ACAP
9/10/2015
Agenda Item 3c

Name of Institution
The Citadel

Name of Program (include concentrations, options, and tracks)
Masters of Science in Electrical 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
Aug 2016

CIP Code
14.1001

Delivery Site(s)
Courses offered on-site and/or at the Low Country Graduate Center

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 Curriculum Committee: 17 Feb 2015
Academic Board: 24 Feb 2015
President: 10 April 2015

Background Information

State the nature and purpose of the proposed program, including target audience and centrality to institutional mission. (1500 characters)

The MSEE is intended to meet the expressed needs of South Carolina industries, especially Charleston based companies. Nationally, Electrical Engineering is broken out as a separate category by the Department of Labor which shows that electrical engineers are the most hired group of engineers after civil and mechanical engineers.

The engineering related job market in the Charleston area has exploded in recent years, especially as the Lowcountry has become a manufacturing hub. Employers include architectural-engineering firms, firms with specialties in multiple areas of electrical engineering, aviation, defense applications, power and energy firms, manufacturing, and many others. The MSEE supports The Citadel's LEAD 2018 Objective 2 (academic programs of distinction), Objective 4 (expand enrollment in The Citadel Graduate College), and Objective 8 (provide outreach to the region and serve as a resource in its economic development) and is being developed at the request of a number of Charleston based companies. The desire to hire local talent and educate an existing workforce drives the need for a local graduate EE program to complement an existing undergraduate engineering program. Our ability to offer graduate courses within The Citadel MSEE is complementary to any other graduate courses being offered in the Lowcountry in providing graduate engineering education.

Engineering problem solving is in increased demand and electrical engineers are a necessary and diverse core engineering skill set that are primarily focused on power and energy, controlling manufacturing processes and professional services.

List the program objectives. (2000 characters)

Student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program. Graduates of the Master of Science degree program in Electrical Engineering will, by the time of graduation:

- **Outcome 1:** Demonstrate breadth of knowledge in complimentary areas of electrical engineering that promotes an awareness of and skill in interdisciplinary problem solving.
- **Outcome 2:** Demonstrate a depth of knowledge in a chosen focus area of electrical engineering that allows the student to apply innovative techniques to solve problems.
- **Outcome 3:** Demonstrate knowledge in methods of advanced analysis appropriate for professional use when solving problems.
- **Outcome 4:** Demonstrate knowledge of contemporary issues in their chosen focus area.
- **Outcome 5:** Demonstrate the skills relevant to graduate level work to include the ability to formulate problems, synthesize and integrate information, work collaboratively, and to communicate effectively.
- **Outcome 6:** Demonstrate preparation for successful careers in industry or continued graduate work and an ethic for lifelong learning.

Assessment of Need

Provide an assessment of the need for the program for the institution, the state, the region, and beyond, if applicable. (1500 characters)

The number of students taking engineering courses at The Citadel has increased dramatically over the last few years. For example, the number of undergraduate engineering students within the Corps of Cadets has grown from 318 in 2012 to 379 students in 2014. The number of evening students has grown from 65 to 85 students. All of this growth is prior to the inclusion of the mechanical engineering undergraduate cadet and evening students who began to attend in fall 2014 (90 new students). The number of enrollments in our MS in Project Management has grown from 95 in 2010-2011 to over 350 in 2013-2014. Many of the evening students in Project Management have asked when will we begin to offer more technical masters level courses and degrees. The arrival of Boeing and their survey of employee educational needs estimate nearly 1000 employees needing undergraduate degree completion, many in engineering. However, recent discussions with key leaders and news releases at Boeing and other companies in the Lowcountry have noted a desire for their current workforce to complete certificates that will show immediate skill attainment as well as master's level technical degrees.

The Charleston Regional Competitiveness Center forecasts there will be a 16.4% growth (7200 new jobs) in the engineering field in the area by 2018. This information follows closely to the Department of Labor statistics that show a 12 month growth rate for construction in South Carolina as 7.2% while in Charleston it was 16.2%, growth rate for manufacturing in South Carolina as 2.0% while in Charleston it was 25.4%, and the growth rate for trade, transportation, and utilities in South Carolina as 2.5% while in Charleston it was 3.1%. Many other areas were growing at a faster rate in Charleston than the state as a whole.

Employment Opportunities

Is specific employment/workforce data available to support the proposed program?

