New Program Proposal
Bachelor of Science, Mechanical Engineering
The Citadel

Summary

The Citadel requests approval to offer a program leading to the Bachelor of Science degree in Mechanical Engineering to be implemented in January 2014. The proposed program is to be offered through traditional instruction on campus. The following chart outlines the stages for approval of the proposal; the Committee on Academic Affairs and Licensing (CAAL) voted to recommend approval to the Commission. The full program proposal is attached.

Stages of Consideration	Date	Comments
Program Planning Summary received and posted for comment	8/15/2012	
Program Planning Summary considered at ACAP	10/11/2012	ACAP members expressed support for the proposed program. CHE staff requested that the full proposal provide more detail about the articulation agreement with Trident Technical College
Program Proposal Received	5/14/2013	
Comments and suggestions from CHE staff to the institution	6/3/2013	Staff requested additional information and asked that the institution revise and resubmit the proposal using the template approved by the Commission in Fall 2012.
Revised Program Proposal received	6/7/2013	Revisions made to follow the program proposal format and include all information requested.
Program Proposal posted to ACAP members for review	6/13/2013	
ACAP Consideration	6/20/2013	There were no objections, substantive comments, or suggestions. ACAP voted to recommend approval of the program.
Program Proposal distributed to CAAL for review	8/21/2013	
Comments received from CAAL members	8/27/2013	Commissioner Munns asked questions concerning the anticipated growth of the proposed program, new courses to be developed and the cost to produce these courses, the need to reallocate funds from other programs to support this program, and the need for and approval process status of the proposed new engineering building. Staff requested that the institution address these issues.
Responses provided to CAAL	9/2/2013	Staff received responses and distributed the information to CAAL.

Stages of Consideration	Date	Comments
CAAL consideration	9/5/2013	Commissioner Munns acknowledged the responses to his previous questions and requested that they be included in the proposal to CHE. CAAL voted to recommend approval to CHE.

Recommendation

The Committee on Academic Affairs and Licensing recommends that the Commission approve the program at The Citadel leading to the Bachelor of Science degree in Mechanical Engineering to be implemented in January 2014, provided that no additional "unique cost" or other special state funding be required or requested.

Commissioner Munns' Questions and CHE/Institutional Responses Regarding New Academic Degree Program Proposals

The Citadel, B.S., Mechanical Engineering

QUESTION: On page 5, table two… please explain the rational for the anticipated growth in Evening Headcount over the next 6 years of 20,42,50,55,59. How confident are you in achieving these numbers?

INSTITUTIONAL RESPONSE: These evening numbers are based on local anticipation for the development of the first mechanical engineering program in the Lowcountry. If using the estimated number of Boeing employees alone as an indicator, these numbers could be low. Visits with Boeing employees at the recent college fair where more than 1000 employees visited The Citadel booth, large numbers of these employees were asking about when and how a new ME degree would be delivered. Many of those employees have varying levels of course work that must be completed at Trident Technical College before attending The Citadel for the last two years of the program (2+2 MOU with Trident Technical College). The discussions with these employees support the gradual increase of students into The Citadel ME program from Trident Technical College. Trident Technical College is already seeing growth in their Associates of Science, ME transfer program. Additionally, there has been a sharp increase in new local companies that support Boeing as well as there are companies seeing the advantages of establishing new manufacturing businesses in the Charleston area. The newly established ME advisory board which represents many ME heavy companies within the Charleston area have stated that they also have large numbers of employees interested in continuing their education as well needing new ME hires each year. Add the MOUs with other Technical Colleges to transfer their students into our evening program, we believe that we will be able to achieve these numbers.

QUESTION: Pg 17. I am surprised by the need for 39 new courses… this is the largest I have seen of any program. What is the time required and the cost to produce these courses. More importantly how can these courses be developed with just the initial .75 FTE that is claimed for the first year?

INSTITUTIONAL RESPONSE: The courses listed in the proposal are only the new ME courses that are proposed to provide depth (most are possible electives) for the five focused tracks within the program. The draft curriculum provides a listing by semester on its first page (first page after page 24 of the proposal) of the required 16 ME courses. The rest of the courses are listed on the second page of the draft curriculum and are presented by focus area as electives to fill the four declared electives: ME Option I and II (a two course sequence in a focus area), the Mechanical Elective and the Technical Elective. Similar to many programs around the country, not every elective in the catalog is offered each year with many being offered based on enrollments. The list of courses provided in the proposal is the anticipated required and elective courses required over a period of time within a fully established ME program with the five defined focus areas. The Citadel has hired two new faculty to begin Jan 2014. In Jan 2014, we anticipate to

offer a couple of ME junior level courses as we begin the evening program with the full launch of the evening program which will offer the full slate of the fall junior level courses in fall 2014. Additionally, these two faculty are being hired this fall as adjunct faculty to begin developing the courses (and associated labs) offered within the junior year. We also anticipate beginning the ME program for our cadets by building out the program by starting with freshman only in fall 2014, new freshman and rising sophomores in fall 2015, etc. Please note that there are only two new ME courses listed within the freshman year and none within the sophomore year of the ME program. Current core, CE and EE courses complete the ME course requirements within the first two years as noted in the draft curriculum. This program build out plan will provide the necessary time to create the required courses and fully subscribed to elective courses as we hire additional new faculty per the proposal's timeline.

QUESTION: Pg 18 discusses the need for a new engineering building. Is this approved and funded?. If it was approved for other programs is there room in the facility for this new program?

INSTITUTIONAL RESPONSE: The proposed new building is our wish list to provide laboratory space for this new ME program, but any delay in locating necessary funding for a new building will not affect the offering of the ME four year degree. The two new ME faculty hired to begin in Jan 2014 and the Dean are already working with the faculty in CE and EE to rearrange existing labs to correctly place the new laboratory equipment to not only provide ME lab space, but to enhance the CE and EE labs (e.g., New welding equipment is being placed in the CE materials laboratory to support a ME material laboratory, but will also enhance the current CE materials lab experience; a small autoclave will be placed in the CE Materials lab as well as the large autoclave at Trident Technical College will be utilized until space for a large autoclave is located at The Citadel; etc.). Fundraising for a new building is on the foundation's list of high priority funding efforts; however, the current facilities will adequately support the new program.

QUESTION: Pg 24 reports the need to reallocate funds from other programs to support this program. What is the probability that this action will lead to an increase in annual student tuition?

