New Program Proposal

Master of Engineering: Civil Engineering with a concentration in Risk Engineering and System Analytics

Clemson University

Summary

Clemson University requests approval to offer the program leading to the Master of Engineering: Civil Engineering with a concentration in Risk Engineering and System Analytics to be implemented in the Fall of 2017. The proposed program is to be offered as a distance education program and provided 100% online. The following chart outlines the stages of approval for the proposal. The Advisory Committee on Academic Programs (ACAP) and the Committee on Academic Affairs and Licensing (CAAL) voted to recommend approval of the proposal. The full program proposal and support documents are attached.

<table>
<thead>
<tr>
<th>Stages of Consideration</th>
<th>Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Proposal Received</td>
<td>12/1/17</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>
| ACAP Consideration                       | 1/26/17| The Clemson University representative introduced the proposed Master of Engineering program, explaining it is an interdisciplinary degree for working professionals that would be offered exclusively 100% online. Moreover, he explained this degree was indicated as “in demand” by workforce contacts and that the field was growing by 85 jobs per year in South Carolina.

Commission staff inquired about the differential tuition in the proposal and the representative clarified that the differential refers to the graduate assistants who will help provide instruction.

ACAP members noted that the workforce data was focused exclusively on South Carolina and encouraged the representative to complement this with Southeast regional data as well.

After remaining discussion, ACAP voted to approve the program proposal. Staff transmitted remaining questions for additional clarity.

Comments and suggestions from CHE staff sent to the institution | 2/1/17 | Staff requested the proposal be revised to address the following information:
• Update the employment chart to include a more thorough explanation of total positions available annually;
• Review the projected enrollment chart for accuracy and explain how the projections were calculated;
• Provide a list of program-specific fees and describe fee usage; And, given the net total of financing minus costs, explain why fees are necessary to support the program;
• Explain the increases and decreases in costs for the graduate assistants;
• Clarify whether this program uses differential tuition, and, if so, briefly include the rationale for setting tuition rates; and
Review

Proposal consideration focused on accurate budget projections, opportunities for marketing and industry partnerships, and employing graduate students to deliver the curriculum. Institution representatives responded satisfactorily by ensuring the qualifications of graduate teaching assistants, and elaborating on the programs’ intentions regarding marketing of the program and future workforce partnerships. Representatives also revised the budget justification to clarify fee schedules and tuition rates.

Recommendation

The Committee on Academic Affairs and Licensing recommends the Commission approve the program leading to the Master of Engineering in Civil Engineering with a concentration in Risk Engineering and System Analytics to be implemented in Fall 2017.
Name of Institution
Clemson University

Name of Program (include concentrations, options, and tracks)
Master of Engineering: Civil Engineering with a concentration in Risk Engineering & System Analytics (M. Eng)

Program Designation
- Associate's Degree
- Bachelor's Degree: 4 Year
- 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
08/01/2017

CIP Code
14.0801

Delivery Site(s)
Clemson University Main Campus (Clemson, SC)
Online Distance Education

Delivery Mode
- Traditional/face-to-face*
- Distance Education
  - 100% online
- Blended (more than 50% online)
- Other distance education

Program Contact Information (name, title, telephone number, and email address)
Dr. Hsein Juang, RESA Faculty Lead and Glenn Professor of Civil Engineering, (864) 656-3322, hsein@clemson.edu
University Contact: Dr. Jeremy King, Associate Provost for Institutional Effectiveness, (864) 656-4592, jking2@clemson.edu

Institutional Approvals and Dates of Approval
University Graduate Curriculum Committee (11/11/16)
College of Engineering, Computer, and Applied Sciences, College Curriculum Committee (10/21/16)
President, 4/1/2016
Provost, 4/1/2016
University Board of Trustees (4/12/16)
Background Information

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

The Master of Engineering in Civil Engineering with a concentration in Risk Engineering & System Analytics is a multidisciplinary study developed by faculty in the Department of Civil Engineering in collaboration with other engineering and non-engineering faculty. This master's program is closely tied to the Center for Risk Engineering and Systems Analytics (RESA), which is run mainly by the faculty in the Department of Civil Engineering. This master's program is developed to integrate interdisciplinary education and research efforts in risk-related science and engineering to improve the understanding of risks linked to natural and man-made phenomena, mitigate their effects, and to better prepare for, respond to, and recover from disasters.