☐Yes

☒No

If yes, complete the table and the component that follows the table on page 4. If no, complete the single narrative response component on page 5 beginning with "Provide supporting evidence."

Employment Opportunities			
Occupation	**Expected Number of Jobs**	**Employment Projection**	**Data Source**

Provide additional information regarding anticipated employment opportunities for graduates. (1000 characters)

Provide supporting evidence of anticipated employment opportunities for graduates, including a statement that clearly articulates what the program prepares graduates to do, any documented citations that suggests a correlation between this program and future employment, and other relevant information. Please cite specific resources, as appropriate. (3000 characters)

Note: Only complete this if the Employment Opportunities table and the section that follows the table on page 4 have not previously been completed.

There is not specific employment data beyond the fact that there is documented growth of current and new companies providing engineering support and/or products for the rapidly expanding manufacturing hub here in the Lowcountry. One example; Boeing has expanded its workforce to 7500 employees within the last year (many desiring additional skills through graduate certificates and MS degrees) and is currently bringing in a design center, a research center, and expanding the plant footprint. This only scratches the surface of the numerous newspaper articles noting companies moving production of required aeronautical parts to decrease the shipping costs from Washington State. Each of these companies requires an engineering team to support design and production. The future deepening of the harbor heightens the desire for more companies to locate their production efforts here in the Lowcountry such as Continental Tire and the expansion of the Daimler Truck manufacturing center. Most of the students that will be taking the courses within the MSEE and its associated certificates will be existing mid-level employees with Lowcountry companies working to improve their current skill set.

The argument within the State House for many years is the need for a comprehensive university in the Lowcountry to be able to offer those already here the ability to obtain PhD level degrees. To support the long-term goal to offer engineering PhD's in the Lowcountry, The Citadel is positioned with its all PhD faculty team to offer an MSEE degree. The new electrical engineering graduate program will closely resemble course offerings at Clemson University and USC to ensure ease of transfer for students desiring to transfer for a MS Thesis option or PhD. An MSEE degree at The Citadel will support the needs of local students unable to fully attend Clemson or USC for an MS degree, courses needed by PhD students conducting research in the Lowcountry, employees of local companies, and the current students already taking a BSEE at The Citadel whether as a cadet or an evening student.

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

☐Yes

☒No

If yes, explain. (500 characters)

n/a

List of Similar Programs in South Carolina

Program Name	Institution	Similarities	Differences
MSEE	Clemson University	Offering of courses in computer engineering, power and energy engineering, and electromagnetics (RF) engineering	The Citadel MSEE will only be a no thesis MS degree, only requires 6 EE courses and the other 4 courses can be Technical (ME, CE, EE, other) or non-technical (accounting, business, leadership, project management, etc.)
MSEE	The University of South Carolina	Offering of courses in computer engineering, power and energy engineering, and electromagnetics (RF) engineering	The Citadel MSEE will only be a no thesis MS degree, only requires 6 EE courses and the other 4 courses can be Technical (ME, CE, EE, other) or non-technical (accounting, business, leadership, project management, etc.)

Notes:
There are no Masters of Science in Electrical Engineering programs in the Lowcountry of South Carolina. There are MSEE programs at Clemson University and The University of South Carolina, but limited opportunity for local students in the heavily populated area of Charleston to attend face-to-face an Electrical Engineering program without leaving the area as well as limited opportunity for local employees to further their education face-to-face in Electrical Engineering. The Citadel has Bachelor of Science in Electrical Engineering. Trident Technical College has an Associate in Science, Electrical Engineering Transfer. Many students in the Associate in Science, Electrical Engineering Transfer program at Trident Technical College matriculate into The Citadel's evening undergraduate Electrical Engineering program. Many of these students desire to continue living in the Lowcountry and eventually obtain a MSCE degree face-to-face.

Description of the Program

Projected Enrollment						
Year	Fall		Spring		Summer	
	Headcount	Credit Hours	Headcount	Credit Hours	Headcount	Credit Hours
2016-2017	5	45	5	45	3	9
2017-2018	10	90	12	90	6	18
2018-2019	15	135	19	135	10	30
2019-2020	17	153	29	153	13	39
2020-2021	25	225	39	225	18	54

Besides the general institutional admission requirements, are there any separate or additional admission requirements for the proposed program?

☐Yes

☒No

If yes, explain. (1000 characters)

Are there any special articulation agreements for the proposed program?