INSTITUTIONAL RESPONSE: This new degree program will not lead to an increase in annual student tuition. The reallocated funds will occur within the institution's current strategic initiative funding that supports *LEAD 2018: The Citadel's Strategic Plan for Leadership Excellence and Academic Distinction*. These reallocated funds will occur as other projects are completed. In addition, as retirements occur in programs with lower enrollment, The Citadel plans to reallocate faculty FTE lines to support this program.

The Citadel

School of Engineering

REQUESTING TO OFFER A NEW DEGREE PROGRAM

Bachelors of Science Degree

in

Mechanical Engineering

Submitted to the South Carolina Commission on Higher Education
May 10, 2013
Revised June 7, 2013

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John Rosa, LTG
President
The Citadel

Program contact: Dr. Ronald Welch
Dean of Engineering
843-953-6588
ronald.welch@citadel.edu

University Contact: Dr. Sam Hines
Provost
The Citadel
hiness1@citadel.edu
843-953-5007

Classification:

Program Title: Mechanical Engineering

Academic Unit: School of Engineering

Designation: Bachelors of Science in Mechanical Engineering (BSME), 4-year program

135 credit hours including leadership and physical education requirements

Proposed date of implementation: January 2014

CIP code from the current USDOE's Classification of Instructional Programs:
14.1901

Site: On-site, four-year day degree program as well as two-year evening degree completion program with courses offered on-site and at the Low Country Graduate Center for transfer students.

Delivery Mode: Campus-based, traditional instruction.

Program qualifies for supplemental Palmetto Fellows Scholarship and LIFE Scholarship awards: Yes __X__ No

Institutional Approval:

The proposal to add a new mechanical engineering undergraduate degree program was developed as part of the School of Engineering strategic plan. The Citadel's strategic planning committee, senior administration, and Board of Visitors also adopted this proposal for inclusion in *LEAD 2018: The Citadel's Strategic Plan to Promote Leadership Excellence and Academic Distinction* as a funding priority. The proposed mechanical engineering degree program and all associated courses were approved by The Citadel's Curriculum Committee on 12 March 2013, the Academic Board on 26 March 2013, and the President on 10 May 2013.

Purpose:

The mechanical engineering program will provide additional engineers for the rapidly growing industry base in the lowcountry, while providing enhanced educational opportunities for the existing work force of these new and expanding companies. Additionally, many of the current students who desire to attend a military school like the Citadel and study engineering have very limited choices. The mechanical engineering program's objectives include a focus in composites, mechatronics, manufacturing, power/energy, design and aeronautics which align with the needs within the local economy.

Justification:

The Bachelors of Science in Mechanical Engineering is intended to meet the expressed needs of South Carolina industries. The US Department of Labor, Bureau of Labor Statistics includes a mechanical engineering category which projects a 9% growth in mechanical engineering jobs from 2010-2020. Additionally, the Department of Labor shows that mechanical engineers are the second most hired group of engineers after civil and before electrical engineers.

The engineering related job market in the Charleston area has exploded in recent years, including a drastic increase in the need for mechanical engineers. Two large employers in the area, Boeing and SPAWAR Systems Center Atlantic, employ thousands of engineers. Other large industries in the area include automotive, manufacturing, medical device manufacturers, power generation, and processing. The Bachelor of Science in Mechanical Engineering is being developed at the request of a number of these South Carolina companies, particularly those based in Charleston such as Boeing, SPAWAR, SAIC, BAE System Support Solutions, UEC Electronics, AAI Corporation – Textron Inc., Metal Works Inc., Design Mill Inc., and Caterpillar to mention a few. Each company is a member of our mechanical engineering advisory board and expects multiple hires each year tied to current growth. A recent Boeing internal survey highlighted one-sixth of current workforce desiring to increase their education, many in engineering, especially mechanical engineering. Articles in the Post and Courier report new engineering divisions heavy with mechanical engineering sub-disciplines being stood up by Boeing in the next few years. In May 2013, the Post and Courier reported a Boeing announcement of a $1.1 billion investment and hiring plan for 2,000 additional employees in the State of South Carolina. The desire to hire local talent and educate an existing workforce drives the need for a local undergraduate mechanical engineering program to complement the available civil and electrical engineering programs as well as close the engineering skills gap in the area and state. A recent survey of mechanical engineering job postings found positions in health care, aviation, defense applications, power systems, telecommunications, automotive, manufacturing, testing, data centers, and many others. This diversity means that employment as a mechanical engineer is more robust than other more narrowly focused engineering specialties.

The need for mechanical engineers will continue to grow and currently the US is not producing enough as we are seeing an increase in manufacturing and design returning to the US, including in the greater Charleston area. Engineering problem solving is in increased demand and mechanical engineers have a necessary and diverse core engineering skill set that primarily focuses on manufacturing processes and professional services. In this manner, they bridge the gap between civil engineering and electrical engineering needs. The proposed program is needed because products will become increasingly complex with greater demand for sustainability that can only be answered through use of innovative processes that consider the human condition while being produced in less time.

The mechanical engineering program is central to the mission of The Citadel. In addition to offering the degree program to members of the South Carolina Corps of Cadets,

The Citadel also proposes to offer it as a degree program for undergraduate evening students through The Citadel Graduate College. The Citadel Graduate College provides adults in the Lowcountry and the State of South Carolina opportunities for higher education by offering a broad range of educational programs of recognized excellence at both the graduate and undergraduate levels. These programs are designed to accommodate the needs of adult students seeking traditional and demanding academic challenges. By providing additional undergraduate degree programs that are directly linked to industry needs, The Citadel Graduate College supports and encourages stronger economic development in the region.

The Bachelor of Science in Mechanical Engineering is an interdisciplinary degree. It includes electives that could be taken from civil and electrical engineering as well as chemistry, biology, and physics, all of which are available at The Citadel. In addition, the overlap into psychology should not be overlooked as the research into the human condition associated with products and manufacturing processes are explored within the curriculum.

There is no Bachelor of Science in Mechanical Engineering program in the lowcountry of South Carolina. There are BSME programs at Clemson University and at the University of South Carolina, but there is no opportunity for local students in the heavily populated area of Charleston to attend a mechanical engineering program without leaving the area as well as no opportunity for local employees to complete their education in mechanical engineering. Trident Technical College offers an Associate in Science, Mechanical Engineering program as well as an Associate in Science, Civil and Electrical Engineering program. Many graduates of the Civil and Electrical Engineering programs matriculate into The Citadel's evening undergraduate Civil and Electrical Engineering programs. Many of the lower level courses required within a mechanical engineering program are within the foundational courses in civil and electrical engineering.

The following table shows 2012 enrollment of engineering students in select engineering programs at The Citadel, University of South Carolina, and Clemson University. These numbers were available within the institutional research reports located on each schools web site.

