University Council

March 10, 2023

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Dear Colleagues:

The attached proposal from the College of Engineering to offer a new Undergraduate Certificate in Electric Mobility will be an agenda item for the March 17, 2023, Full University Curriculum Committee meeting.

Sincerely,

Susan Sanchez, Chair

cc: Provost S. Jack Hu
Dr. Marisa Pagnattaro

PROPOSAL FOR UNDERGRADUATE CERTIFICATE

Date: February 17, 2023

School/College/Unit: College of Engineering

Department/Division: School of Electrical and Computer Engineering

Certificate Title: Undergraduate Certificate in Electric Mobility

Effective Term: Fall 2023

Which campus(es) will offer this certificate? Athens

Level (Undergraduate, Graduate, or Post-Baccalaureate): Undergraduate

CIP: 14410101

Proposal Abstract:
Electronic mobility is an emerging field that combines the technologies, infrastructure, and public policy initiatives associated with the design, deployment, and use of electric propulsion. The certificate provides engineering students with the opportunity to specialize their engineering program of study towards applications in electronic mobility. Based on a program of study that guides students' selection of technical elective credits and the focus of their capstone project, the electronic mobility certificate requires 13 hours of coursework and is open to all engineering students. Admission to the certificate program is based on expression of interest during the regular engineering capstone project selection phase that occurs during the first week of the required engineering capstone course. Completion of the certificate program requires successful completion of ENGR 3620, Introduction to E-Mobility, completion of two other elective courses from a list technical elective courses, and completion of a capstone project focused on an electronic mobility application area. Students who earn the electronic mobility certificate will be well positioned to enter the engineering workforce with companies or government agencies that are focused on electronic mobility application areas.

1. Purpose and Educational Objectives

State the purpose and educational objectives of the program. How does this program complement the mission of the institution?

This certificate is designed to educate students on the technologies that comprise electric mobility and its supporting infrastructure, and to introduce students to aspects of policy that pertain to electric mobility adoption. In addition to providing a fundamental understanding of electric mobility, this certificate will also provide engineering students with the coursework and project experience that will prepare them for jobs in the growing electric mobility sector.

The following Program Educational Objectives relate to the knowledge, skills, and behaviors that UGA College of Engineering alumni with an engineering degree and the certificate in electric mobility should demonstrate as they move through their careers as engineers working in the electric mobility sector:

- Demonstrate a high level of expertise to create designed solutions that address needs for the development of electric mobility-based systems.
- Establish themselves in positions of leadership in their profession and their community.
- Maintain the integrity of the engineering profession and the field of electric mobility by passing on knowledge and skills associated with electric mobility.

2. Need for the Program

Explain why this program is necessary. In addition, provide the following information:

a. Semester/Year of Program Initiation: Fall 2023
b. Semester/Year of Full Implementation of Program: Academic Year 2023-2024
c. Semester/Year First Certificates will be awarded: Spring 2024
d. Annual Number of Graduates expected (once the program is established): 15-20
e. Projected Future Trends for number of students enrolled in the program: 25/year

The adoption of electric mobility for transportation is being accelerated by advances in key technologies and significant private and public investment. Battery technology - often cited as a limiting factor in the widespread use of electric vehicles - has advanced to the point where it has the energy storage capacity and form factor to enable the design of electric vehicles that rival the performance of vehicles that utilize internal combustion engines. Private investment by legacy vehicle manufacturers and new firms has created the manufacturing base required to sustain the industry. Public investment at the federal and state level is rapidly creating the charging infrastructure needed to support the widespread use of electric vehicles.

Electric mobility is having a profound impact on economic development in Georgia. The state is rapidly becoming a manufacturing hub for the industry due to private investment by firms such as SK Battery America, Rivian, Hyundai, and Ascend Elements. These investments are occurring parallel to government programs that promote future expansion in the state, e.g., the 2021-2022 Electric Mobility Innovation Alliance sponsored by the Governor, and possible legislation that creates additional incentives for the expansion of electric mobility in Georgia. Significant action is also occurring at the local level as communities understand how new resources can help them transition their infrastructure to support electric vehicle adoption and usage.

