Five Year Planning Perspectives Cover Sheet and Instructions

The UC requires that faculty/unit administrators submit to the Campus Office of the Provost a brief (approximately 2 pages) summary of anticipated actions to transfer, consolidate, or disestablish graduate degree programs and academic units. This summary is the first step toward such actions and neither obligates proposers to follow through nor implies campus approval of the action once fully proposed.

Instructions
1. Complete this cover page including all signatures (Chair, Assistant Dean, Dean).
2. Address the attached questions required for the two page summary (See program summary format and example).
3. Submit this packet via email to the Office of Academic Planning at AcadPlan@uci.edu.

<table>
<thead>
<tr>
<th>Self-Supporting [Grad. Prof. only] (yes/no)</th>
<th>Professional Degree Supplemental Tuition [Grad. Prof. only] (yes/no)</th>
<th>Will all or part of the program be taught online? (yes/no)</th>
<th>If taught online, what percent of the program will be online?</th>
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<tr>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>25%</td>
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Chair Name: Vasan Venugopalan  
Chair Signature:  
Assistant Dean Name: Lorrie Aguirre  
Assistant Dean Signature:  
Dean Name: Magnus Egerstedt  
Dean Signature:
Two-Page Summary

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Campus: University of California Irvine

Name and Anticipated Action: Graduate Program in Electrochemistry & Electrochemical Engineering; PhD and MSc degrees; Henry Samueli School of Engineering

Description and Rationale for Anticipated Action: The graduate, predominantly PhD program in Electrochemistry & Electrochemical Engineering, supplemented by a MSc program (not considered as terminal Masters) is coming to solidify the excellence in electrochemical energy conversion engineering (hydrogen, fuel cells and electrolyzers), sustained contributions in electrochemical energy storage (battery) technology, CO2 capture and valorization, and emerging electrochemical manufacturing research as it relates to difficult to decarbonize sectors such as metallurgy, cement and ammonia manufacturing. These areas of research practiced by more than 18 faculty at UCI and some 12 of them from HSSE are currently in the focal point of national programs signified by the DOE EarthShots in (i) hydrogen technology, (ii) energy storage and (iii) carbon capture.

National move towards zero emission grid and low carbon technologies creates a most urgent demand in highly trained labor force to lead that change. National Academies of Science, Engineering and Medicine have identified electrochemistry as underlying science being fundamental to decarbonization technologies. California has a lead nationally in all these transitions and it is expected that substantial (up to 40%) of the new highly paid jobs will be related with the energy sector as understood broadly (including zero-emission transportation and low-carbon footprint manufacturing). With this UCI aims to establish the first in the nation PhD graduate program in Electrochemistry & Electrochemical Engineering and to ensure that the needs of the State are served, and national leadership upheld.

Relationship to Existing Campus Programs, Units, and Mission

From the interdisciplinary programs at UCI the closest in subject matter and breadth is Chemical, Applied, and Materials Physics (ChAMP), and interdisciplinary program, which is NOT a PhD/MS granting itself, but rather a focal point for cross-disciplinary students training. The program proposed here is to offer a degree, internationally recognizable (as several UK and EU institutions have a similar one) and to specifically train students in electrochemical sciences that (at first) address energy focus. With that, the existing Advanced Power and Energy Program (APEP) is the closest non-academic unit on campus (not offering a degree as well). APEP is being currently transformed into ORU under working title: Clean Energy Institute (CEI), which could offer some synergy in hosting, administrating and collaborating with the Electrochemistry & Electrochemical Engineering graduate program, mostly due to the fact that 5-6 critical faculty involved with the creation of the CEI are engaged as instructors in the core classes of the proposed PhD/MS graduate program. The mission of the graduate program is to prepare doctoral and MS-level participants in the most critical decarbonization sectors of the state and national economy; to uphold and further develop electrochemical science and a
fundamental interdisciplinary engineering science and to create the subdisciplines of this science as they relate to energy, sensors/actuators and water resource engineering.

**Resources:** Most of these faculty initially involved in program are from Departments of Chemical & Biomolecular Engineering (CBE) and Mechanical & Aerospace Engineering (MAE), with participation from Materials Science & Engineering (MSE) faculty as well. In future, a new component (concentration) in this program will be developed to embrace electrochemical sensor and biosensor engineering and this will add participation of faculty from Electrical Engineering & Computer Engineering (EECE) and Biomedical Engineering (BME). At its mature stage the program will also incorporate electrochemical and bio-electrochemical water treatment and remediation technologies and with that include faculty from Civil & Environmental Engineering (CEE) department as well. With this, at completion PhD/MSc program in *Electrochemistry & Electrochemical Engineering* will have participation from all HSSoE departments.

At present 3 CBE (Iryna Zenyuk, Plamen Atanassov and Vojislav Stamenkovic), 3 MAE (Marc Madou, Jack Brouwer, Yun Wang) and 1 MSE faculty are teaching classes from the domain of fundamental and applied electrochemistry, electrochemical engineering, electrochemical power systems and materials electrochemistry. This is complemented by an established Chemistry graduate course in electrochemistry (Chem-248) thought by Prof. Reg Penner and/or Prof. Shane Ardo for two decades, which can be a great bridge to Physical Sciences. Prof. Will Bowman and Prof. Allon Hochbaum (MSE) and Prof. Hung Cao (EECE) are considering offering elective courses in this area. Prof Zenyuk Electrochemical Engineering established undergraduate course will be upgraded to graduate introductory course, followed by Prof. Madou and Prof. Atanassov electrochemical thermodynamics and kinetics courses, followed by Prof. Stamenkovic electrochemical energy storage course and the fuel cell module of 4 courses offered for years by Prof. Brouwer and Prof. Wang. These courses will build the core of the electrochemical energy conversion and storage concentration of the program. All these courses are existing and thought several times.

**Funding:** We do not have external sources of funding at preset. Will apply for NSF and DOE support through graduate fellowship programs for the students. Component of the funding can be sought also through the intuitive for SoCal National Labs Hub (via LANL, LLNL and LBNL).

**Students:** Students currently enlisting in MAE 214A and MAE214B exceed 60. PhD students employed as GRA in the labs of the key faculty exceed 60. Thus, at least 20 students will be employed by the program (conservative estimate), growing to probably graduate 20 PhD students/year at its highest point (100 students in the program with 5 year-to-degree). As it will be the first national program in this area and in the area of maximal growth of the new energy technology, substantial number of transfers could be expected.

**Employment Opportunities:** SoCal is the “hotbed” for battery, electric/battery vehicle, and grid storage industry. National leadership will ensure placement of students in Bay Area with electrolyzer and materials companies and penetrating Massachusetts/New England and Connecticut electrolyzer, battery and fuel cell industry markets. Substantial number of PhD graduates will go to National Laboratories (increase in funding two-fold at least) and DOE. The program will have an entrepreneurship module to foster startup forming by graduates.

**Anticipated Campus Review and Implementation Dates:** June 2022 ready for review. We would like to start Fall 2022 with existing courses, which are already aligned. We have de facto though all the courses in the sequence already this academic year. We need the approval to start advertising and recruiting through offering of a minor to existing engineering programs.