A Proposal for an
NAE Grand Challenge Scholars Program
at the University of Maryland

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1.0 Background about NAE Grand Challenges
In 2008 a distinguished committee of experts convened by the National Academy of Engineering-NAE selected 14 major Grand Challenges for Engineering whose solutions were considered critical to the future well-being of humanity and the planet. The Grand Challenges range from advances to ensure sustainable life on the planet, to improving health outcomes for individuals through engineering, to addressing threats to our security generated by humans or nature, to engineering that amazes us in the way it improves our quality of life.

The goal of the NAE Grand Challenge Scholars Program is to prepare young engineers to confront these challenges with a multidisciplinary, socially aware, and entrepreneurial background. The Grand Challenge Scholars Program (GCSP) will increase the awareness of the next generation of engineers in the issues facing the world today through a broadened curriculum and diverse extracurricular components. Students successfully completing the program will be recognized by the National Academy of Engineering as Grand Challenge Scholars and we are requesting that they receive the transcript designation “NAE Grand Challenge Scholar”.

2.0 University of Maryland’s A. James Clark School of Engineering

Feeding the world’s population. Engineering new medicines. Developing dependable sources of renewable energy. The 21st century poses challenges as daunting as any in human history. To tackle them, we’ll need great engineers. “We must solve today’s problems.” A. James Clark

The A. James Clark School of Engineering at the University of Maryland serves as a catalyst for high-quality research, innovation, and learning, delivering on a promise that all graduates will leave ready to impact the Grand Challenges (Energy, Environment, Security, and Human Health) of the 21st century. In 2014, the Clark School embarked on a strategic planning process to continue our pursuit of academic excellence and our goal to be an eminent college of engineering. The process included input from all constituencies including representatives from each department, program, and unit, as well as alumni and members of the Clark School board of visitors.

- Four pillars emerged and stand as our fundamental principles:
- Develop Fearless Engineers who will impact the Grand Challenges and other societal problems of the 21st century.
- Lead and transform the engineering discipline and the profession.
- Accelerate innovation and entrepreneurship.
- Build a culture of impact among Clark School faculty, staff, students, alumni, donors, friends, and the local, state, national, and international community.

These pillars are consistent with the core competencies required to educate the next generation of students who will impact the NAE Grand Challenges in the 21st Century.

To offer students this unique experience, we will leverage several of our existing experiential multi-cultural and global, multi-disciplinary live-in and learning, and honors programs to enable our students to master the five Grand Challenge Scholars Program-GCSP core competencies. These unique honors and experiential learning programs include:

- QUEST
- RISE
- College Park Scholars-Science, Technology and Society
- EIP/Hinman CEOs

Each of these University of Maryland and A. James Clark School Honors programs that can contribute competencies to the Grand Challenge Scholars Program are summarized below:

2.1 Honors and Experiential Service Programs:

2.1.1 QUEST-Quality Enhancement Systems and Teams Honors Program

The Quality Enhancement Systems and Teams (QUEST) Honors Program is a multidisciplinary, hands-on program for University of Maryland undergraduates from three participating colleges (Business, Engineering and Natural Science). Students participate in a challenging course of study that focuses on quality management, process improvement, and system design through
teamwork and co-curricular programming. The program combines diverse knowledge, skills, and perspectives to enhance the professional and personal development of our students.

2.1.2 RISE=Research, Instruction, Service and Entrepreneurship Academy

The RISE Leadership Academy: RISE (Research, Instruction, Service, and Entrepreneurship) will brand the leadership ability of select students within the engineering college. Only students with exceptional leadership potential will be invited to join the academy. Selection will occur in the sophomore year based upon academic performance (GPA) and leadership qualities demonstrated during the first three semesters of academic study.

Students who join will select two of four “areas” (Research, Instruction, Service, and Entrepreneurship) in which to demonstrate their leadership abilities. In their junior year they will concentrate on one area (Research, for example) and in their senior year they will concentrate on another (Instruction, for example). The choice of concentration areas is entirely up to the student, and RISE program faculty will help to pair students with appropriate faculty mentors. Students are encouraged to interact with their department's RISE representative to identify their activities and to be matched with possible R, I, S, or E activities. Students may be able to earn independent study credits, but will not routinely be paid a stipend for their RISE activities. Those students who focus on Instruction can apply either through the Keystone Program or through their own Department to become UGTFs, in which case they can receive a stipend. RISE students who select Instruction as one of their ‘leadership areas can be involved in running a tutoring center to assist students in their 3rd and 4th years in much the same way as the Keystone TA’s and UGTF’s run the Keystone center for the 1st and 2nd years at present.