☐Yes

☒No

If yes, identify. (1000 characters)

Curriculum

Select one of the following charts to complete: Curriculum by Year **or** Curriculum by Category

Curriculum by Category*					
Computer Engineering		**Depth component Electrical and Computer Engineering**			
ELEC 675 Computer Architecture	3	ELEC 605 Advanced Power Systems	3		
ELEC 645 Data Communications Networks	3	ELEC 615 Spectral Analysis	3		
ELEC 655 Digital Communications	3	ELEC 625 RF Systems	3		
ELEC 635 Adaptive Signal Processing	3	ELEC 665 Fundamentals of Advanced Energy Conversion	3		

* Add category titles to the table (e.g., major, core, general education, concentration, electives, etc.)

Total Credit Hours Required 30

Notes:

The new electrical engineering graduate program will closely resemble course offerings at Clemson University and USC to ensure ease of transfer for students desiring to transfer for a MS Thesis option or PhD. A comparison of the degree with those at Clemson University and the University of South Carolina is provided below in Table 1. The Citadel MSEE will require 30 credit hours where 18 credit hours will be technical while 12 credit hours can be non-technical (finance, accounting, leadership, program management, etc.). As shown in Table 1, there will be the opportunity to complete individual graduate certificates in three main focus areas to meet the needs of the local industry in South Carolina: Computer engineering (in this submittal) and in the future power and energy engineering and electromagnetics (RF) engineering.

Table 1: MS Electrical Engineering Comparison to Other Institutions

	Citadel	Clemson		USC	
	MS Non Thesis	MS Thesis	MS Non Thesis	MS Thesis	ME Non Thesis
Total Hrs	30	30	33	30	30
Core / Focus Area Possibilities	Computer Engineering Power and Energy Engineering Electromagnetics Engineering	Communications Electromagnetics Mechatronics Electronics Photonics Computer Architecture Software Enabled Systems Renewable Energy Power Systems Engineering Advanced power Systems Engineering Minor outside of Engineering (2 courses – Math, Physics, Computer Science, or Industrial Engineering)		Power systems Power electronics Simulation environments for power electronics and interdisciplinary systems Microwave power amplifier and MOS devices based on wide bandgap semiconductors Growth device processing, and characterization of wide bandgap (SiC and GanN) semiconductors Nanoelectronics Electromagnetic scattering Wireless communication applications Outdoor and indoor wave propagation Millimeter-wave integrated circuits Microwave and antenna design Electronic packaging	
Other Tech	N/A	Advisor	Advisor	Advisor	Advisor
Other	12	Advisor	Advisor	Advisor	Advisor

Citadel MS in Electrical Engineering:

- 30 credit hours, non-thesis
- Require at least 6 courses (18 hours) in technical classes
- 4 courses (12 hours) in technical or non-technical classes (Mechanical, Electrical, Civil, Mathematics, Science, Program Management, Business, Leadership)

Example Course Plan:

If a student, for example, has a focus in Computer Engineering, he/she must take the 4 Computer Engineering courses. The remaining technical courses must be a minimum combination of 2 from the Other Technical Courses. The Other 4 courses can be from non-technical (Business, Leadership, Program Management) or from technical programs (Mechanical, Electrical, or Civil, Mathematics, Science). See example in Table 2, below.

Table 2: Sample Course Plan for Structures Focus in MSEE Program

	Course # and Title		Credit Hours
MS EE Tech Courses	ELEC 675	Computer Architecture	3
	ELEC 645	Data Communications Networks	3
	ELEC 655	Digital Communications	3
	ELEC 635	Adaptive Signal Processing	3
	ELEC 605	Advanced Power Systems	3
	ELEC 615	Spectral Analysis	3
Other Courses	PMGT 650 Overview of Technical Project Management		3
	PMGT 651Tech Project Planning and Scheduling		3
	PMGT 671: Project Manager Leadership Development		3
	BADM 604 Foundation of Management and Organization		3
			30 Total

Course Descriptions for New Courses

Course Name	Description
All courses above currently exist in The Citadel's graduate catalog as previous single offerings, most recently as electives within the MS in Project Management.	