Risk engineering and analytics is used by insurance and reinsurance companies as part of their strategic planning and execution. While significant advancements have been achieved in evidence-based risk management and decision making, utilizing advanced analytics and incorporating real-time information to target specific economic goals is still in its infancy. This master's program is designed with input from industry leaders and targeted toward post-baccalaureate working professionals in this growing area. The industries that benefit most from the program include civil engineering, healthcare, nuclear and power, logistics, transportation, workplace safety, and natural and man-made hazard management.

The proposed program supports Clemson University's 2020 Forward foundation of research by creating opportunities for "unique public/private partnerships driven by the University's Innovation Campuses." This master's program will be offered to our Center's partner, American International Group (AIG), and will be marketed and presented to other local and global organizations.

List the program objectives. (2000 characters)

This master's program is aimed at offering an interdisciplinary education on risk engineering and system analytics, providing students with the knowledge and capability to become experts in their profession, and developing a workforce for risk-related industries. The emphasis of this program is on both analytical skills and practical ability for real world risk assessment and management. The specific objectives of this program are as follows:

1. Provide the comprehensive knowledge and analytical skills on uncertainty analysis, problem identification, and risk model development.
2. Offer the latest theories, methods and tools for risk assessment and risk management.
3. Teach the students the science behind, and strategies for, effective risk communication.
4. Provide the knowledge on evidenced-based risk management programs for natural and man-made catastrophe, and apply risk management to a specific domain.
5. Teach the students the cutting-edge knowledge and technologies for data analysis and system analytics.
6. Develop strategies and approaches for enhancing risk management and decision making using data analysis technologies.
7. Equip the students with expertise and capability to work in the risk related profession such as underwriters, risk analysts, risk managers, and decision makers.
8. Prepare the students as leaders in their professional and civic communities.
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)

As part of the Center for Risk Engineering and Systems Analytics (RESA) relationship with its corporate partner American International Group (AIG), identified an industry need for a professional degree in risk engineering and system analytics. This master’s program will introduce professionals to measures of risk related to natural hazards that impact our state and region including hurricane modeling, flood risk analysis, and earthquake models. An introduction to the risks associated with human error, supply chain, and data mining will better equip professionals in the healthcare, nuclear, and other related fields in risk mitigation and management. Emphasis on civil engineering will also equip transportation engineers and urban developers with a means to prepare for and mitigate risk.

This program will initially target our RESA Center’s industry partner, American International Group (AIG), as part of our larger partnership with this organization. Surveys and analysis with AIG indicates that 5-10% of professionals in the risk related fields will benefit from a graduate degree in risk engineering and system analytics, which in their organization alone amounts to 3,000-6,000 employees. Indeed, the strong interest of AIG in this master's program partially reflects the huge demand from the market for this program.

This program will appeal to professionals throughout the state. Subsequent offerings and marketing to other organizations and students will occur. Professionals at the Savannah River Site, employees of distribution centers across the midlands, the aerospace industry centered in Charleston, professionals of General Electric across the state, professionals at BMW and Fluor in Upstate, to name just a few, will all benefit from this program.

Graduates of this program will be able to find employment or advance to senior leadership positions in risk-related industries. Employment opportunities abound worldwide in many industries for these roles, including insurance, civil engineering, healthcare, nuclear and power, logistics, transportation, workplace safety, and natural and man-made hazard management.

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

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Expected Number of Jobs</th>
<th>Employment Projection</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction and extraction</td>
<td>34 / year</td>
<td>Increase by 22.91%</td>
<td>2015 South Carolina Economic Analysis Report</td>
</tr>
<tr>
<td>Architecture and engineering</td>
<td>8 / year</td>
<td>Increase by 10.84%</td>
<td>2015 South Carolina Economic Analysis Report</td>
</tr>
<tr>
<td>Management</td>
<td>15 / year</td>
<td>Increase by 6.76%</td>
<td>2015 South Carolina Economic Analysis Report</td>
</tr>
<tr>
<td>Production</td>
<td>18 / year</td>
<td>Increase by 4.92%</td>
<td>2015 South Carolina Economic Analysis Report</td>
</tr>
</tbody>
</table>

Provide additional information regarding anticipated employment opportunities for graduates.

