

**New Program Proposal  
Master in Engineering  
Systems Engineering  
Clemson University**

**Summary**

Clemson University requests approval to offer a program leading to the Master in Engineering degree with a major in Systems Engineering to be implemented in July 2012.

The Board of Trustees of Clemson University approved the proposal on October 20, 2011. The proposal was submitted for Commission review on November 1, 2011. The Program Planning Summary was reviewed by the Advisory Committee on Academic Programs at its meeting on January 29, 2012, without substantive comment.

According to the proposal, the purpose of the program is to prepare students who are working professionals to obtain the credentials needed for career advancement in a field that has vigorous growth expectations in coming years. The institution notes that goals for the program include preparing students for workforce development leadership roles that support industry and state needs. According to the proposal, employment in systems and software engineering is expected to grow by well over 3% per year through 2018. The institution notes that the position of Systems Engineer is time and again rated in the top 50 positions nationally by CNN Money. The proposal also states that these ratings include the criterion of employment opportunities in the construction of CNN's data.

The institution also notes that the proposed program finds its origin in a twelve hour graduate certificate program in Systems Engineering which was implemented in direct response to requests from a number of companies in the state, specifically companies based in Charleston. The addition of the Systems Engineering curriculum is a public service which is being offered in direct response to a request for service from several companies in South Carolina. The proposal states that implementation of this program will allow for the creation of an academic program structure that can support doctoral programs in the university's participating departments. The courses offered in this program will have direct ties to research programs of eleven distinct College of Engineering and Science programs and to the industrial needs of the state. The program will fuel applied research programs of the university's College of Engineering and Science in areas such as ecology, environmental engineering and science, transportation, and information technology.

According to the proposal, Systems Engineers are paramount to the types of businesses the state seeks to attract in that such professionals help ensure that large, complex projects are properly defined, budgeted, and scheduled. Types of industries in which Systems Engineers are employed include avionics, health care, defense, telecommunications, power companies, and others. The institution reports that students graduating from the program can expect to earn an average starting salary of \$57,000 and that the average salary for such positions is \$76,000, according to at least one source. Systems Engineers apply problem solving techniques to a wide range of technical problems.

The program's curriculum will provide a blended core consisting of general systems knowledge and study with an emphasis area and a practical project based within a company near the student's location. The Systems Engineering curriculum may potentially be of interest to students and researchers in all of the emphasis areas listed below:

- Manufacturing and Composites
- Software and Cybersecurity
- Transportation, Infrastructure
- Power Systems
- Health Systems
- Sustainable Systems

The proposal also notes that training in Systems Engineering provides students with the requisite perspectives and knowledge to support the incorporation of teams whose members have diverse backgrounds that support such professionals acting as liaisons between management and technical resources by providing for a translation of the needs of customers into the parlance of engineering specialists. The proposal also states that this program has a strong alignment with several emphasis areas chosen because of societal need and that the eleven programs which will participate in the curriculum planning for this program all view the field of Systems Engineering as having a role in their disciplines. Moreover, the program is viewed as having strong alignment with the institution's mission.

According to the institution, this program finds its origin in the university's existing Systems Engineering certificate program. Existing courses that comprise the certificate program will provide the foundational Systems Engineering components of the program and the emphasis area will serve to link the program to the eleven disciplines represented in the College of Engineering and Science. Moreover, the requirements for the degree are grouped into three categories including a Systems Engineering core comprised of 12 hours, a six hour capstone project, and a Systems Engineering emphasis area of 12 hours. The proposal states that the emphasis area courses will be chosen based upon the student's individual interests in one of the suggested emphasis areas. The proposal provides a list of suggested courses for the various emphasis areas from which students may choose. The proposal notes that several new courses required for the degree have already been added to support the existing certificate program in Systems Engineering and that the emphasis areas currently exist in existing courses. Specific courses which have been added to support the certificate include Systems Engineering 1 and 2; a project management course which introduces students to the framework needed to manage projects within a Systems Engineering approach and emphasizes the Project Management Institute's (PMI) approach; a course in Improving Systems Using Quality and Lean Principles; a capstone course; and a capstone project. The proposal states that beyond these courses, no other special Systems Engineering courses are planned. The proposal notes, however, that as with all disciplines, as the body of knowledge and practices evolve, the curriculum will be reexamined by the committee responsible for this degree.

The proposal also states that the design of this degree adheres to the International Council on Systems Engineering (INCOSE) proposed curriculum for Systems Engineering education and that because of adherence to this design, the degree will be very similar to other programs nationally. The institution notes, however, that the emphasis area requirement will distinguish this program from others as it will provide students with the problem solving skills gained through the study of Systems Engineering and the domain knowledge acquired through

the study of particular disciplines. Accordingly, this program will provide more opportunities to gain an expanded base of knowledge than many similar programs.

This degree will be the only one of its kind in South Carolina. The institution notes that there are three similar programs in Georgia and two in North Carolina; however, in Georgia, one such program is a business management degree and among the North Carolina programs, one is an undergraduate degree and the other a business management degree. According to the proposal, while a number of online programs are available, only a few exist within the offerings of peer institutions such as Georgia Tech and Johns Hopkins. The institution believes that this program will provide a very attractive alternative to other programs available nationally.