Faculty

Faculty and Administrative Personnel				
Rank	**Full- or Part-time**	**Courses Taught or To be Taught, Including Term, Course Number & Title, Credit Hours**	**Academic Degrees and Coursework Relevant to Courses Taught, Including Institution and Major**	**Other Qualifications and Comments (i.e., explain role and/or changes in assignment)**
Professor	Full-time	ELEC 635, Adaptive Signal Processing, 3 credit hours, *to be taught*	BS, MS and PhD, Electrical Engineering MS, Acoustics Engineering	Fundamental research in Wavelet Theory/Signal Analysis, Extensive graduate and undergraduate teaching in area.
Professor	Full-Time	ELEC 605, Advanced Power Systems, 3 credit hours, *to be taught*	BS, MS and PhD, Electrical Engineering	Fundamental research in advanced power systems. Extensive undergraduate teaching in area.
Professor	Full-time	ELEC 665, Fundamentals of Advanced Energy Conversion, 3 credit hours, *initially taught* - spring 2011	BS, MS and PhD, Electrical Engineering	Fundamental research in photovoltaic energy conversion, Graduate and undergraduate teaching experience in area.
Associate Professor	Full-time	ELEC 675, Computer Architecture, 3 credit hours, *initially taught* - summer 2012	BS in Computer Science, MS and PhD in Electrical Engineering	Fundamental research in computer hardware architecture. Graduate and undergraduate teaching experience in area.
Associate Professor	Full-Time	ELEC 645, Data Communications Networks, 3 credit hours, *to be taught* ELEC 655, Digital Communications, 3 credit hours, *to be taught*	BS, MS and PhD, Electrical Engineering	Fundamental research in wireless networks. Extensive undergraduate teaching in area.
Associate Professor	Full-time	ELEC 615, Spectral Analysis, 3 credit hours, *to be taught*	BS, MS and PhD, Electrical Engineering	Fundamental research in digital filtering. Extensive undergraduate teaching in area.
Assistant Professor	Full-time	ELEC 625, RF Systems, 2 credit hours, *initially taught* – summer 2011	BS, MS and PhD, Electrical Engineering	Fundamental research in RADAR systems. Focused undergraduate teaching experience in RF Systems.

Note: Individuals should be listed with program supervisor positions listed first. Identify any new faculty with an asterisk next to their rank.

Total FTE needed to support the proposed program (i.e., the total FTE devoted just to the new program for all faculty, staff, and program administrators):

Faculty	1	Staff	0	Administration	0

Faculty /Administrative Personnel Changes

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

Faculty are required to teach a full load – 12 credit hours each semester. Each faculty member may consult one day per week and can gain teaching release time for successful research proposals. Additionally, The Citadel has a foundation grant that provides funding ($2500 each area/year) in the following three areas: research seed funding, result presentations at conferences, and/or participate in faculty development opportunities. The new MSEE program will start with current faculty teaching courses as an add pay in the summer while leveraging the ability for students to take up to 4 non-technical courses already being offered throughout the year. As the demand increases beyond the ability for faculty to cover courses with add pay, faculty positions will be requested or reallocated. Current estimates would allow the program to cover 4 graduate courses per semester and one additional FTE faculty member. The staff and administration positions supporting the BSEE will also support the MSEE program.

Library and Learning Resources

Identify current library/learning collections, resources, and services necessary to support the proposed program and any additional library resources needed. (1000 characters)

The 2011 Standards for College Libraries does not address Electrical Engineering specifically beyond recommending that a comparison of our holdings should occur with a group of peer institutions. The Citadel's holdings were compared with those of Clemson and USC (PASCAL members), VMI, UT-Chattanooga, Western Carolina, and University of North Florida. The Citadel library catalog holdings are small for civil engineering; however, the current ebook package, Academic Complete from ebrary, yields 3,521 hits from the same phrase search. These ebooks are available from on and off campus to currently-enrolled students.

The top 5 U.S. journals in electrical and electronic engineering are *IEEE Wireless Communications*; *IEEE Journal of Solid-State Circuits*; *IEEE Communications and Tutorials*; *IEEE Journal on Selected Areas in Communications*; and *International Journal of Robotics Research* (access through *Sage*). The Citadel has access to all of them.

The new BSME program has purchased a print version of the entire ASTM package. We expect many fully employed students will be using company resources to complete assignments. The Citadel currently spends approximately $40,000 per year on engineering.

Student Support Services

Identify academic support services needed for the proposed program and any additional estimated costs associated with these services. (500 characters)

The Citadel currently has strong student support services for existing undergraduate programs, graduate programs and veterans. These same services would provide support for the evening students who would be taking courses within the MSEE degree or associated certificates. It is expected that a majority of the students will be either full time employed or completing research degrees through Clemson's Restoration Institute.