This program intends to develop a workforce with knowledge in both engineering and risk management. For the occupations listed on the 2015 South Carolina Economic Analysis Report (SCEAR2015), construction and extraction, architecture and engineering, management, and production are fields directly influenced by the proposed master’s program. The employments in these four fields are expected to increase from 2012 to 2022 by 22.91\%, 10.84\%, 6.76\%, and 4.92\%, respectively. The corresponding numbers of employments increase in these fields are 16989, 4160, 7419, and 8889, respectively. We estimate in these fields, 2\% of positions are for graduates with expertise in risk engineering and system analytics. The total number of positions per year related to this program is thus estimated to be 75. Following the same methodology, the employment opportunities in the Southeast outside South Carolina is estimated to be 1100 based on projection data from Department of Labor from different states.
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.

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

☐ Yes

☒ No (It is offered online to targeted groups that are not, and will not be, served by existing programs)

If yes, explain. (500 characters)
<table>
<thead>
<tr>
<th>Program Name</th>
<th>Institution</th>
<th>Similarities</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Engineering (MS)</td>
<td>Clemson University</td>
<td>Both existing Civil Engineering programs and the proposed RESA program aim to develop experts in the engineering field. Both require sound background knowledge in engineering science, advanced mathematics, and basic science.</td>
<td>The existing MS civil engineering programs intend to develop graduates with expertise in fields such as structural, transportation, environmental, water, and geotechnical engineering. The proposed RESA program is focused on risk modeling and system analytics as applied to civil and other engineering fields and non-engineering fields.</td>
</tr>
<tr>
<td></td>
<td>University of South Carolina</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The Citadel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk Engineering (PBCERT)</td>
<td>Clemson University</td>
<td>Risk Engineering is a certificate program that is the foundation for the proposed master's program on Risk Engineering and System Analytics.</td>
<td>Risk Engineering is a certificate program that is the foundation for the proposed master's program on Risk Engineering and System Analytics. With additional courses in system analytics and other courses covering more general theories and tools for risk management, the proposed program offers a complete and unique risk-focused Master of Engineering degree program.</td>
</tr>
<tr>
<td>Risk Management and Insurance (BSBAdm)</td>
<td>University of South Carolina</td>
<td>Both programs centers on risk management and insurance. Both require sound background in advanced mathematics and basic science. Risk engineering and management is an important field of future employment opportunities.</td>
<td>The existing program is for the BSBAdm degree. It focuses on risk associated with management and finance. The proposed program is for a Master of Engineering degree. The proposed program is closely related to risk associated with natural and engineering systems.</td>
</tr>
<tr>
<td>Data Science (BS)</td>
<td>College of Charleston</td>
<td>Both programs intend to develop graduates with expertise in extracting information from data. Both require background in advanced mathematics and basic science.</td>
<td>The existing program is a BS program that focuses on developing skills of mathematics and computer science. Background on engineering and natural catastrophe, and risk and insurance is not required. The proposed program is a master's program focusing on risk engineering and management and evidence-based decision making with analytics skills, in which data mining is one of the tools.</td>
</tr>
</tbody>
</table>

The table above provides a list of similar programs in South Carolina, along with their institutions and attributes, highlighting the similarities and differences between the programs.
Description of the Program

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Spring</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Headcount</td>
<td>Credit Hours</td>
<td>Headcount</td>
</tr>
<tr>
<td>2017</td>
<td>15</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>30</td>
<td>90</td>
<td>15</td>
</tr>
<tr>
<td>2019</td>
<td>45</td>
<td>135</td>
<td>30</td>
</tr>
<tr>
<td>2020</td>
<td>60</td>
<td>180</td>
<td>45</td>
</tr>
<tr>
<td>2021</td>
<td>60</td>
<td>180</td>
<td>60</td>
</tr>
</tbody>
</table>

Note: In year one, we will not have students enrolled in the spring and summer terms (i.e., student enrollment starts in the fall of year one). Projections were calculated based on demand from industry partners and infrastructure in place to offer the program. Students will only complete 3-credit hours per semester, it is a part-time online program for working professionals. We do not anticipate having students attempt more than one course per semester while working full-time.

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)

Students will be accepted into the program based on the following criteria:

- Meeting all applicable Graduate School requirements for admission
- Application for admission approved by a subcommittee of the Graduate Program Committee of the Department of Civil Engineering
- At least two years of risk-related industry experience
- Applicants GRE scores may be waived if they have completed prior related graduate courses with grades of B or better at Clemson University.