The proposal states that students who are full time employees and who work in technical fields will be those who are most likely to enroll. As part of the requisite admissions criteria, the student must hold an undergraduate degree from an accredited institution, have mathematics and problem solving skills in mathematical analysis and multivariate calculus, and have existing experience in industry. According to the proposal, the Master of Engineering in Systems Engineering degree will prepare program graduates for technical positions requiring a diverse skill set needed to design complex systems.

The proposal also describes an evaluation plan which will include alumni and employer surveys as well as exit interviews in order to determine whether 80% of graduates employed in the field will respond positively as to the level of preparation they received. The plan outlines three specific outcomes: graduates will have the ability to apply knowledge of Systems Engineering methodologies and tools to be able to design, develop, implement, and improve solutions to a variety of systems problems; be able to use requisite techniques, skills, and modern engineering tools for engineering practice; and will have the ability to design and conduct experiments as well as to analyze and interpret data. Each criterion will have been judged to be attained when 80% or more of program graduates are judged to have each of these abilities.

The proposal states that there will be 40 students enrolled in the program in Fall, Spring, and Summer of 2012-2013 and that the institution estimates a total number of 20 new students each year beginning in the second year of implementation, accounting for a total of 60 students projected total enrollment through the first five years of the program. If the enrollment projections are met, the program will meet the Commission's program productivity standards for enrollment and degrees awarded.

According to the proposal, the university's College of Engineering and Science has an established interdisciplinary curriculum committee which will oversee the program. Members of this committee will also serve as the principal faculty members teaching in and supporting the program. There is no anticipated need to add new faculty or staff to support the proposed program.

The proposal states that since this program will be offered only via Internet-based instruction, there are no physical plant requirements beyond office space needed for faculty and staff. The university's information technology and telecommunications infrastructure are world-class and will fully support all teaching and learning requirements of the program. Likewise, no additional specialized equipment items are needed to support the proposed program.

The proposal states that library resources to support the degree are already in place and that no need exists for additional library resources. Students will have access to all electronic journals and other electronic resources available to all university students via the Internet.

The institution notes that the proposed program is not subject to specialized or professional accreditation or approval by any state agency other than the Commission on Higher Education.

The proposal notes that no formal articulation arrangements currently exist with other institutions but that in the case of one student enrolled in a Systems Engineering class during the Fall 2011 semester, the student intended to transfer her hours to the Citadel as part of a Certificate in Systems Engineering Management. Discussions have begun between the institutions to allow Clemson students who may want to pursue an emphasis area in management to articulate courses at the Citadel and for Citadel students interested in technical Systems Engineering courses to attend Clemson via the online courses.

**Costs**

**COSTS TO THE INSTITUTION**

<b>ESTIMATED COSTS BY YEAR</b>						
<b>Category</b>	<b>Year #1</b>	<b>Year #2</b>	<b>Year #3</b>	<b>Year #4</b>	<b>Year #5</b>	<b>TOTALS</b>
Program Administration	New	33,660	26,000	22,927	24,765	154,052
Faculty Salaries	60,000	105,000	150,000	150,000	150,000	615,000
Graduate Assistants	16,000	38,000	40,000	42,500	40,000	176,500
Clerical/Support Personnel	20,200	20,840	21,500	22,073	22,735	107,348
Supplies and Materials Library Resources	7,500	7,500	7,500	7,500	7,500	37,500
Equipment	28,600	14,000	14,000	14,000	14,000	84,600
Facilities	1,000	1,000	1,000	1,000	1,000	5,000
Other (Identify)						
<b>TOTALS</b>	180,000	220,000	260,000	260,000	260,000	1,180,000
<b>SOURCES OF FINANCING BY YEAR</b>						
Tuition Funding	135,000	135,000	135,000	135,000	135,000	675,000
Other State Funding						
Reallocation of Existing Funds						
Federal Funding						
Other Funding* (Endowments from Companies and Educational Grants)	45,000	85,000	125,000	125,000	125,000	505,000
<b>TOTALS</b>	180,000	220,000	260,000	260,000	260,000	1,180,000

\* Private endowments from companies who have indicated significant interest in the development of the new program and through funds from competitive educational grants.

As noted above, the institution expects to receive significant contributions that will help to offset costs and expenditures associated with the proposed program. These sources of funding include monies from endowments as well as grant opportunities the institution will identify and apply for on a competitive basis.

### **Summary**

In summary, the proposed program will provide students of Systems Engineering in the state with an expanded and needed choice in preparation for success in either the workplace or in further academic pursuits in the field of Systems Engineering. It will also serve to fill a critical need for the preparation of much needed Systems Engineering professionals in the Palmetto state.

### **Recommendation**

The Committee on Academic Affairs and Licensing commends favorably to the Commission approval of the program at Clemson University leading to the Master in Engineering degree with a major in Systems Engineering to be implemented in July 2012, provided that no “unique cost” or other special state funding be required or requested.