Total Undergraduate Students Enrolled in Select Engineering Programs Fall 2012	**Total Engineering**	**Civil**	**Electrical**	**Mechanical**
The Citadel	356	219	137	None
The University of South Carolina	1260	355	283	622
Clemson University	1420	467	299	654
Undergraduate Degrees Awarded				
The Citadel	84	53	31	None
The University of South Carolina	222	76	47	99
Clemson University	479	196	96	187

Citadel Office of Institutional Research, Student Enrollment Profile and Factbook
Clemson Office of Institutional Research Factbook
USC Office of Institutional Assessment and Compliance Table Generator

The Mechanical Engineering programs at Clemson University and The University of South Carolina have a number of similarities with each other as well as with this newly proposed Citadel program. The Mechanical Engineering program at Clemson University offers experimental, analytical, and computational work in bioengineering/biomechanics, design, dynamics and controls, fluid mechanics, materials and materials processing, manufacturing, solid mechanics, thermodynamics, heat transfer and combustion, and transportation vehicles and systems. The Mechanical Engineering program at The University of South Carolina offers manufacturing and design, thermo-fluids and energy, mechanics and materials, and sustainable design. The new mechanical program at The Citadel would offer experimental, analytical, and computational work in materials (composites), manufacturing, mechatronics, energy and power, aeronautics, and design. The focus areas are not unique, but The Citadel mechanical program desires to specialize in composites, power, and manufacturing based on the local industry. However, there are growing local needs in each of the focus areas presented. What appears to be unique is that each Citadel student will receive at least one course in each of the focus areas; thereby, providing each student an experience base in each area before selecting the two course option to focus on during the senior year.

Trident Technical College offers an Associate in Science, Mechanical Engineering program with many students taking their courses in the evening. In Fall 2012, 120 students were enrolled in Trident Technical College's Mechanical Engineering Program. The Citadel

already has a partnership with Trident Technical College for 2+2 articulation agreements for the Civil and Electrical Engineering degrees and just developed one for Mechanical Engineering (attached as an appendix). A full-time evening undergraduate mechanical engineering program in the Charleston area will assist students from across the state and nation to take mechanical engineering courses while completing an internship or cooperative educational opportunity (CO-OP), where a student takes at least one semester off to work full time, generally during either the junior to senior year with local companies. This proposed program will not only increase student skills while working, but increase the ability of timely graduation for more engineering students who choose to complete a CO-OP or internship in the Charleston area.

Admission Criteria:

Currently, admission to The Citadel results in acceptance into the Civil and Electrical Engineering programs. No change for admission to Mechanical Engineering is suggested.

Enrollment:

The number of students taking evening engineering courses at The Citadel has increased dramatically in the last few years. For example, the electrical engineering numbers have more than doubled from 15 electrical engineering students to 38 students. Trident Technical College has an average of 15-25 students with the Associate in Science, Mechanical Engineering who currently transfer to other schools who could now transfer to The Citadel each year. The arrival of Boeing and its survey of employee educational needs estimate nearly 1,000 employees needing undergraduate degree completion, many in mechanical engineering. Many current civil and electrical engineering cadets (estimate 15) have expressed a desire to take mechanical engineering, but the over-arching desire to attend The Citadel overshadows the desire to study mechanical engineering and forces them to study civil or electrical engineering. Additionally, there are a number of potential cadets (estimated 10-15 per year) who decide to attend either VMI or Norwich which do have mechanical engineering programs.

Projected Total Enrollment						
Year	Fall		Spring		Summer	
	Headcount Day Evening	Credit hours	Headcount Day Evening	Credit Hours	Headcount	Credit Hours
2013-2014	10; 20	440	10; 20	430	15	135
2014-2015	27; 43	1027	27; 43	1022	30	270
2015-2016	48; 50	1480	48; 50	1494	35	315
2016-2017	89; 55	2248	89; 55	2289	37	333
2017-2018	134; 59	3028	134; 59	3150	40	360

Assumptions for the table:

A) New students will enter the program in the fall semester;
B) There will be some attrition between academic years;
C) Some students in the program will take summer courses.

Curriculum:

The new mechanical engineering program will rely on a number of courses within the existing ABET-accredited civil and electrical engineering programs. The proposed eight semester program is provided at the end of the document due to formatting requirements. The course descriptions for new mechanical engineering courses are provided below. As shown in the draft curriculum, there will be five main focus areas to meet the needs of the local industry in South Carolina: Manufacturing, Materials, Mechatronics, Power, and Aeronautics with the possible inclusion of others through future discussion and development of coursework in programs such as Biomechanical, HVAC, Systems, Management, etc.

MECH 101 Introduction to Mechanical Engineering (1 credit hour)
Required of all Mechanical Engineering freshmen. The engineering design process is demonstrated through use of practical problem-solving methods for public infrastructure and mechanical projects. Course subjects include mechanical engineering career paths, ethical canons of the engineering profession, and requirements for professional licensure. Course assignments, conducted within a collaborative learning environment, focus on creative engineering solutions through technical analysis, teamwork, communication skills, and professionalism. As a foundation for sustained success in mechanical engineering, additional course topics include: lifelong learning, time management, community and professional service, and career development. Laboratory: two hours.

MECH 102 Engineering Computer Applications (2 credit hours)
Required of all Mechanical Engineering freshmen. Foundations of computing to include software tools and engineering processes for mechanical engineers. Topics may include: structured programming (MATLAB), graphical drawings and 2D and 3D modeling of parts and assemblies, interface of 2D and 3D data with Computer Aided Manufacturing, simulation of rigid body motion (Working Model), presentation software (PowerPoint, HTML), and spreadsheets. Introduction to teaming and creativity. Laboratory: four hours.

MECH 310 Thermal-Fluid Systems I w/Lab (3 credit hours)
Prerequisite: MATH 132, PHYS 221, PHYS 271; prerequisites or corequisites: MATH 231, CIVL 301. Thermal-Fluid System I is an integrated study of fundamental topics in thermodynamics and fluid mechanics. The course introduces conservation principles for mass, energy, and linear momentum as well as the 2nd Law of Thermodynamics. Principles are applied to incompressible flow in pipes and turbomachinery, external flows, power generation systems, refrigeration cycles, and total air-conditioning focusing on the control

volume approach. Laboratory exercises are integrated into classroom work. This course includes completion of a comprehensive, out-of-class design problem. This design problem provides the opportunity for students to apply engineering science and the engineering design process to a hands-on project. Lecture: 2 hours; Laboratory: 2 hours.