Based on the growing demand for technologies that support electric mobility and the realization that electric mobility is rapidly becoming a significant economic driver, the Georgia Department of Economic Development has been spearheading efforts to position Georgia as a national leader in electric mobility. As a result, companies are beginning to establish or expand their operations in electric mobility technologies and services. With this growth in electric mobility capabilities across the state, there is an increasing demand for engineers with the specialized skills that are needed to produce core electric mobility technologies as well as design and deploy electric mobility systems. To support this workforce need, this proposed certificate program provides coursework and design project

experiences that will help students add electric mobility specialization to their undergraduate engineering degree.

The School anticipates initiation of this certificate in fall 2023 with full implementation being achieved during the 2023-2024 academic year. With the initial offering of ENGR 3620, Introduction to E-Mobility, in spring 2023, all courses required for implementation of the certificate are approved and being regularly offered. The School further anticipates awarding the first certificates in spring 2024.

A recent survey of students who are currently enrolled in the initial offering of ENGR 3620, Introduction to E-Mobility, had 42 responses from the 46 students registered in the course. Half of the responses (21 of 42) indicated an interest in pursuing the certificate. Of those, two of the students expect to graduate in May 2023. Two students plan to take their capstone in the 2024-2025 academic year and 17 students are planning to take their capstone in the 2023-2024 academic year. Thus, it is anticipated 15-20 students will pursue the certificate program in the initial offering year. The School is currently working on scheduling strategies to increase capacity for ENGR 3620, which had a waitlist in spring 2023. This should allow an enrollment of approximately 60 students in ENGR 3620 in future semesters. Based on the distribution of responses to the electric mobility interest survey, a slight increase in student enrollment to approximately 25 students completing the certificate program annually once the program reaches steady state is projected.

3. Student Demand

a. Provide documentation of evidence of student demand for this program, including a student survey.

b. Provide evidence that demand will be sufficient to sustain reasonable enrollment.

c. To what extent will minority student enrollments be greater than, less than, or equivalent to the proportion of minority students in the total student body?

As a precursor to the development of this undergraduate certificate program, the course ENGR 3620, Introduction to E-Mobility, was proposed and approved in the fall of 2022. The course is being offered for the first time in spring 2023. Scheduled in the largest computer-supported classroom available in the College of Engineering, the course enrollment for this initial offering is capped at the maximum room capacity of 46. With seven students on the waitlist for this initial offering, current student demand for the course exceeds 50 students. The School is already considering course scheduling and/or course implementation changes that will increase capacity to approximately 60 students.

As previewed in the previous section, the current cohort of ENGR 3620 students were recently surveyed regarding their interest in an electric mobility certificate. The survey had a 91% response rate (42 out of 46 students currently enrolled in the course responded to the survey). The survey results suggest that half of the student would be interested in pursuing the certificate. As detailed above, 17 of the 21 anticipate taking their capstone course and completing the certificate in the 2023-2024 academic year.

Students were also asked to suggest topic areas for the capstone project. Responses included:

- Interest in engineering policy work
- Design of new electric propulsion systems,

- Design of electric vehicles including E-bikes and other E-Vehicles including automotive, truck and bus.
- Design of next generation E-charging stations.
- Impact of electric mobility on exiting and next generation electric grid capabilities.

The College of Engineering capstone project coordination team has already initiated a planning cycle to identify corporate-sponsored capstone projects that can meet the interest areas expressed in this student survey.

Given the current high societal demand for electric mobility systems and the increased awareness among engineering disciplines for the need to focus training in this emerging area, it is reasonable to assume that the level of interest in this certificate will remain high. This conclusion is independently supported by the increased demand for participation in an Electric Mobility Summit (http://engineering.uga.edu/electric-mobility-summit) coordinated by the College of Engineering. Although this event is focused more on electronic mobility stakeholder engagement than student learning opportunities, the Electric Mobility Summit has seen significant expansion in planned participation that extends regionally beyond the state of Georgia. In general, the participants in the Electric Mobility Summit are a large cross section of the companies and government agencies who are likely to employ the students completing the electronic mobility certificate.