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
The curriculum consists of 19 hours of core course work and 12 hours of electives selected by the student and his/her graduate advisory committee.

### Curriculum by Category

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours*</th>
<th>Required</th>
<th>Electives</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 8560</td>
<td>Human Factors in Risk Engineering</td>
<td>3</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>CE 8570</td>
<td>Fundamentals of Uncertainty Modeling</td>
<td>3</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>CE 8580</td>
<td>Fundamentals for Risk Engineering</td>
<td>3</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>CE 8590</td>
<td>Quantitative Methods in Risk Engineering</td>
<td>3</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>CE 8500</td>
<td>Design Thinking for Risk Engineering</td>
<td>3</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>CE 8700</td>
<td>Capstone Design for Risk Engineering</td>
<td>4</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>CE 8450</td>
<td>Data Mining for System Analytics</td>
<td>3</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CE 8470</td>
<td>Optimization Support Systems</td>
<td>3</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CE 8480</td>
<td>Risk Analytics in Supply Chains</td>
<td>3</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CE 8490</td>
<td>Enterprise Risk Analytics</td>
<td>3</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CE 8420</td>
<td>Natural Catastrophe Risk Analytics</td>
<td>3</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

**Total Credit Hours Required**
31
# Course Descriptions for New Courses

The following courses have been approved by the curriculum committees and are ready for implementation on approval of the degree program.

<table>
<thead>
<tr>
<th>Course Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CE 8500: Design Thinking for Risk Engineering</strong></td>
<td>Design thinking methodology introduced in the context of risk engineering. Emphasis on understanding risk engineering challenges, exposure to tools, brainstorming solutions, designing systems, and engage in continuous short cycle innovation process to continually improve the design. Course offered as contract online course to industry clients, enrollment limited to industry professionals.</td>
</tr>
<tr>
<td><strong>CE 8700: Capstone Design for Risk Engineering</strong></td>
<td>Students solve open-ended, real world engineering problems. Team-project including development, project management, and economic decision making. Design and report methodologies for use in work-related projects. Communication skills reinforced through presentation of reports. Course offered as contract online course to industry clients, enrollment limited to industry professionals.</td>
</tr>
<tr>
<td><strong>CE 8450: Data Mining for System Analytics</strong></td>
<td>Essential theoretical and practical techniques in data mining, including fundamental concepts in data mining, data preprocessing, characterization and comparison, frequent pattern analysis, classification and prediction, cluster analysis, hypotheses evaluation, feature extraction, outlier analysis, and dimensionality reduction. Course offered as contract online course to industry clients, enrollment limited to industry professionals.</td>
</tr>
<tr>
<td><strong>CE 8470: Optimization Support Systems</strong></td>
<td>Development of optimization models to aid in complex decision-making and mitigate risk. Risk measures of basic stochastic and robust optimization models. Soft constraints to measure risk. Implementation of models in software systems in decision support systems. Course offered as contract online course to industry clients, enrollment limited to industry professionals.</td>
</tr>
<tr>
<td><strong>CE 8480: Risk Analytics in Supply Chains</strong></td>
<td>Supply chain risk management principles reviewed with an emphasis on the identification, mitigation, and measurement of disruptions on potential supply chain scenarios. Disruptions and risks covered will include those linked to both natural and manmade risks. Course offered as contract online course to industry clients, enrollment limited to industry professionals.</td>
</tr>
<tr>
<td><strong>CE 8490: Enterprise Risk Analytics</strong></td>
<td>Study of enterprise risk-management (ERM); ERM process; ERM frameworks, including cooperate governance, line management, portfolio management, risk transfer, and risk analytics; ERM applications including: credit, market, operation risk, business applications, and financial institutions; ERM implementation. Course offered as contract online course to industry clients, enrollment limited to industry professionals.</td>
</tr>
<tr>
<td><strong>CE 8420: Natural Catastrophe Risk Analytics</strong></td>
<td>Fundamentals of natural catastrophe modeling, derivation of exceedance probability curve, hazard model, inventory model, vulnerability model, loss model, sources and impact of uncertainties, applications of catastrophe modeling to hurricane and earthquake hazards. Course offered as contract online course to industry clients, enrollment limited to industry professionals.</td>
</tr>
</tbody>
</table>
### Faculty and Administrative Personnel