MECH 304 Engineering Materials w/Lab (3 credit hours)
Prerequisite: CIVL 304/307 and CHEM 151. Course explores the relationships between the microscopic structure and macroscopic properties of materials used in engineering applications. The origin of mechanical, electrical, and thermal properties is studied. Important material failure modes such as occur under fatigue, elevated temperature, rapid loading and corrosive environments are explored. Emphasized is an understanding of the fundamental aspects of atomic and microstructural concepts for proper materials selection, effects of processing on material properties, and enhancement of engineering properties. Materials under study include important metals and alloys as well as key nonmetallic materials such as polymers, ceramics, and composites. Laboratory exercises are integrated throughout the course to provide practical experience in making decisions concerning material composition and processing in order to optimize engineering properties. Experiences from the field are detailed to demonstrate applicability of concepts. Lecture: 2 hours; Laboratory: 2 hours.

MECH 330 Measurements & Instrumentation w/ Lab (3 credit hours)
Prerequisite: ELEC 202/204. Fundamentals of measurement systems in mechanical engineering including transducer operation, signal conditioning, data reduction, and presentation of results. Transducer and measurement system characteristics including resolution, sensitivity, loading, time response, and frequency response. Operating principles of basic instrumentation for measurement of mechanical quantities such as force, torque, pressure, velocities, accelerations, temperature, and flow. Topics include uncertainty analysis, data analysis, probability and statistics, calibration, data acquisition, presentation of results, and an introduction to experiment design. Lecture: 2 hours; Laboratory: 2 hours.

MECH 340 Manufacturing Processes w/lab (3 credit hours)
Prerequisite: CIVL 304/307. This is an introductory course that examines the interactions between design and manufacturing from the designer's point of view. The first portion of the class is devoted to safe, hands-on experience with manufacturing machines and equipment. Students will have an opportunity to work on civil and mechanical manufacturing machines that are common in machine, woodworking, and sheet metal shops such as a mill, lathe, grinder, belt sander, drill press, and band saw. Common manufacturing processes will be introduced and design guidelines will be developed for each process. The successful student will leave this class with an appreciation that a designer must consider the method of manufacture during the design process to ensure that a product is functional, economically viable, and safe. Basic principles of metal processing; applied mechanics of metal cutting and forming; cost analysis of manufacturing operations. Lecture: 2 hours; Laboratory: 2 hours.

MECH 325 Computer Applications w/lab (3 credit hours)
Prerequisite: MECH 102, ELEC 202/204, CIVL 301. Introduction to structured programming and applied numerical methods in scientific computing. The course uses applied problems in engineering and mathematics to introduce numerical methods such as numerical interpolation, finite differencing, integration, root finding, and linear algebraic system solutions. MATLAB is taught as a vehicle for programming of computational algorithms and solving the problems numerically in a structured high speed environment. Lecture: 2 hours; Laboratory: 2 hours.

MECH 311 Thermal-Fluid Systems II w/Lab (3 credit hours)
Prerequisite: MECH 310. Thermal-Fluid Systems II continues the integrated study of fundamental topics in thermodynamics and fluid mechanics. The course applies conservation principles for mass, energy, and linear momentum as well as the 2nd Law of Thermodynamics. Principles are applied to an automotive system to examine engine performance (Otto and Diesel Cycles) and heat exchangers and to high performance aircraft to examine the Brayton Cycle, compressible flow, external flow, lift, and drag. Laboratory exercises are integrated into classroom work. This course includes completion of a comprehensive, out-of-class design problem. This design problem provides the opportunity for students to apply engineering science to the design of a comprehensive thermal-fluid system. Lecture: 2 hours; Laboratory: 2 hours.

MECH 345 Machine Design (3 credit hours)
Prerequisite: CIVL 304/307. This course introduces mechanical engineering design as an iterative decision making process and fundamental engineering science applied to machine components. Analysis for the design and manufacture of basic mechanical elements and their role in the design of machines; application of finite element modeling; introduction to failure theory, fatigue analysis, and energy methods for deflection analysis and their application of them to the design and analysis of machine elements; design of multi-component systems. Useful design techniques (such as modeling, CPM, optimization, probabilistic approaches, etc.) and factors influencing design (such as human factors, products liability, ethics, societal, economics, safety, etc.) are presented, discussed, and incorporated. Design against static failure and fatigue failure of structural members and machine parts: design and selection of components including fasteners, welds (and welding techniques), shafts, springs, gears, bearings, and chain drives. The course culminates in a team-oriented process, design, and manufacture of a mechanical engineering product using the techniques, tools, machines, and equipment that were developed and taught throughout the course.

MECH 350 Modeling/Analysis of Dynamic Systems w/lab (3 credit hours)
Prerequisite: CIVL 301, MECH 330, MATH 335. This course covers dynamic modeling and control of linear systems through an overview of classical control theory as the foundation for control applications in electrical, mechanical, and aeronautical systems. Topics include system modeling using Laplace transform, frequency domain, state variable methods, Boolean logic and algebra, system hardware and software development, and interfacing for mechanical applications. Mathematical models are developed for electrical, mechanical,

aeronautical, and other physical control systems. Control systems analysis and design techniques are studied within the context of how each system is physically controlled in practice to include applications of microprocessors and microcontrollers and digital electronics to the design and utilizations of embedded control systems in smart systems and products. Laboratory exercises include feedback design and system identification. Lecture: 2 hours; Laboratory: 2 hours.

MECH 415 Heat Transfer (3 credit hours)
Prerequisite: MATH 335, MECH 311. The three modes of heat transfer (conduction, convection, and radiation) are studied in detail and applications are made to various engineering systems. The principles of conduction and convection are used to study the mechanisms of heat transfer during boiling, condensation and the design and operation of heat exchangers.

MECH 460 Mechanical Engineering System Design (3 credit hours)
Prerequisite: MECH 345. This course provides experience in the integration of math, science, and engineering principles leading to a comprehensive engineering design project. Open-ended, client-based design problems emphasize a multidisciplinary approach to total system design providing multiple paths to a number of feasible and acceptable solutions which meet the stated performance requirements. Design teams are required to develop product specifications, generate alternatives through modeling, make practical engineering approximations to include probabilistic approaches, perform appropriate analysis to support the technical feasibility of the design, and make decisions leading to an optimal system design. System integration, reverse engineering/redesign projects, human factors engineering, products liability, ethics, safety, computer-aided design, maintainability, and fabrication techniques are addressed. This course provides an integrative experience in support of the overarching academic program goal.