Assuming the survey results are indicative of future demand for the certificate, an enrollment of 60 students in ENGR 3620 would suggest a steady state demand for the certificate of 23-28 students per year. The certificate and capstone coordination teams feel that this level of program enrollment is easily sustainable into the foreseeable future.

It is anticipated that enrollment of underrepresented students in the electric mobility certificate will be equivalent to the enrollment of underrepresented student in the College of Engineering degree programs.

4. Program of Study

Provide a detailed program of study for the certificate program, including:

a. Specific course prefixes, numbers, and titles

b. Identify any new courses created for this program

The program of study for the undergraduate certificate in electric mobility is designed such that an engineering student can earn the certificate by selecting their technical electives and focusing their required Engineering Capstone Project on the field of electric mobility.

The certificate program of study requires completion of 13 hours of coursework as defined below:

1) ENGR 3620, Introduction to E-Mobility (3 hours)
2) Select two courses from the following list of electric mobility-related technical elective courses (6 hours total).
    - CVLE 4210/6210, Transportation Engineering (3 hours)
    - CVLE 4220/6220, Highway Design and Traffic Safety (3 hours)
    - ELEE 4710, Fundamentals of Power Engineering (3 hours)
    - ELEE 4720, Electrical Machines (3 hours)

- ELEE 4745, Power Electronics (3 hours)
- ELEE 4750, Power System Analysis (3 hours)
- ENVE 4230/6230, Energy in Nature, Civilization, and Engineering (3 hours)
- ENVE 4250, Energy Systems and the Environment (3 hours)
- ENVE 4530/6530, Energy and Environmental Policy Analysis (3 hours)
- ENVE 4550/6550, Environmental Life Cycle Analysis (3 hours)
- ENVE 4720, Urban Infrastructure Planning and Development (3 hours)
- MCHE 4410, Industrial Process Design (3 hours)
- MCHE 4420, Industrial Controls (3 hours)
- MCHE 4820, Mechatronics (3 hours)
- MCHE 4860/6860, Advanced Vehicle Manufacturing (3 hours)

3) Complete a 2-semester Engineering Capstone Experience (4 hours) in the student's major discipline with a project focus on an electric mobility design problem. Any of the following capstone design sequences are acceptable for meeting this requirement:
    - AENG 4910, Capstone Design I, and AENG 4911, Capstone Design II
    - BCHE 4910, Capstone Design I, and BCHE 4911, Capstone Design II
    - BIOE 4910, Capstone Design I, and BIOE 4911, Capstone Design II
    - CVLE 4910, Capstone Design I, and CVLE 4911, Capstone Design II
    - CSEE 4910, Capstone Design I, and CSEE 4911, Capstone Design II
    - ELEE 4910, Capstone Design I, and ELEE 4911, Capstone Design II
    - ENVE 4910, Capstone Design I, and ENVE 4911, Capstone Design II
    - MCHE 4910, Capstone Design I, and MCHE 4911, Capstone Design II

Regardless of engineering discipline, the capstone sequence requires a 2-hour course offered in the fall (XXXX 4910) and a 2-hour course offered in the spring (XXXX 4911).

It should be noted that all of the courses listed above already exist and are regularly offered as technical elective courses that can be selected by engineering students. While the list of courses above is a subset of the technical elective courses available to engineering students, this list constitutes a set of elective topics that a relevant to the electronic mobility certificate program. As the implementation of the electronic mobility certificate does not require the creation of any new courses, it is anticipated the electronic mobility certificate will be fully implemented upon approval and graduate the first students in the certificate program by the end of the first academic year after implementation.

5. Model Program and Accreditation

a. Identify any model programs, accepted disciplinary standards, and accepted curricular practices against which the proposed program could be judged. Evaluate the extent to which the proposed curriculum is consistent with these external points of reference and provide a rationale for significant inconsistencies and differences that may exist.

b. If program accreditation is available, provide an analysis of the ability of the program to satisfy the curricular standards of such specialized accreditation.