<table>
<thead>
<tr>
<th>Rank</th>
<th>Full- or Part-time</th>
<th>Courses Taught or To be Taught, Including Term, Course Number &amp; Title, Credit Hours</th>
<th>Academic Degrees and Coursework Relevant to Courses Taught, Including Institution and Major</th>
<th>Other Qualifications and Comments (i.e., explain role and/or changes in assignment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Coordinator Professor 1</td>
<td>Full-time</td>
<td>CE 8580: Fundamentals of Risk Engineering (3)-Summer</td>
<td>Ph.D. Civil Engineering, Purdue University&lt;br&gt;M.S. Civil Engineering, National Cheng Kung University&lt;br&gt;B.S. Civil Engineering, National Cheng Kung University</td>
<td>Professor jointly employed by the Department of Civil Engineering and RESA. Professor serves in a leadership capacity for M. Eng and for international collaboration initiatives.</td>
</tr>
<tr>
<td>Professor 2</td>
<td>Full-time</td>
<td>CE 8450: Data Mining for System Analytics (3)-Spring</td>
<td>Ph.D. Computer Science, University of Central Florida&lt;br&gt;M.S. Computer Science, University of Science and Technology of China&lt;br&gt;B.S. Computer Science, University of Science and Technology of China</td>
<td>Professor to teach course on an overload basis as necessary.</td>
</tr>
<tr>
<td>Professor 3 &amp; Chair (IE)</td>
<td>Full-time</td>
<td>CE 8470: Optimization Support Systems (3)-Summer</td>
<td>Ph.D. Industrial and Systems Engineering, Virginia Tech&lt;br&gt;B.S. Mathematical Sciences, Clemson University</td>
<td>Professor to teach course on an overload basis as necessary.</td>
</tr>
<tr>
<td>Professor</td>
<td>Full-time</td>
<td>Course</td>
<td>Degree Details</td>
<td>Notes</td>
</tr>
<tr>
<td>-------------------------------</td>
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<td>-------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Professor 4</td>
<td></td>
<td>CE 8480: Risk Analytics in Supply Chains (3)- Fall</td>
<td>Ph.D. Industrial Engineering, Arizona State University</td>
<td>Professor to teach course on an overload basis as necessary.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M.S. Operations Research, The University of Texas at Austin</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>B.S. Mechanical Engineering, The University of Texas at Austin</td>
<td></td>
</tr>
<tr>
<td>Professor 5 &amp; Chair (CE)</td>
<td></td>
<td>CE 8420: Natural Catastrophe Risk Analytics (3)- Fall</td>
<td>Ph.D. Civil Engineering, Virginia Tech</td>
<td>Department chair and director of research center. To offer course on an overload basis.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M.S. Civil Engineering, Virginia Tech</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>B.S. Civil Engineering, Virginia Tech</td>
<td></td>
</tr>
<tr>
<td>Professor of Practice 1</td>
<td></td>
<td>CE 8570: Fundamentals of Uncertainty Modeling for Risk Engineering (3)- Fall</td>
<td>Ph.D. Civil Engineering, Georgia Tech</td>
<td>Professor will serve as instructor as part of regular course load or as overload as necessary.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M.S. Civil Engineering, Utah State University</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>B.S. Civil Engineering, Utah State University</td>
<td></td>
</tr>
<tr>
<td>Associate Professor 1</td>
<td></td>
<td>CE 8590: Quantitative Methods in Risk Engineering (3)- Spring</td>
<td>Ph.D. Civil Engineering, Michigan Tech</td>
<td>Professor will serve as instructor for course as part of regular course load or as overload as necessary.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M.S. Civil Engineering, Michigan Tech</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>B.S. Civil Engineering, Michigan Tech</td>
<td></td>
</tr>
<tr>
<td>Assistant Professor 1</td>
<td></td>
<td>CE 8560: Human Factors in Risk Engineering (3)- Fall</td>
<td>Ph.D. Industrial Engineering, Clemson University</td>
<td>Professor with joint appointment to Civil and Industrial Engineering. Will serve as instructor as part of regular course load or as overload as necessary.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CE 8500: Design Thinking for Risk Engineering (3)-</td>
<td>M.S. Industrial Engineering, Clemson University</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjunct 1</td>
<td>Part-time</td>
<td>Spring CE 8700: Capstone Design for Risk Engineering (4)-Summer</td>
<td>Spring CE 8490: Enterprise Risk Analytics (3)-Spring</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>-------------------------------------------------------------</td>
<td>--------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>University</td>
<td>Adjunct professor to teach course as overload, current appointment at other SC public institution.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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):

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Staff</th>
<th>Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>1.1</td>
<td>0.25</td>
</tr>
</tbody>
</table>

*No new hires (existing faculty and staff)

**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)

There will be no addition of new faculty and staff, or changes in administrative assignments as a result of implementing this program. Staff and faculty are already in place, funded, and prepared to assume the responsibilities of this program’s operations.

