this expansion. In fact, Clemson has seen significant enrollment growth in its graduate programs in engineering and computer science (over 50% in the last ten years, with the PhD student enrollment nearly doubling). The expansion into the Charleston area will increase the capacity of Clemson to serve more graduate students and expand research capability, and this is expected to have a positive impact through continued increased growth in areas of strategic importance to Clemson, the state of South Carolina, and its constituents.

The increase in the number of faculty in these programs will be done strategically to increase both the depth and breadth of intellectual capital. As a result, the degree programs on the main campus as well as CURI will greatly benefit. Faculty located at CURI will be expected to be fully engaged with the programs on the main campus, and to teach students on the main campus via the same distance education technology that students at CURI will use when being taught by faculty from the main campus.

LIST OF SIMILAR PROGRAMS IN SOUTH CAROLINA

The SC CHE database lists the following similar programs at the graduate level other than Clemson University. The University of South Carolina programs have approval for the main campus in Columbia and via distance education through the APOGEE program. USC's M.Engr. in Electrical Engineering is also approved for delivery at the Low Country Graduate Center in Charleston. The College of Charleston and the Citadel have a joint M.S. in Computer Science. As mentioned previously, discussions are currently on-going between the universities for collaboration.

University of South Carolina – Columbia:

Civil Engineering; M.Engr., M.S., and PhD
Computer Science and Engineering; M.Engr., M.S., and PhD
Electrical Engineering; M.Engr., M.S., and PhD
Mechanical Engineering; M. Engr., M.S. and PhD
Software Engineering; M.S.E.
Systems Engineering; M.S.

College of Charleston and the Citadel:

Computer and Information Sciences; M.S. (joint)

6. ENROLLMENT

Currently, the Systems Engineering and Industrial Engineering programs are being offered by distance education, and student enrollment will be primed with those programs. These programs are both currently taught via distance education, with some students currently located in the Charleston area. Since its launch in 2008 the M. Engr. in Industrial Engineering has graduated over 75 students and has a current enrollment of 130. Electrical Engineering (specifically the Power Systems specialization), Mechanical Engineering, and Systems Engineering will be the first programs launched at CURI. Anticipated five year enrollment across all CURI-based programs expected to be at least 150 by 2019. Estimated summer enrollment will be 50% of the fall and spring terms since students will either find summer employment or be engaged in research projects at CURI. Projected enrollment and credit hours are provided in the table below.

Table H – Estimated New Enrollment

ESTIMATED NEW ENROLLMENT						
YEAR	FALL		SPRING		SUMMER	
	Headcount	Credit Hours	Headcount	Credit Hours	Headcount	Credit Hours
2015 – 16	30	180	30	180	15	90
2016 – 17	60	360	60	360	30	180
2017 – 18	90	540	90	540	45	270
2018 – 19	120	720	120	720	60	360
2019 – 20	150	900	150	900	75	450

7. CURRICULUM

The curricula for these programs is already approved and in place. There are no changes from the current programs, all of which follow the previously-approved curricula. The program courses are identical to that of currently-offered programs, and have the following general degree requirements:

- Master of Engineering: 30 to 33 credits.
- Master of Science: 30 credits.
- Master of Fine Arts (DPA program): 36 credits of coursework, 18 credits of studio, and 6 credits of research and thesis.
- PhD (without prior MS): 60 credit hours beyond the BS degree or 42 credits beyond the MS, comprising coursework and research/dissertation.

Each student will be assigned a faculty advisor (i.e., a “major professor”) with whom they will collaborate to develop a degree plan. Students will also have an advisory committee of faculty who will review both the student’s course plan and research and scholarship activities (e.g., dissertation). University policy dictates the details and procedures that are required for graduate degrees at the University. The nature of graduate study is individualized and graduate students and their graduate committees develop and approve a Plan of Study (GS-2) for each student which includes any common core requirements, other courses that may be selected by the student with faculty approvals.

Selected key policies guiding graduate education at Clemson are identified below:

Doctor of Philosophy/Education degree, coursework, length

The advisory committee aids the student in developing a degree curriculum which includes the selection of specific courses and their sequence as well as the development of an acceptable research topic. At Clemson University, a minimum of 30 credits past the masters and 60 credits past the bachelor’s degree, inclusive of research credits, are required to earn the doctoral degree. A minimum of 18 credits of doctoral research is required. A minimum of 12 credit hours of non-research coursework is required. Coursework leading to the Doctor of Philosophy/Education degree is planned to give the student a comprehensive knowledge of his/her field of specialization and a mastery of the methods of research. The degree is not awarded solely on the basis of coursework completed, residence, or other routine requirements. The final basis of granting the degree is the student’s grasp of the subject matter of a broad field of study, competence in planning and conducting research, and ability to express him/herself adequately and professionally orally and in writing.