While there are a few institutions, mostly European, that offer coursework targeted specifically in electric mobility, there is not currently a model program, standard, or accepted

curricular practice that defines expectations for training in electronic mobility. Similarly, there are not any program accreditation bodies focused specifically on electronic mobility.

6. Student Learning Outcomes

Describe the proposed learning outcomes for the certificate program.

Students who complete the electric mobility certificate will be able to:

1) Identify and explain the use of various technical components in an electronic mobility system.
2) Summarize the historical, public policy and core technical knowledge necessary to communicate effectively with engineers and the broader community on electric mobility topics.
3) Apply specialized technical knowledge enabling them to relate their specific engineering degree to applications in electric mobility.
4) Demonstrate engineering design skills associated with electronic mobility applications.

7. Assessment and Admissions

Describe how the learning outcomes for the program will be assessed. Describe the process and criteria for how students will be admitted to and retained in the program.

Assessment of engineering courses follows student outcome assessment practices that align with ABET (the accrediting body that accredits post-secondary education programs in applied and natural sciences, computing, engineering, and engineering technology). ABET has proscribed definitions of student outcomes and requires all ABET accredited programs to maintain a continuous improvement process that involves routine assessment of these student outcomes. Thus, this certificate will use ABET student outcome assessment data that are collected by each degree program from their capstone design sequence (see list of prefixes in the program of study section). To meet ABET accreditation requirements, students are assessed against the following student outcomes as defined by ABET:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. an ability to communicate effectively with a range of audiences.
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

These 7 ABET student outcomes can be mapped to the Student Learning Outcomes associated with this certificate program using the following table:

E-Mobility Student Learning Outcome	Related ABET Student Outcome
1) Identify and explain the use of various technical components in an electronic mobility system	ABET SO #1, ABET SO #2
2) Summarize the historical, public policy and core technical knowledge necessary to communicate effectively with engineers and the broader community on electric mobility topics.	ABET SO #3, ABET SO #4
3) Apply specialized technical knowledge enabling them to relate their specific engineering degree to applications in electric mobility.	ABET SO #1, ABET SO #2,
4) Demonstrate engineering design skills associated with electronic mobility applications.	ABET SO #5, ABET SO #6, ABET SO #7

Completion of a capstone sequence (XXXX 4910/4911) is a degree requirement for all engineering undergraduate degrees. In the existing capstone process, the capstone coordination team identifies both internal and external/corporate sponsored projects each year during the summer. In the first week of the XXXX 4910 course, students express their interest level in the identified projects, and the capstone instructors determine capstone project team assignments such that students are assigned to work on one of their high interest projects over the two-course capstone sequence.

To facilitate enrollment into the electronic mobility certificate program, the capstone project interest survey, completed by student in the first week of the XXXX 4910, will be modified to allow students to indicate interest in pursuing the electronic mobility certificate. Students who indicate an interest in pursuing the electronic mobility certificate will then be admitted to the electronic mobility certificate program and given priority for assignments on electronic mobility projects.

The School does not currently anticipate using a formal application process or a GPA requirement for admission to the certificate program; all students who express an interest in pursuing the electronic mobility certificate on the capstone project interest survey will be admitted to the certificate program. Should demand for the electronic mobility reach a point where it exceeds the capacity of the capstone team to provide appropriate capstone project experiences in the electronic mobility space, then an application process would be put into place where a statement of interest, GPA and previous experience with electronic mobility could be evaluated to determine admission to the certificate program.

Completion of the electronic mobility certificate will be determined by successful completion of the courses identified in the certificate program of study. There is not a minimum grade requirement associated with completion of the certificate, however engineering degree completion requirements limit students to no more than two courses with a D grade.

Documentation of Approval and Notification

Proposal: Undergraduate Certificate in Electronic Mobility

College: College of Engineering

Department: School of Electrical and Computer Engineering

Proposed Effective Term: Fall 2023

Approvals:

- Electrical and Computer Engineering School Chair, Dr. Fred Beyette, 2/20/23
- College of Engineering Associate Dean, Dr. Ramaraja Ramasamy, 3/10/23