MECH 481 Senior Design I (2 credit hours)
Prerequisite: MECH 345; corequisite: MECH 460. Design projects with industry. Students work in teams with three or four members on design projects furnished from external clients. The emphasis is on creating design solutions, with appropriate analyses, to meet stakeholders' needs. In addition to regular meetings with their faculty advisors, the teams are expected to maintain close and continuous communications with their clients during the semester. The projects culminate in oral presentations and Interim Written Reports which are submitted to the clients. Lecture: 1 hour; Laboratory: 2 hours.

MECH 450 Mechatronics w/lab (3 credit hours)
Prerequisite: MECH 350. Applications of microprocessors and microcontrollers and digital electronics to the design and utilization of embedded control systems in smart systems and products. Topics include Boolean logic and algebra, system hardware and software development, and interfacing for mechanical applications. Lecture: 2 hours; Laboratory: 2 hours.

MECH 482 Senior Design II (3 credit hours)
Prerequisite: MECH 481. This course is a continuation of MECH 481. The student teams continue their design solutions to a general problem furnished by an external client. Continuous and regular communication with the outside clients is expected, as well as with the faculty advisors. During this semester the teams continue refining their solutions, complete the detail design, make oral presentations of the final design, and complete and submit the Final Written Report. Lecture: 1 hour; Laboratory: 4 hours.

Electives:

MECH 499 Advanced Independent Study in Mechanical Engineering (3 credit hours)
Prerequisite: Department Head approval. Other requirements as determined by the Faculty Advisor. The student, on an individual or small group basis, pursues advanced study of a research topic in mechanical engineering. The scope of the course is tailored to the desires of the student in consultation with his faculty advisor. The student is required to define and analyze the problem, study the fundamentals involved, organize the approach, determine the procedure, achieve a solution, and submit a written report. LESSONS and LABS: No formal class. Consultation with Department Faculty Advisor at least once a week on individual work required.

MECH 430 Robotics Engineering w/lab (3 credit hours)
Prerequisite: MECH 350. Interdisciplinary course in engineering systems applied to computer controlled devices. Topics include kinematics, control, operation, sensing, and design as applied to various types of industrial and other robots and programmable manipulators. A related project is required.

MECH 435 Finite Elements for Engineering Applications (3 credit hours)
Prerequisite: CIVL 304, 301, MECH 310. Emphasizes solving various one-dimensional, transient, non-linear problem statements including heat conduction, beam deflection, convection/diffusion (transport), gas dynamic shocks, and open channel flows. Assesses higher order bases, time stepping procedures, iterative solvers, and finite difference methodologies. Utilizes MATLAB for computational experiments.

MECH 425 Advanced Heat Transfer (3 credit hours)
Prerequisite: MECH 415. This course covers additional topics in conduction, convection and radiation heat transfer as well as mass transfer, phase change and numerical methods.

MECH 426 Air Conditioning (3 credit hours)
Prerequisite: MECH 311. Human comfort and the properties of air. Air conditioning in residences, public and industrial buildings using vapor compression and absorption units. Cooling loads, psychrometry, fans, duct sizing and layout, automatic control, and acoustic design considerations.

MECH 497 Special Topics in Mechanical Engineering (3 credit hours)
Prerequisite: Department Head approval. This course provides in-depth study of a special topic in engineering mechanics or mechanical engineering not offered elsewhere in the curriculum. Course content will be based on the special expertise of the Visiting professor or a senior mechanical engineering faculty member.

MECH 498 Mechanical Engineering Internship (3 credit hours)
Prerequisite: Department Head approval. The student, on an individual basis, pursues advanced understanding by working for a mechanical engineering company. The scope of the activities is tailored to the educational focus of the student in consultation with his faculty advisor and eh supervisor at the company. The student is required to provide weekly journaling, monthly supervisor evaluations, a final presentation, and a final report on the experience. LESSONS and LABS: No formal class. Consultation with Department Faculty Advisor at least once a week on individual work accomplished.

MECH 416 Mass and Energy Balance (3 credit hours)
Prerequisite: CHEM 152. Introduction to mass and energy balances in single phase and multiphase, nonreactive and reactive systems. Course topics include an introduction to engineering calculations and process variables, use of computers in solving chemical engineering problems, fundamentals of material balances in single-phase and multi-phase systems, energy balances on nonreactive and reactive processes, applications of combined material and energy balances, balances on transient processes, introduction to chemical engineering unit operations, and a general introduction to the field of chemical engineering.

MECH 417 Renewable Energy (3 credit hours)
Prerequisites: MECH 310. Covers renewable energy sources such as solar heating and cooling, wind energy, biomass, and photovoltaic energy. Surveys the energy availability of these sources and life cycle cost and present value used to evaluate the system. Students will design a system which utilizes a renewable energy source and economically evaluate the system.

MECH 418 Energy Conversions Systems (3 credit hours)
Prerequisites: MECH 415. An overview and historical evolution of both classical and state-of-the-art energy conversion technology. Advanced analysis of energy conversion hardware, air conditioning and refrigeration as well as fossil fuel combustion processes using concepts of energy. Major methods of direct energy conversion are covered, including thermoelectricity, photovoltaics, thermionics, magneto hydrodynamics, and fuel cells. Applications of the thermodynamic, heat transfer, and fluid flow principles to the modeling and design of thermal systems. These systems include pumps, fans, and heat and mass exchangers. The current state of national and world energy is presented and alternatives including renewable energy and a hydrogen economy are explored with reference to economic, political, environmental and technological factors.

MECH 419 Mechanical Power Plants (3 credit hours)
Prerequisites: MECH 311. Students engage in the analysis, testing and evaluation of internal combustion engines and their subsystems with a view toward understanding the underlying principles which affect their design. Spark ignition and compression ignition engine systems are studied in detail. Steam, cogeneration and combined cycles are studied. Introduces the theory and issues related to the design of axial and radial flow turbines, compressors and pumps.

MECH 420 Nuclear Reactor Analysis (3 credit hours)
Prerequisites: MECH 415. This course focuses on nuclear reactor systems, the release of nuclear energy in the reactor core, and its removal as heat for producing electric power. Specific topics emphasize reactor kinetics, heterogeneous reactors, control rods and shim, reactor poisons, heat transfer, and alternative energy systems. The fundamentals of transport theory and the solution to the transport equation using Monte Carlo N-Particle (MCNPX) transport code are introduced.

MECH 440 Advanced Manufacturing Processes and their Application (3 credit hours)
Prerequisite: CIVL 301 and MECH 340. This course examines major manufacturing processes, their capabilities, analysis, economics and manufacturing process selection. Students perform both kinematic (the study of the motion of machinery without regard to forces) analysis and kinematic design of planar and spatial mechanisms, cams, and gear trains. Computer programming is used for iterative methods in both analysis and design. Specific methods and techniques taught and applied are operations strategy, product design and selection, supply chain management, total quality management, forecasting, capacity planning, facility location, facility layout, work system design, inventory management, material requirements planning, and scheduling.