Doctor of Philosophy/Education degree, comprehensive examinations

Policy: Satisfactory completion of the comprehensive examination must occur no more than five years and at least six months prior to the date of graduation. For examinations consisting of several parts (for example, a written plus an oral, or a written in cumulative format), the date of completion will coincide with the date of the last examination activity. The time span from the beginning to the end of the examination, however, must not exceed 12 months.

Doctor of Philosophy/Education degree, dissertation

Candidates for doctoral degrees receive academic credit for conducting research and preparing a dissertation under the direction of the research advisor. A dissertation, mandatory for all candidates for the PhD or EdD degree, requires 18 hours of doctoral research (991) exclusive of any research credits earned at the master's level.

Doctor of Philosophy/Education degree, dissertation defense

The candidate for the Doctor of Philosophy/Doctor of Education degree must pass an oral examination - the dissertation defense - at least three weeks prior to the commencement at which he/she plans to obtain the degree. The student's advisory committee will administer the examination. Members of the faculty as well as the deans of the Graduate School are invited to attend the examination. A student who fails a dissertation defense may be allowed a second opportunity only with the recommendation of the advisory committee. Failure of the second dissertation defense will result in dismissal from the Graduate School.

Dual Master's degrees

Policy: If a student pursues two master's degrees simultaneously, one-sixth of the graded graduate coursework may be used toward both degrees. The one-sixth course rule references one-sixth of the curriculum with the highest number of graduate credits. Required core courses for either degree may not be displaced by selecting the option to participate in the dual degree option.

Master's degree, credits required

The total number of graduate credits required for the degree is determined by the student's advisory committee, consistent with the specific program guidelines and Graduate School policy. These credits constitute the core of the student's graduate degree curriculum. Supplemental courses, carrying undergraduate or graduate credit and chosen to broaden the student's academic experience, are not required on the Plan of Study; however, if a listing is desirable, such courses may be included. The Graduate School requires that each master's degree program consist of a minimum of 30 hours of graduate credit with at least 12 credit hours (exclusive of master's thesis research) in the major discipline as defined by the advisory committee, subject to degree program regulations. A minor outside that degree program, if chosen, shall consist of at least six credit hours in that area.

- **Master of Arts or Master of Science, thesis option.** Each program includes a minimum of 24 hours of graduate credit and six hours of master's thesis research (891). At least one-half of the total graduate credit hours required by the advisory committee, exclusive of thesis research, must be selected from courses numbered 800 or above.
- **Master of Arts or Master of Science, nonthesis option.** Each program includes a minimum of 30 hours of graduate credit, none of which may be master's thesis research. At least one-half of the total graduate credit hours required by the advisory committee must be selected from courses numbered 800 or above.
- **Professional master's degrees.** Each program includes a minimum of 30 hours of graduate credit. Except for professional programs in the College of Architecture, Arts, and Humanities that require a thesis, master's research credits (891) may not be included in the program requirements. Any additional requirements for professional master's degrees are delineated by the colleges that offer the degrees.

Master's degree, theses credits required

Candidates for master's degrees receive academic credit for conducting research and preparing a thesis under the direction of the research advisor. In those Master of Arts or Master of Science degree programs requiring a thesis, six credits of research (891) are required; however, some program variation does exist. The number of research credits (891) in select programs include: Master of Architecture - 15, Master of City and Regional Planning - 6-9, and Master of Fine Arts - 15.

Below is one such example; a description of the program, curriculum, and plan of study for the M.Engr. in Electrical Engineering from the department's graduate handbook. The other programs at Clemson have similarly detailed information on their respective degree programs in their required graduate handbooks. Each can be provided if needed or requested.