**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 library is a hub of strategic importance for research and scholarship in Clemson University. Currently, the Clemson University Library has over 1.6 million print volumes, 415,000 eBooks, 65,878 eJournals, and approximately 500 databases. There are more than 800 risk related books and journals in the Clemson library, which are enormous resources to support the proposed program. These library collections are sufficient for the proposed program. Additional resources, if needed, can be requested from the Interlibrary Loan Service provided by the Clemson University library, which enables all Clemson University students, faculty, and staff to borrow material from libraries around the world at no cost to them. Students both on and off campus have access to resources needed and the University has experience in delivering the resources to the students.

**Student Support Services**

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

All students are enrolled online and will receive support in the form of academic advising and mentoring from their course instructors, the program coordinator, and other staff members in the Civil Engineering department. Online course delivery is through the University’s Learning Management System (Blackboard and/or Canvas), with access to the library system. Further, Clemson Online, a unit to support delivering top-quality online courses, is available to students and instructors. The above services are well-established at Clemson and no additional costs will be incurred.
Physical Resources

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

There will be no new instructional equipment needed for the proposed program. The Civil Engineering department currently utilizes an Echo 360 lab to record lectures. Some faculty members also have access to Camtasia recording software. There are no additional required materials needed for lab demonstrations and course instruction.

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)

There are no additional facilities needed to support this program. All staff and faculty will be housed in existing office space, and all classes will be held online.
Financial Support

<table>
<thead>
<tr>
<th>Category</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Administration</td>
<td>$230,880</td>
<td>$379,275</td>
<td>$488,475</td>
<td>$512,850</td>
<td>$512,850</td>
<td>$2,124,330</td>
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<tr>
<td>Faculty and Staff Salaries</td>
<td>$192,894</td>
<td>$226,398</td>
<td>$260,255</td>
<td>$261,293</td>
<td>$286,756</td>
<td>$1,227,596</td>
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<tr>
<td>Graduate Assistants</td>
<td>$45,648</td>
<td>$57,040</td>
<td>$54,894</td>
<td>$43,133</td>
<td>$43,137</td>
<td>$243,852</td>
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<tr>
<td>Equipment</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Facilities</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Supplies and Materials</td>
<td>$10,205</td>
<td>$10,209</td>
<td>$10,214</td>
<td>$10,215</td>
<td>$10,215</td>
<td>$51,057</td>
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<tr>
<td>Library Resources</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$479,627</td>
<td>$672,922</td>
<td>$813,838</td>
<td>$827,491</td>
<td>$852,958</td>
<td>$3,646,834</td>
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</tbody>
</table>

Sources of Financing

<table>
<thead>
<tr>
<th>Category</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuition Funding</td>
<td>$786,000</td>
<td>$1,167,000</td>
<td>$1,503,000</td>
<td>$1,578,000</td>
<td>$1,578,000</td>
<td>$6,612,000</td>
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<tr>
<td>Program-Specific Fees</td>
<td>$1,520</td>
<td>$1,480</td>
<td>$1,520</td>
<td>$1,480</td>
<td>$1,480</td>
<td>$7,480</td>
</tr>
<tr>
<td>State Funding (i.e., Special State Appropriation)*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Reallocation of Existing Funds*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Federal Funding*</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Other Funding*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$787,520</td>
<td>$1,168,480</td>
<td>$1,504,520</td>
<td>$1,579,480</td>
<td>$1,579,480</td>
<td>$6,619,480</td>
</tr>
<tr>
<td>Net Total (i.e., Estimated New Costs Minus Sources of Financing)</td>
<td>$307,893</td>
<td>$495,558</td>
<td>$690,682</td>
<td>$751,989</td>
<td>$726,522</td>
<td>$2,972,646</td>
</tr>
</tbody>
</table>

*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.