MECH 445 Manufacturing Design w/lab (3 credit hours)
Prerequisite: MECH 345 and MECH 440. Applications of fundamentals of engineering mechanics in analysis and synthesis of machine components and systems to the manufacture of products from metals, polymers, ceramics, and composites. Use and management of computer in engineering for drafting, design management, documentation, and manufacturing. Covers drafting methods and standards, design data management, CNC operations, implementation, kinematics, control, operation, sensing, and design as applied to various types of industrial models. A related project is required.

MECH 470 Introduction to Applied Aerodynamics (3 credit hours)
Prerequisite: MECH 311. The fundamental laws of fluid mechanics are used to develop the characteristic forces and moments generated by the flow about aerodynamic bodies. Physical properties of the standard atmosphere as well as lift, drag, and aerodynamic moments are studied for airfoils (2-D) and finite wings (3-D) in the subsonic and supersonic flow regimes. Development of equations of conservation of mass and momentum lead to development of aircraft performance and design parameters.

MECH 475 Aircraft Performance and Statistics Stability (3 credit hours)
Prerequisite: MECH 470. The course applies the principles developed in applied aerodynamics to develop the equations of motion for a rigid aircraft in steady state level flight, maneuvering flight, and during takeoff and landing. These equations are analyzed to determine such performance characteristics as maximum range, endurance, turning rate, climb rate, etc. Piston-prop, turbo-prop, and jet aircraft are considered. The equations of motion are then analyzed to develop static stability criteria and investigate steady state control characteristics. Design constraints based on customer requirements, mission profiles, aircraft sizing, optimization, and presentation of performance capabilities are considered.

MECH 476 Propulsion Systems (3 credit hours)
Prerequisite: MECH 311. Application of basic principles in the study of the performance characteristics of air and space vehicles to include the aerodynamics of steady one dimensional isentropic compressible flow. Shock waves, gas turbines, turbojet, turbofan, turboprop, turboshaft, ram jet, rocket, nuclear propulsion and space propulsion systems are discussed and compared.

MECH 477 Vibration Engineering (3 credit hours)
Prerequisite: CIVL 301. In this course students develop a foundation in the analysis and design of free and forced single and multi-degree of freedom systems. Applications include modeling, damping, resonance, force transmissibility, vibration absorbers, matrix formulation and modal analysis. Emphasis is placed on vibration examples from several engineering fields. Out-of-class design problems provide students with the opportunity to apply principles taught in the classroom to realistic problems encountered by practicing engineers. In-class demonstrations supplement the theory development.

MECH 478 Light Weight Structures (3 credit hours)
Prerequisite: CIVL 304/307. Applies the principles of mechanics to the structural analysis of mechanical and aerospace components. Covers stress tensors, shear flow in open and closed sections, beam columns, unsymmetrical bending, Castigliano's theorem, statically indeterminate structures, thin walled pressure vessels, introduction to elasticity.

MECH 404 Advanced Materials (3 credit hours)
Prerequisite: MECH 304. Fundamentals of deformation and fracture in metals, polymers, ceramics and composites with application to design. Emphasis on time-temperature dependence of polymers, brittle behavior of advanced ceramics, and the fracture mechanics approach to design of high strength and critical application materials, and composite behavior.

MECH 408 Composite Design (3 credit hours)
Prerequisite: MECH 304. Introduces materials and mechanics of composites with emphasis on high performance polymer matrix composites. Topics include material selection, laminate analysis/design, design implications from manufacturing and joining methodology, and interpreting test results. A team design-built-test project is required.

MECH 409 Composite Manufacturing w/lab (3 credit hours)
Prerequisite: MECH 304. This course covers manufacturing fundamentals, manufacturing processes, composite fabrication and assembly, quality and inspection methods, repair, and required equipment. Topics include material selection, laminate analysis, manufacturing, joining, and testing.

MECH 452 Digital Logic and Circuits w/lab (3 credit hours)
Prerequisite: ELEC 202/204. This course covers the analysis, design, simulation, and construction of digital logic circuits and systems. The material in this course provides the necessary tools to design digital hardware circuits such as digital clocks and locks, as well as computer hardware. The course begins with the study of binary and hexadecimal number systems, Boolean algebra, and their application to the design of combinational logic circuits. The first half of the course focuses on designs using small-scale integration (SSI) logic circuits, medium-scale integration (MSI) circuits, and programmable logic devices (PLDs) to implement combinational logic functions. The second half of the course emphasizes sequential logic circuits like counters and sequence recognizers, and also covers memory systems. Laboratory work in this half of the course focuses on using very high speed integrated circuit hardware description language (VHDL) to simulate digital systems and to program those systems into PLDs. As a final project, cadet teams design, build, and test a digital logic system such as a programmable alarm clock, digital lock, or burglar alarm.

MECH 455 Advanced Mechatronics (3 credit hours)
Prerequisite: MECH 450. A comprehensive course in the field of mechatronics. Mechatronics is the crossroads in engineering where mechanical engineering, electrical engineering, computer science, and controls engineering meet to create new and exciting real-world systems. Knowledge of mechanical and electrical components, controls theory, and design are integrated to solve actual physical design applications.

Assessment:

The assessment of mechanical engineering student learning outcomes, which closely follow the ABET learning outcomes (shown below), will be conducted through a robust program assessment annual cycle. For each of the learning outcomes specified below, multiple assessment methods will be triangulated to provide a comprehensive picture of student learning in each area. Most assessments will be embedded in coursework at multiple strategic points during the program to gauge learning progression associated with each learning outcome to ensure that timely continuous improvements can be made to the mechanical engineering curriculum. Examples of the types of program-level assessments that will be embedded in courses include projects, exams, and papers associated with the program learning outcomes. The program will also employ the Engineering Fundamentals Exam (FE) – a national normed exam, multi-disciplinary team oriented Capstone projects, and surveys of seniors, faculty, alumni, and employers as program assessment tools. Mechanical engineering student results will be compared against the national norms for the

FE, embedded indicators for the best, average, and worst student performance will be assessed against established rubrics, capstone projects will be assessed with a rubric by local and advisory board professional engineers, and surveys will assess skill level against stated program outcomes at time of graduation to establish whether the students are prepared to use their skills to grow in responsibility as required by the profession. Action plans will be established based on the assessment of the data for each assessment method and the collection of assessment methods as a whole for each outcome.