Master of Engineering Program in Electrical Engineering (MENGR)

The MENGR degree is designed and intended for professionals who are working full-time as practicing engineers. Courses taught on campus and courses delivered via distance-learning methods (such as on-line delivery) can both be applied towards the requirements of the degree. Thus the degree is available to off-campus students who enroll in distance-education courses. The MENGR degree is different from the M.S. degree in several respects: the MENGR applicant is not required to take the Graduate Record Examination (GRE), the MENGR student is not required to satisfy focus-area requirements, and the student must submit an Engineering Report instead of a conventional M.S. thesis. (The Engineering Report addresses the solution of a problem in engineering design, whereas the M.S. thesis details original discoveries in engineering research.) The Engineering Report must conform to a format specified by Clemson University's College of Engineering and Science (whereas the M.S. thesis must satisfy the University's thesis format requirements).

MENGR Advisory Committee

Each MENGR student must have an advisory committee of at least three Clemson University faculty members. A majority (more than 50%) of the committee members must be ECE faculty. One of the ECE faculty on the committee must serve as the student's academic advisor and as the chair of the committee. A committee member from outside the ECE faculty may serve as a co-chair of the committee with the approval of the Dean of the Graduate School.

The student's academic advisor is his/her first contact in planning a program of study. The advisor, along with the student's advisory committee, will serve the following functions:

- Work with the student to determine course selection for each semester.
- Approve the student's program of study (specified in the GS-2 form).
- Supervise the engineering report project.
- Administer the final examination.
- Initiate recommendations for awarding the degree.

MENGR Plan of Study

The student's planned program of study, documented on the GS-2 form, must be submitted no later than the mid-term of the second semester of the program. If circumstances necessitate later changes to the plan a revised GS-2 form must be completed and given to the ECE Graduate Student Services Coordinator for submission to the Graduate School.

Summary of MENGR Degree Requirements

The requirements of the MENGR degree in EE are as follows:

- Satisfy any undergraduate course deficiencies specified at the time of admission.
- Complete the graduate course-work requirements as detailed below.
- Complete a written engineering report.
- Pass the final examination.

The GS-2 form for the MENGR degree must include a minimum of 30 credit hours of graduate-level course work at the 6000-level, 7000-level, 8000-level, or 9000-level, including the following:

- Exactly six (6) credit hours of ECE 7010 (MENGR Design Report)
- A minimum of 24 credit hours of letter-graded course work.

- At least twelve (12) credit hours of the letter-graded course work must consist of ECE courses.
- At least twelve (12) credit hours of the letter-graded course work must be at the 8000-level or 9000-level.
- No credit for ECE 8910 can be applied towards the degree requirements.
- No credit for MTHSC 6000 can be applied towards the degree requirements.

A student in the Master of Engineering Program must write an Engineering Report which is approved by the student's advisory committee. (Administratively, the Engineering Report is approved by the Dean of Engineering.) The project serving as the basis for the Engineering Report must be focused on a problem in engineering design. The student must also pass a final examination administered by the student's advisory committee, which includes an oral presentation of the student's work in the Engineering Report.

MENGR Engineering Report

The MENGR Engineering Report must demonstrate the solution to a substantive problem in engineering design following best practices of the electrical-engineering profession.

Minor Subject Option

Each MENGR candidate is eligible to include a minor subject in the degree program. To accomplish a minor the student must take 2 courses (6 credit hours) in a subject outside of electrical and computer engineering, such as Math, Physics, Computer Science, or Industrial Engineering, as approved by their advisory committee. If a minor is declared, this subject must be represented on the Advisory Committee by a faculty member from the corresponding department. The minor is designated on the GS-2 form only. A minor discipline will not be listed on the student's transcript.

Restrictions on Use of ECE 8920

A maximum of 3 hours of ECE 8920, Special Problems in Electrical and Computer Engineering, may be included on any MENGR candidate's GS-2 form. In addition, a student must obtain advance approval of his/her advisory committee before taking this course if it is to be used on the GS-2 form.

Transferring Coursework

A maximum of one third (1/3) of the required graded coursework may be transferred to an ECE graduate program. All transfer coursework must be approved by the student's advisor and advisory committee prior to being included on the GS-2. Coursework eligible for transfer must be from a regionally accredited institution, graded with a B or higher, and is subject to the Graduate School's six-year time limit for validity. Please note all limitations for transfer work set forth by the Graduate School apply. Coursework applied towards the requirements of a prior degree earned by the student cannot be used for transfer credit. (If requested by the Department, the student must be able to provide verification of eligibility for each course in which transfer credit is requested.)