Students doing Research are encouraged to ask if their selected research mentors can pay them for their research participation, for example from REU grants, or grant them independent study research credit. Students who opt to receive independent study credit for their Research activities cannot also receive a stipend during a semester in which they earn academic credit. Students wanting to do Entrepreneurship are encouraged to ask if the entity that they want to work with can pay them a stipend. Service, such as serving as an Ambassador, advisor, or mentor should be purely volunteer in nature and normally there will be no stipend for it.

RISE students are required to take a 1-credit leadership seminar in each of their two years in the RISE Program. These seminars are ENES 304 (first year) and ENES 305 (second year). RISE students with unavoidable scheduling conflicts, or who are studying abroad, take an online version of these classes. Upon graduation RISE students will receive a medallion to wear across the stage at Commencement with their name and their year of graduation on the back and RISE Leadership Academy on the front.

2.1.3 College Park Scholars-Science, Technology and Society Program

College Park Scholars-Science, Technology and Society (CPS-STS) program explores the powerful social, ethical, and political relationships that drive research and innovation. The program delves into the challenges of living and innovating in a world where emerging science and technologies are becoming increasingly interconnected, pervasive, and powerful. The program’s primary goal is to give students analytical skills that help connect science and technology to broader social needs. STS pursues this goal through individual research projects,
collaborative problem solving activities, user-centered design projects, and service-learning. STS welcomes students from all majors who are interested in understanding how we can responsibly maximize the societal benefits of scientific inquiry and technological innovation.

2.1.4 Entrepreneurship and Innovation Program
The Entrepreneurship and Innovation Program (EIP) provides University of Maryland Honors College freshmen and sophomores with an interdisciplinary, living and learning education to help build the entrepreneurial mindsets, skill sets, and relationships invaluable to developing innovative, impactful solutions to today's problems. A joint program of the Honors College and the Maryland Technology Enterprise Institute (Mtech), EIP has a proven pedigree of successful creativity and innovation-related education and achievement. Mtech has been a leading force in entrepreneurial education and innovation for more than 25 years. EIP is based directly on Mtech's groundbreaking Hinman CEOs program, the first undergraduate living-learning entrepreneurship program in the United States. EIP students have access to Mtech's venture development resources and activities, as well as those specifically designated for EIP and the Honors College.

2.2 Multicultural and Global Programs:
2.2.1 Engineers Without Borders (EWB)
Engineers Without Borders USA (EWB-USA) is a nonprofit humanitarian organization established to support community-driven development programs worldwide through partnerships that design and implement sustainable engineering projects, while creating transformative experiences that enrich global perspectives and create responsible leaders.

2.2.2 Maryland Sustainability Engineering (MDSE)
MDSE is an organization dedicated to sustainable development locally and abroad. In the past, MDSE has completed on-campus bioretention projects intended to combat pollution in the Anacostia watershed, designed and implemented a solar powered drip irrigation system for the Peace and Friendship garden, and has worked with the Greenbelt Middle School to educate and raise awareness about environmental conservation. They have also installed a solar array at the Abigail D. Butscher Primary School in Calaba Town, Sierra Leone to provide the school electricity.

3.0 Administrative Structure of Grand Challenge Scholars Program
The GCSP Steering Committee will be comprised of faculty members from eight engineering departments along with the GCSP Faculty Director, and the Associate Dean for Undergraduate Education and Student Services. The committee will convene monthly and members of the Committee will be reappointed each year. For the GCSP program, the responsibilities of the committee include the selection of students, the tracking of their progress with the GCSP Mentors, approving GCSP portfolios, and compiling and conveying the accomplishments of GCCP Scholars to the Director of the Grand Challenge Scholars Program.

GCSP Mentors will be appointed through the faculty liaisons of each department that comprise the GCSP
Steering Committee. Students may choose to use these appointed officials as their mentors, or they have the choice of finding their own from the A. James Clark School of Engineering faculty.