The Citadel utilizes Taskstream Accountability Management (AMS) software to collect and analyze program-level assessment data annually and to report on annual continuous improvement efforts occurring in degree programs. The Citadel also uses Taskstream Learning Achievement Tool (LAT) software to facilitate required student E-Portfolios to assess student learning.

MECHANICAL ENGINEERING PROGRAM OUTCOMES
Program Outcomes *Students who qualify for graduation with a mechanical engineering major will be able to demonstrate*:
apply knowledge of mathematics, science, and engineering
design and conduct experiments, as well as to analyze and interpret data
design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
function on multidisciplinary teams
identify, formulate, and solve engineering problems
comprehend professional and ethical responsibility
communicate effectively
comprehend the impact of engineering solutions in a global, economic, environmental, and societal context through a broad education
recognize the need for and engage in life-long learning
apply knowledge of contemporary issues within solutions
use the techniques, skills, and modern engineering tools necessary for engineering practice

Faculty:

Faculty will be 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 ($2,500 each area/year) in the following three areas: research seed funding, results presentations at conferences, and/or participation in faculty development opportunities. New faculty will be hired to coincide with the required offering of mechanical engineering courses primarily located within the junior and senior years. Initial

hires will support those students who transfer in as juniors within the evening program which is anticipated to start as early as spring 2014. The day program which is anticipated to start as early as Fall 2014 will require only 2 mechanical engineering courses each year until the Fall of 2016 (if the day program starts Fall 2014) when the students begin their junior level courses. The first faculty hire will serve as the mechanical engineering program director until the program spins off as a separate department.

Initial administrative support will be provided by the Department Head of the new Department of Engineering Leadership and Program Management which already includes our Masters of Science in Project Management. Initial staff support for the new program will be provided by the laboratory technicians in the civil and electrical engineering departments since those existing laboratories will be used for many of the mechanical engineering laboratories with some equipment augmentation.

List Faculty By Rank	Highest Degree Earned	Field of Study	Teaching in Field (Yes/No)
Professor #1	PhD	Mechanical Engineering	Yes
Associate Professor #1	PhD	Mechanical Engineering	Yes
Assistant Professor #1	PhD	Mechanical Engineering – Energy/Power	Yes
Assistant Professor #2	PhD	Mechanical Engineering – Materials/Composites	Yes
Assistant Professor #3	PhD	Mechanical Engineering – Aeronautical	Yes
Assistant Professor #4	PhD	Mechanical Engineering - Manufacturing	Yes
Assistant Professor #5	PhD	Mechanical Engineering - Mechatronics	Yes

The Citadel defines full-time equivalent (FTE) as 0.75 for faculty and 1.0 for staff/administration.

Unit Administration/Faculty/Staff Support						
Year	**New**		**Existing**		**Total**	
	Headcount	FTE	Headcount	FTE	Headcount	FTE
Administration						
2013-2014	0	0	1	0.25	1	0.25
2014-2015	1	1	0	0	1	1
2015-2016	0	0	1	1	1	1
2016-2017	0	0	1	1	1	1
2017-2018	0	0	1	1	1	1
Faculty						
2013-2014	0.75	0.75	0	0	0.75	0.75
2014-2015	1.5	1.5	0.75	0.75	2.25	2.25
2015-2016	1.5	1.5	2.25	2.25	3.75	3.75
2016-2017	0.75	0.75	3.75	3.75	4.5	4.5
2017-2018	0.75	0.75	4.5	4.5	5.25	5.25
Staff						
2013-2014	0	0	2	.66	2	.66
2014-2015	0	0	2	.66	2	.66
2015-2016	1	1	0	0	1	1
2016-2017	0	0	1	1	1	1
2017-2018	1	1	1	1	2	2

Physical Plant:

The current Citadel physical plant will support the needs of the program except for the composite materials laboratory work, which will be necessary in evening students first year of the program and cadet's third year of the program. Requirements for equipment to support course and laboratory efforts surrounding composites will be supported initially by Trident Technical College composite facilities at mutually agreeable times. This arrangement (described in the appendix) will allow leveraging the outstanding composite material facilities and trainers that have been augmented by Boeing. In addition, The Citadel Physics program has just purchased and installed a wind tunnel for the study of physical flight and will be used in support of fluid and aeronautical courses.

Current physical plant supervisors will be hired to train and supervise student use of equipment in their areas during the day and evening as required. These same personnel will support the hired laboratory technicians to provide required coverage throughout the day and evening laboratory periods. The new program will rely primarily on the existing, adequate civil (CE) and electrical (EE) engineering classrooms and laboratory space. Some junior and senior level courses will use the available machine, fabrication, and maintenance areas within the Facilities and Engineering Division's physical plant, the supplementing of the small existing fabrication shop that supports EE and Physics courses, supplementing, when necessary, the current CE and EE laboratories where space exists, and coordinating

use through Memorandum's of Agreement with local colleges and organizations when necessary, such as for composites.

Equipment:

The equipment necessary for the first two years of the program are available on campus within the civil and electrical engineering laboratory areas. Some of the equipment needed for the third year is available in the civil and electrical as well as physics laboratory areas.

Equipment by year required			
	Equipment	**Estimated Cost**	**Year required**
Instrumentation Lab	Strain gages, load cells, instrumented beams, potentiometers, accelerometers, USB DAQ devices	$12k	3rd
Fluid/Thermal Lab	Fluids benches, refrigeration trainers, heat transfers trainers, process control breadboard systems, pressure gages, monometers, paddlewheel meters, pressure sensors, thermometers, thermocouples, small wind tunnel	$200k	3rd
Mechatronics Lab	Solenoids, AC motors, DC motors, stepper motors, air regulators, solenoid valves, USB-based DAQ w/LabView, DC regulated power supplies, digital oscilloscopes, digital multimeters, 10 MHz, sweep function generators, Thermister thermometers, analog output, air compressor (pneumatic source), solder stations, soldering rods, laptops	$20k	4th
Materials & Manufacturing Lab	Hardness tester, Impact tester, 100 kN properties testing machine, grinding/polishing systems, metallurgical microscopes, micrograph images evaluation software, optical comparator w/ digital readout, Samplemet 2 Abrasive Cutter, Heat treat furnace, baby autoclave (can wait –Trident Technical College MOU to provide initial support)	$140k $250k - autoclave	3rd 4th
Technical Elective Lab	Desktop CNC mill, desktop CNC Lathe, CAD/CAM software w/FEM module, desktop robots, 3d printer, laser cutter, HVAC design kit	$150k	3rd

Library Resources:

The 2011 *Standards for College Libraries* does not address Mechanical 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 (as members of PASCAL), VMI, UT-Chattanooga, Western Carolina, and University of North Florida. All of these are listed as having ABET-accredited programs in Mechanical Engineering.