The above budget considers a 5-year projection for revenues and costs associated with the Master of Engineering in Civil Engineering with a concentration in Risk Engineering & System Analytics. The budget years (e.g. 1st, 2nd, 3rd, 4th, and 5th) follow the academic calendar beginning in the Fall semester and ending in the summer semester of the subsequent year.

The following assumptions were considered in the development of this budget:

- Each new cohort will consist of 12-15 students.
- Development funds (e.g. $4000/course) are only anticipated for 2 courses, the remaining courses have already been developed.
- For each course offering, instructor salary and graduate teaching assistant costs are included. The cost for the graduate teaching assistant (not for the graduate students enrolled in this program) include stipend and tuition remission (GAD).
- A portion of RESA staff salaries are included to facilitate the management of the program, and normal university overhead is included.
- All courses in this MENGR program are offered online and do not use any physical facilities at Clemson University (other than the online delivery platform) and the tuition rate is different from that of standard Clemson tuition. Tuition rate has been set at $1,000 per credit hour (or $3,000 per 3-credit hour course) so that it is competitive with similar online courses offered on the market and enables the program to be self-sustaining and scalable to meet demand. This online program does not have a differential tuition (e.g., GAD) policy for its students.
- Application fee waivers expense will be recovered by direct invoices to industry partners.

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)

Program outcomes will be monitored and assessed by the Civil Engineering Department’s accreditation coordinator and faculty committee. Assessments and assignments associated with each learning outcome will be compiled, summarized, and analyzed with the assistance of the accreditation coordinator.

Faculty serving as instructors for each course will be asked to ensure their courses comply with professional standards and internal standards for the program. These courses will be assessed using a rubric, and feedback will be delivered to faculty. Additionally, faculty will continue to be reviewed by their respective departments as part of normal departmental processes. Staff members working for the program will undergo annual review in accordance with university and state guidelines.

Surveys and focus groups will be conducted with industry clients (employers) to ensure the program’s effectiveness. Student learning outcome assessments are detailed in the table below.
### Expected Student Learning Outcomes

| Students will be able to analyze and quantify different types of uncertainties, and develop risk models for real world problems. | 1. An exam or project from selected courses will be used as an assessment tool.  
2. Project assignment in Capstone course will be used as an assessment tool.  
4. Alumni of the program will be surveyed three years after completing the degree program. |
|---|---|
| Students will be able to perform risk assessment and management using different methods and tools. | 1. An exam or project from selected courses will be used as an assessment tool.  
2. Project assignment in Capstone course will be used as an assessment tool.  
4. Alumni of the program will be surveyed three years after completing the degree program. |
| Students will be able to develop science-based strategies to communicate risk with different shareholders efficiently and effectively. | 1. An exam or project from selected courses will be used as an assessment tool.  
2. Project assignment in Capstone course will be used as an assessment tool.  
4. Alumni of the program will be surveyed three years after completing the degree program. |
| Students will be able to develop evidence-based risk management programs for natural and man-made catastrophe, and apply risk management to a specific domain. | 1. An exam or project from selected courses will be used as an assessment tool.  
2. Project assignment in Capstone course will be used as an assessment tool.  
4. Alumni of the program will be surveyed three years after completing the degree program. |
| Students will be able to use cutting edge methods and technologies for data analysis and system analytics related to risk management. | 1. An exam or project from selected courses will be used as an assessment tool.  
2. Project assignment in Capstone course will be used as an assessment tool.  
4. Alumni of the program will be surveyed three years after completing the degree program. |
| Students will be able to enhance risk management through use of the latest tools and technologies of data analysis and system analytics. | 1. An exam or project from selected courses will be used as an assessment tool.  
2. Project assignment in Capstone course will be used as an assessment tool.  
4. Alumni of the program will be surveyed three years after completing the degree program. |
| Students will be able to enter risk-related professions such as underwriters, risk analysts, risk managers, and decision makers. | 1. Survey of graduating students.  
2. Alumni of the program will be surveyed three years after completing the degree program. |
| Students will be able to serve and become leaders in their professional and civic communities. | 1. Survey of graduating students.  
2. Alumni of the program will be surveyed three years after completing the degree program. |
Performance Targets for Assessment:

As the M-Eng program is started, the following assessment thresholds will be set. As with typical assessment efforts, these thresholds will be refined once some history has been established with the program.