3.1 Selection of Students

3.1.1 Student Marketing

The GCS Program will be promoted at the University of Maryland in various ways. Incoming freshman are required to take an engineering seminar class to help familiarize them with the university, thus incoming freshmen will be made aware of the GCSP in our ENES100 Introduction to Engineering Design course. To further increase awareness and interest in the program, current GC Scholars will advocate for the program in freshman engineering classes as the program progresses.

3.1.2 Academic Requirements

- Grand Challenge Scholars must meet the following academic requirements in order to be considered for acceptance into the GCSP.
- Be an engineering major at the sophomore or junior level
- Have a cumulative GPA of at least a 3.2 to be eligible for program. Higher consideration will be given to students who also have a major GPA above a 3.2.
- Students must maintain the 3.0 cumulative GPA for the duration of the program. Students already accepted to the program will have one semester to regain their cumulative GPA should it fall below a 3.0.
- We note that the academic requirements are the same as those to maintain honors status in the College. However, this program does not meet (and is not intended to meet) the university honors program requirement of at least 6 honors level courses. This requirement may be reconsidered in the future.

3.1.3 Program Requirements:

Choose 1 or more of the 14 grand challenges as a focus for their three years in the program,

a) Fulfilling the 5 competencies by taking courses and gaining experiences related to their chosen theme (s)

b) Achieving and maintaining at least a 3.0 GPA by Senior year

c) Construct a portfolio that details how their experiences relate to their chosen theme and how these experiences have influenced their future as an engineer

d) Attend GCSP seminars to help foster community amongst the scholars

i) Various topics

ii) Invite speakers

3.1.4 Program Acceptance

Prospective GC Scholars will have to complete a GCSP Application and Plan of Study and have it approved by both the GCSP Steering Committee in the A. James Clark School of Engineering. The Plan of Study will include a description of how the student intends to complete the five components of
program, which are listed below. Additionally, students must express connectivity amongst the five program pillars in their Plan of Study that thematically addresses GC themes. The program expects to allow thirty students to join per rank per year. Students will apply by end of their sophomore year. If unsuccessful in their first application, students will be given constructive feedback by the GCSP Steering committee and their GC mentor in regards to their original Plan of Study. They will have the opportunity to reapply if they still meet the eligibility requirements.

3.1.5 Application Process:

a) Students complete an online application that includes:

b) A 250 -300 word essay on why the Grand Challenges are important? and Why they should be selected for the program

c) Resume

d) Chosen Grand Challenge (s) to focus on and a Plan (can be an outline; we can provide a format) on how they will complete the five competencies focusing on their chosen theme. (If they choose more than one they must clearly demonstrate in their plan how their chosen coursework/experiences relate to all chosen themes and how the themes interconnect)
4.0 Proposed Maryland Model to meet GCSP Core Competencies
The pictorial displayed in Figure 1 illustrates how students in the proposed Maryland GCSP will conceptually meet the necessary requirements to become a Grand Challenge Scholar. Many of Maryland’s existing Honors program fulfill core competencies of the GCSP. Thus, a student would simply need to be admitted into one of these Honors program and request permission to enroll in the Clark School’s GCS program.

A final requirement for all Grand Challenge Scholar nominees/ participants would be to come together as one cohort in a class that embodies the social consciousness required to develop scalable solutions to affect real world change. This will be done in ENME 467: Engineering for Social Change.

5.0 Detailed Program Requirements
The Grand Challenge Scholars program has five core components that students must pursue in order to tackle a Grand Challenge. Students must participate in each of the five components, however, their involvement in each component can vary. It is required for students to have in-depth, immersive engagement in at least two of the five components, and medium level engagement in at least two of the five components. The last component may be pursued at a minimum depth. Levels of immersion will be described individually for each component. Overlap amongst the components is valid and
recommended to get the most out of the program.

1. **Research/creative:**
Mentored research or project experience related to a Grand Challenge to enhance technical competence and creativity.

- Scholars should complete two semesters or two summers of research experience.
- Research experience gained through the University of Maryland FIRE program is applicable.
- Scholars can seek funding and guidance from the many resources already offered:
  - LSAMP Undergraduate Research Program
  - SEEDS Research Fellowship
  - Ronald E. McNair Post-Baccalaureate Program
  - ASPIRE Scholarship
  - UMD Howard Hughes Medical Institute Fellowship
  - Maryland Summer Scholars
  - NSF Research Experiences for Undergraduates-REU Programs

All GC scholars will be required to present at *Undergraduate Research Day* (this is also a requirement for most of the above campus research programs).