Physical Resources

Identify any new instructional equipment needed for the proposed program. (500 characters)

The equipment being purchased as part of the new BSME program as well as the equipment used within the BSCE and BSEE programs will support any physical demonstrations needed within MSEE level courses. Since the MSEE degree requires only 10 courses and no thesis, the lab equipment needs will be limited to support for displaying theoretical concepts within a given course. The focus areas: computer engineering, power and energy engineering and electromagnetics (RF) engineering follow the focus areas within the BSEE and associated equipment being purchased.

Will any extraordinary physical facilities be needed to support the proposed program?

☐Yes

☒No

Identify the physical facilities needed to support the program and the institution's plan for meeting the requirements, including new facilities or modifications to existing facilities. (1000 characters)

Financial Support

Estimated New Costs by Year						
Category	**1st**	**2nd**	**3rd**	**4th**	**5th**	**Total**
Category	**1st**	**2nd**	**3rd**	**4th**	**5th**	**Total**
Program Administration	0	0	0	0	0	0
Faculty and Staff Salaries	6,000	12,000	105,000	105,000	117,000	345,000
Graduate Assistants	0	0	0	0	0	0
Equipment	0	0	0	0	0	0
Facilities	0	0	0	0	0	0
Supplies and materials	500	500	500	500	500	2500
Library Resources	0	0	0	0	0	0
Other*	0	0	0	0	0	0
Total	6,500	12,500	105,500	105,500	117,500	347,500
Sources of Financing						
Category	**1st**	**2nd**	**3rd**	**4th**	**5th**	**Total**
Tuition Funding	19,500	45,000	72,000	109,500	147,000	393,000
Program-Specific Fees	0	0	0	0	0	0
State Funding (i.e., Special State Appropriation)*	0	0	0	0	0	0
Reallocation of Existing Funds*	0	0	0	0	0	0
Federal Funding*	0	0	0	0	0	0
Other Funding*	0	0	0	0	0	0
Total	19,500	45,000	72,000	109,500	147,000	393,000
Net Total (i.e., Estimated New Costs Minus Sources of Financing	13,000	32,500	(33,500)	4,000	29,500	45,500

*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.

n/a

Evaluation and Assessment

Programmatic Assessment: Provide an outline of how the proposed program will be evaluated, including any plans to track employment. Identify assessment tools or software used in the evaluation. Explain how assessment data will be used. (3000 characters)

The Citadel is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools. The undergraduate engineering programs are accredited by ABET (EE just completed their reaccreditation visit in Nov 2014 and expects official reaccreditation in July 2015). The MS in Project Management has requested accreditation through the Project Management Institute Global Accreditation Center. The MSEE program will track accomplishment of Program Outcomes through the Taskstream software. All programs within the School of Engineering track employment or employment changes after completion of each degree. The MSEE will track employment data in a similar way, but will also track from where students are initiating their MSEE (full-time employment, research, full-time schooling by continuing their education after a BSEE, etc.).

Student Learning Assessment

Expected Student Learning Outcomes	Methods of/Criteria for Assessment
Demonstrate breadth of knowledge in complimentary areas of electrical engineering that promotes an awareness of and skill in interdisciplinary problem solving	Exams, design projects
Demonstrate a depth of knowledge in a chosen focus area of electrical engineering that allows the student to apply innovative techniques to solve problems	Exams, design projects
Demonstrate knowledge in methods of advanced analysis appropriate for professional use when solving problems	Exams, design projects, homework
Demonstrate knowledge of contemporary issues in their chosen focus area	Papers, presentations
Demonstrate the skills relevant to graduate level work to include the ability to formulate problems, synthesize and integrate information, work collaboratively, and to communicate effectively	Exams, design projects, homework, presentations
Demonstrate preparation for successful careers in industry or continued graduate work and an ethic for lifelong learning	Surveys, work placement tracking

Program Specific Accreditation:

Will the proposed program seek program-specific accreditation?

☐Yes

☒No

If yes, provide the institution's plans to seek accreditation, including the expected timeline for accreditation. (500 characters)

n/a

Will the proposed program lead to licensure or certification?

☐Yes

☒No

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

n/a

Teacher or School Professional Preparation Programs

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

☐Yes

☒No

If yes, complete the following components.

Area of Certification

n/a

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