MENGR Coursework Expiration

All coursework for the MENGR degree must be completed in the six (6) calendar years prior to graduation as per Graduate School policy. Any course work completed before this time window may not be applied towards the requirements of the degree except

under special conditions defined by the Graduate School.

8. FACULTY

The new CURI program will involve a mix of both current and new Clemson faculty, nine of whom will be hired to support CURI educational programs with three reallocations from existing positions. These nine positions, plus start-up, staffing, and other support, will be funded from the \$3M in recurring funds received from the state to support the academic programs at CURI¹. In the first year, the Duke Energy Smart Grid Chair will be hired for anchor position for the power and energy systems engineering-oriented programs. \$4M in funding for this chair has already been secured. As each of these positions are designated as full-time equivalent (FTE), the actual head-count may vary since each faculty member may not be using their entire time working in the program. Many participating faculty are also expected to rotate from the main campus to CURI at least one semester, which will be covered by the additional faculty hires to fill the absence of FTE faculty on the main campus.

9. PHYSICAL PLANT

Development of the Zucker Family Graduate Education Center at CURI began in 2010. Ms. Anita Zucker announced her gift of \$5M for the facility on June 14, 2012, which was augmented by an \$8M offer of award Clemson received from the US Economic Development Administration (EDA) on October 18th, 2012. Additional Zucker Family Graduate Education Center funds will come from \$7M in state infrastructure bond act funds. To support the mission of the CURI campus, approximately 70,000 square feet of building space for classrooms, offices, meeting rooms, and industry partner space will be available to house academic programs plus CURI industry partners and CURI staff. The building design is nearly finished and the scope of work has been approved by the Clemson Board of Trustees, the EDA, the Zucker Family, and the State Budget and Control Board. Currently, Clemson University is preparing to release an RFP/RFQ for a construction manager at risk to work with our design team, with plans to select a firm in September 2014. Site work is planned for December 2014, with construction beginning in February 2015, followed by occupancy in February 2016. The expected dedication and opening of the ZFGEC will occur later that year, in September 2016.

¹ See: http://media.clemson.edu/cfo/budgets/2014_Budget_Document.pdf, pages iii and 3; <http://www.clemson.edu/governmentalaffairs/documents/13eg3.pdf>; and http://www.ciclt.net/sn/new/n_detail.aspx?ClientCode=clemson&N_ID=200777



Figure 3. Conceptual drawings of the Zucker Family Graduate Education Center at CURI

10. EQUIPMENT

The SCE&G/SCANA Energy Innovation Center and the Warren Lasch Laboratory will house most of the equipment required for class and research engineering endeavor at CURI. The SCE&G EIC is a world-class research-and-development facility which houses the Wind Turbine Drivetrain Test Facility (WTTF) and the Duke Energy eGRID facility. Computing resources needed for educational purposes, such as engineering simulation software, is available for students and faculty via the main campus. Instructional equipment, such as videoconferencing and lecture capture, is included in the Zucker Family Graduate Education Center budget.

11. LIBRARY RESOURCES

Access to Books

My Library Account

Students enrolled in off campus programs can log in to their My Library Account to search the Clemson Libraries catalog and request the delivery of print books.

In addition to print books, Clemson affiliates have access to 458,239 electronic books via individual subscriptions, aggregator databases, and consortial agreements.

Books not owned by Clemson University Libraries

Students may use the PASCAL Delivers service to borrow books from any college or university in South Carolina. Requests are made through the Clemson University Libraries home page, and delivered to a participating Charleston library. Students can borrow up to 25 books for six weeks, with an additional three week renewal period.

Students may also check out a maximum of three books for three weeks, with a one week renewal from the following libraries in Charleston (upon presentation of a valid Clemson ID).

Charleston Southern University
The Citadel
College of Charleston
Medical University of South Carolina
Trident Technical College

If a book is not owned by the Clemson University Library and is not available via PASCAL Delivers, students may directly request the item from the Engineering Librarian.

<mailto:comforj@clemson.edu>

Approved books will be rush ordered/cataloged and sent to the requesting patron, who will be responsible for returning them to Cooper Library (via either mail or return to a PASCAL Delivers library.)

Access to Articles

Articles owned by Clemson University Libraries

Students have access to 76,349 unique ejournal titles, many of which may be downloaded directly from Library databases.

Students requiring articles from print journals owned by the Library may request a scanned copy via <http://www.clemson.edu/culib/forms/secure/ill/emp/dd-rp.php>.