Mechanical Engineering Program Library Comparisons			
Comparable Institution	**Why Comparable**	**Hits in Library Catalog with "mechanical engineering" keywords**	**Realted electronic resources including ebooks**
Clemson University	ABET Accredited, part of PASCAL	1901	EngNetBase; Springer; Engineering Village [Compendex]; ACM Digital Library; Annual Reviews; Materials Research Database [ProQuest]; Web of Science; IEEE; ScienceDirect; Applied Science & Technology Full Text
University of South Carolina	ABET Accredited, part of PASCAL	2523	Engineering Village; Web of Science; ScienceDirect; IEEE; ACM Digital Library; Annual Reviews; Applied Science & Technology Full Text; Springer; Wiley
University of North Florida	ABET Accredited, same Carnegie class	174	Engineering Village; Engineering Research Database (ProQuest); IEEE; Web of Knowledge; Materials Research Database (ProQuest); Mechanical & Transportation Engineering Abstracts; ScienceDirect; Springer; Wiley
Virginia Military Institute	ABET Accredited, Used in most comparisons	354	ACM Digital Library; Annual Reviews; Engineering Village; Engineering Research Database (ProQuest); EngNetBase; IEEE; Mechanical & Transportation Engineering Abstracts (ProQuest); Safari Tech Books
University of Tennessee-Chattanooga	ABET Accredited, same Carnegie class	3239	IEEE; Web of Science; Engineering Village; Springer; ACM Digital Library; Wiley, ScienceDirect; Safari Tech Books; Annual Reviews
Western Carolina	ABET Accredited, same Carnegie class	168	IEEE; Web of Science; Applied Science & Technology Retrospective; Applied Science & Technology Abstracts; ACM Digital Library; EngNetBase; Springer; Wiley
The Citadel		97	IEEE; ACM Digital Library; Applied Science & Technology Full Text [Wilson/Ebsco]; EngNetBase; Wiley Online Library; ScienceDirect; Springer

The Citadel library catalog holdings are pretty small for mechanical engineering compared to the other schools' holdings. 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.

According to the SCImago journal and country rank, the top 5 U.S. journals in mechanical engineering are; IEEE/ASME Transactions on Mechatronics (access through IEEE), Precision Engineering (access through ScienceDirect), Journal of Fluids and Structures (access through ScienceDirect), Journal of Sound and Vibration (access through ScienceDirect), Tribology Letters (access through ScienceDirect), and Tribology International (access through ScienceDirect). The Citadel has access to all of them.

Database subscriptions were compared with the other schools' in column four of the table above. While The Citadel has many of the same databases available, the faculty will need to consider adding one of the ProQuest engineering databases, or Web of Science/Knowledge, and/or Engineering Village. Annual Reviews or Safari Tech Books might be an additional consideration based on funding.

Daniel Library does not currently subscribe to ASTM or ASME packages (USC and Clemson both provide ASME packages and Clemson and VMI offer ASTM packages. Others offer occasionally print resources). Other resources and the prices have been summarized below. The Citadel currently spends approximately $40,000 per year on engineering. With review and some adjustment of the current spending, an additional $25,000 annually for library resources will be required to support a Mechanical Engineering program.

Possible database packages	Approximate cost
Engineering Research Database (ProQuest)	$5,000 (as needed)
Web of Knowledge/Web of Science	$12,000
Engineering Village (including Compendex)	$15,000 9as needed)
Annual Reviews	$3060
Safari Tech Books Online	$1000
ASTM Standards	$18,000 for entire set (order individual sets based on need)
ASME (25 journals plus AMR)	$8,078
Total Annual Costs	**$25,000 estimated**

Accreditation, Approval, Licensure or Certification:

The Citadel is currently accredited by the Southern Association of Colleges and Schools and the Civil Engineering and Electrical Engineering programs are accredited by ABET. As soon as the first student in Mechanical Engineering graduates (estimate May 2017), the program will immediately submit an institutional and program self-study and

request a visit by ABET for accreditation of the Mechanical Engineering program. Even though this visit and resulting accreditation will occur between the six year cycle of visits for the other ABET accredited programs at The Citadel, the mechanical program will be re-evaluated on the same cycle as the current accredited programs (estimate 2020).

The state licensing board will be contacted as soon as the program is approved by CHE and begins to matriculate students to ensure the new mechanical engineers can sit for the Fundamentals Exam (FE) during their senior year as is the process for CE and EE students. The FE is the first step after graduating from an ABET accredited engineering program toward licensure as a Professional Engineer (PE).

Articulation:

The Citadel currently has articulation (2+2) agreements with Trident Technical College for both the Civil and Electrical Engineering programs. A similar articulation agreement has been approved for the Mechanical Engineering program. The Citadel is working with eleven other technical colleges within South Carolina to improve the transfer of their students completing an associate of science degree to The Citadel to complete a Bachelor of Science in Civil and Electrical Engineering and soon in Mechanical Engineering.

Estimated Costs:

The funding for the program will be through tuition, foundation support, and funding and space reallocation. The expected evening student enrollments in each course will generate the tuition revenue to nearly cover the cost of faculty salaries after the initial year of each hire such that after year five, the program will have nearly sufficient evening tuition revenue to cover the faculty cost. The college will support start-up of the program during the first five years to include equipment, office furniture, and computers.

ESTIMATED COSTS BY YEAR					
CATEGORY	**1ST**	**2ND**	**3RD**	**4TH**	**5TH**
Program Administration	30k	110k	110k	110k	110k
Faculty Salaries	85k	160k	320k	410k	490k
Graduate Assistants	8k	8k	16k	16k	16k
Clerical/Support Personnel	10k	25k	50k	50k	75k
Supplies and Materials	10k	20k	20k	20k	20k
Library Resources	10k	25k	25k	25k	25k
Equipment	50k	502k	270k	100k	100k
Facilities	0	0	0	0	0
Other (Identify)	0	0	0	0	0
TOTALS	203k	850k	811k	731k	836k
SOURCES OF FINANCING BY YEAR					
Tuition Funding	206k	472k	553k	605k	647k
Program-Specific Fees	0	0	0	0	0
State Spending	0	0	0	0	0
Reallocation of Existing Funds	0	400k	300k	150k	200k
Federal Funding	0	0	0	0	0
Other Funding (Specify)	0	0	0	0	0
TOTALS	206k	872k	853k	755k	847k