1. For course artifacts, the performance target is that at least 90% of the students will perform at a satisfactory level or above (satisfactory performance is usually seen as a score of 80/100, but the actual level used will be set by the course instructor).
2. For the student and alumni surveys, the target threshold for any of the measures is that at least 75% of those surveyed either agree or strongly agree with the survey statements.

Assessment Frequency:

Evaluation of the performance measures will occur on an annual basis. However, the collection of the assessment data will be collected on the following schedule:
1. Scores on course artifacts will be collected at the time the course is taught
2. The graduating student survey will be conducted each semester that there is a graduating class
3. The alumni survey will occur on an annual basis.
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)

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)

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

Please attach a document addressing the South Carolina Department of Education Requirements and SPA or Other National Specialized and/or Professional Association Standards.
Dear Kimberly, John, and Argentini:

Please find attached the updated proposal for Clemson's M.Eng. Civil Engineering, Concentration in Risk Engineering & System Analytics. This proposal revision addresses the last two bullet points in your e-mail request of March 14. Responses to questions in the first four bullet points in your March 14 e-mail request are given below.

Please let me know if we can provide you and the Commission with any additional information.

Best wishes,

Jeremy

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- Please explain how graduate students will be involved with delivery of program curriculum and their qualifications to teach?

PhD students knowledgeable in the subject/content who are recommended by the instructor and approved by the Faculty Lead/Program Coordinator will serve as Teaching Assistants (TAs) for online classes offered by this MENGR program. TAs will assist faculty (instructor) with grading assignments and responding to student questions. TAs will not engage in instruction or record lectures for students.

- Does this program have any contracts with employers to credential its employees?

We have no contracts with any employers to credential employees. All applicable Graduate School policies regarding the admission and degree requirements at Clemson will be followed.

- Is this program available as a certificate program?

This online MENGR program is not a certificate program. However, some of the courses included in this MENGR program will be offered as part of other graduate certificates (including Risk Engineering) offered by the Civil Engineering Department at Clemson University. Recent changes in the Graduate School policy at Clemson that allow certificate credits to be used in graduate degree programs offer flexibility for working professionals who have previously taken Risk Engineering certificate coursework to apply this coursework complete their MENGR degree.

- What are the plans to market this program? Do you anticipate this program being widely marketed?

We plan to market this program to industry partners of Clemson’s Center for Risk Engineering & System Analytics and other companies in risk-related industries. We currently have one industry partner who is sponsoring a select group of
their 23,000 employees to pursue our Graduate Certificate in Risk Engineering. We anticipate adding other industry partners in the next few years as revenues are reinvested to scale up the program appropriately. Extensive public marketing is not envisioned at this time given captive large demand from industry.

- As you shared at CAAL, please revise the budget justification to include a detailed explanation of the fee schedule and why the tuition rate is different from that of standard Clemson tuition?
  Included under Budget Justification. Note that the Program-Specific Fees here are program application fees, and these are covered by industry employers—they are not borne by prospective students.

- Please revise the proposal narrative to address the industries that will be most interested in this program.
  Included under Assessment of Need

From: Kimberly Walker <kwalker@che.sc.gov>
Date: Tuesday, March 14, 2017 at 5:10 PM
To: Jeremy King <jking2@clemson.edu>
Cc: John Lane <jlane@che.sc.gov>, Argentini Anderson <aanderson@che.sc.gov>
Subject: M.Eng. Civil Engineering Concentration in Risk Engineering & System Analytics

Good afternoon Dr. King,
I hope this email finds you well. As discussed at CAAL, please further explain the questions or comments listed below:
  • Please explain how graduate students will be involved with delivery of program curriculum and their qualifications to teach?
  • Does this program have any contracts with employers to credential its employees?
  • Is this program available as a certificate program?
  • What are the plans to market this program? Do you anticipate this program being widely marketed?
  • As you shared at CAAL, please revise the budget justification to include a detailed explanation of the fee schedule and why the tuition rate is different from that of standard Clemson tuition?
  • Please revise the proposal narrative to address the industries that will be most interested in this program.

The only sections of the proposal that need to be updated are the narrative in order to indicate industries that will be most interested in this program and the budget justification detailing the fee schedule, as discussed at CAAL. Please provide this information back to me no later than 5 pm on Tuesday March 21, 2017.

Thank you,
Kimberly Young Walker, PhD
Academic Program Manager
Academic Affairs
South Carolina Commission on Higher Education
1122 Lady Street
Columbia, SC 29201
803.737.3217
www.che.sc.gov