Articles not available from Clemson University Libraries

Students also have free access to interlibrary loan to request copies of articles from journals not available at Clemson. Students must create an account prior to borrowing via the following website: <http://libguides.clemson.edu/ill>

Additional Services

Reference Assistance

Students encountering difficulties finding resource materials may contact the Engineering Librarian, who will respond to requests often immediately or within 24 hours. Students also have access to the Ask a Librarian service to request immediate assistance via phone/chat/text/or email during normal Reference Desk hours.

12. ACCREDITATION, APPROVAL, LICENSURE, OR CERTIFICATION

The programs sought to be offered at CURI are at the graduate level. The accrediting body for engineering and computer science, ABET, does not typically accredit graduate programs. None of these existing programs sought to be delivered at CURI are accredited by ABET.

13. ESTIMATED COSTS AND SOURCES OF FINANCING

The pro-forma budget is shown in the table below, using an estimate of faculty salaries, start-up funds, administrative and support needs, and average tuition revenues. Research funding and corresponding faculty buy-out is not included, and will cause a reduction in the salary requirements. The tuition revenue is provided on a very conservative basis, assuming a relatively light course load (one course per term) and slow ramp-up of students. After Year 2, students in the initial masters' cohorts will be graduating as additional students are added (both replacement and growth enrollments). As can be seen from the chart, the accumulated recurring base funding provides a buffer against the revenue needed to run the program during the initial years.

ESTIMATED COSTS BY YEAR						
CATEGORY	1st	2nd	3rd	4th	5th	TOTALS
Program Administration	\$100,000	\$125,000	\$150,000	\$175,000	\$200,000	\$750,000
Faculty and Staff Salaries	\$450,000	\$900,000	\$1,350,000	\$1,800,000	\$1,800,000	\$6,300,000
Graduate Assistants	\$132,000	\$264,000	\$396,000	\$528,000	\$792,000	\$2,112,000
Supplies and Materials	\$15,000	\$15,000	\$20,000	\$20,000	\$25,000	\$95,000
Travel	\$15,000	\$30,000	\$30,000	\$20,000	\$20,000	\$115,000
Equipment and Infrastructure	\$100,000	\$100,000	\$150,000	\$150,000	\$150,000	\$650,000
Other (Identify) Faculty Start-up costs	\$900,000	\$900,000	\$900,000	\$900,000	0	\$3,600,000
TOTALS	\$1,712,000	\$2,334,000	\$2,996,000	\$3,593,000	\$2,987,000	\$13,622,000
SOURCES OF FINANCING BY YEAR						
Tuition Funding	\$363,870	\$727,740	\$1,091,610	\$1,455,480	\$1,819,350	\$5,458,050
Program-Specific Fees						
State Funding*	\$3,000,000	\$3,000,000	\$3,000,000	\$3,000,000	\$3,000,000	\$15,000,000
Reallocation of Existing Funds**						
Federal Funding	0	0	0	0	0	0
Other Funding (Specify)						
TOTALS	\$3,363,870	\$3,727,740	\$4,091,610	\$4,455,480	\$4,819,350	\$20,458,050
NET TOTAL	\$1,651,870	\$1,393,740	\$1,095,610	\$862,480	\$1,832,350	\$6,836,050

Budget Assumptions:

- Faculty salaries are average values, but will include a mix of senior and junior faculty, plus administrative support staff. Start-up funds are charged in the first year, but may be expended over several years. Technical staff will be charged to research grants and testing revenue and are not included in this budget.
- Administrative and infrastructure costs are scaled over time as the number of students and faculty increase.
- Total student credit hours (CH) include a mix of part-time and full-time students. For this analysis, the split is equally divided.
- Each part-time graduate student is taking an average of four 3-credit courses per year at tuition of \$750/CH. Full-time residential students are taking a full-load, year-round, at in-state tuition rates. Since the in-state tuition rates are the most conservative, the actual tuition generated will likely be higher at the enrollment targets due to some out-of-state enrollment.
- Travel expenses will decrease as some faculty become permanently located at CURI over time.
- The recurring funds from the state were approved in 2013. See http://media.clemson.edu/cfo/budgets/2014_Budget_Document.pdf, pages iii and 3; and <http://www.clemson.edu/governmentalaffairs/documents/13eg3.pdf>; and http://www.ciclt.net/sn/new/n_detail.aspx?ClientCode=clemson&N_ID=200777