2. **Multidisciplinary/Interdisciplinary:**
Understanding gained through experience of the multidisciplinary character of implementable and viable Grand Challenge solutions. Students must take 3 credit non-engineering class related to their grand challenge theme, or participate in a non–engineering optional volunteer/internship experience related to their theme.

- Classes completed for one of the Honors or Scholars, or any other applicable living and learning program will count towards meeting this requirement.
- If the class the student wants is not on the list, they can propose another course that they believe aligns with the program and seek approval for it from the GCSP department faculty advisor and the GCSP Faculty Director.

- **Optional Internship Program:**
  - **UMD Global & Federal Fellows Internship Programs**
    - Open to All Majors:
    - 7 Fall seminar courses (including U.S. Diplomacy, Science Diplomacy, Energy & Environment, Responses to Global Challenges, etc.), taught by expert practitioners and focusing on the real world!
    - Spring Internship, with college credit through our program or through your major; Scholarship in Practice credit
    - Year round professional development activities (field trips to DC, workshops, individual coaching, etc.)
    - Earn transcript notation as a Federal or Global Fellow
    - Join an engaged student cohort group and alumni network for life!

3. **Business/Entrepreneurship/Management:**
Understanding gained through experience that viable business models are necessary for successful implementation of Grand Challenge solutions. This requirement can be completed via participation in
the following business and entrepreneurship honors programs:

- QUEST
- Hinman CEOs
- Hillman Entrepreneurs Program (Incorporating students from this program can also help to retain transfer students from Prince George’s Community College and Montgomery Community College)

-------OR-------

For those not in the above honors programs, scholars should take 3 credits in entrepreneurial coursework. Suggested courses: ENES140/461 and/or ENES 462 (these are the first two classes in the Hinman program and require development of a business plan. ENES 462 is a team project based class where you develop and market a product)

- ENES140 (online only course): Discovering New Ventures
- Students explore dynamic company startup topics by working in teams to design a new venture. This multi-disciplinary course helps students to learn the basic business, strategy, and leadership skills needed to launch new ventures. Topics include learning how to assess the feasibility of a startup venture, as well as how to apply best practices for planning, launching, and managing new companies. Students discuss a wide range of issues of importance and concern to entrepreneurs and learn to recognize opportunities, assess the skills and talents of successful entrepreneurs, and learn models that help them navigate uncertainty.

- ENES462: Marketing High-Technology Products and Innovations
- Examines the opportunities and challenges of marketing high-technology products in turbulent environments requiring rapid decision making with incomplete information. Explores how innovations are introduced at frequent intervals, research-and-development spending is vital, and there are high mortality rates for both products and businesses.

- ENES461: Advanced Entrepreneurial Opportunity Analysis in Technology Ventures
- Explores the factors that influence entrepreneurial opportunity analysis in technology-based ventures. Uses a cognitive theoretical framework to examine the integration of motivation, emotions and information processing modes to make complex entrepreneurial decisions in fast pace technology venture environments.

-------OR-------

Alternatively students can complete this requirement through starting a venture while in college that is related to their GC theme.

4. Multicultural and Global Dimension:
Understanding gained through experience that serious consideration of cultural issues is mandatory for all viable Grand Challenge solutions. This can be completed by:

- Taking ENES 317: Introduction to Global Leadership, or Studying abroad (for any length of time) and relating it to their grand challenge theme*
Taking a 3 credit course focused on understanding global societies and a local experience that has a global focus

- Being a leader in EWB
- Participation in the Global fellows program (should be able to double count between here and the Multidisciplinary requirement)
- Suggested Courses (These all also fulfill Gen Ed requirements):
  - AASP189I: HIV/AIDS in a Global Perspective
  - ANTH265: Anthropology of Global Health
  - GEOG110: The World Today: Global Perspectives
  - GVPT200: International Political Relations
  - MIEH400: Introduction to Global Health
  - URSP372: Diversity and the City
  - COMM382: Essentials of Intercultural Communication
  - ENES472: International Business Cultures in Engineering and Technology
  - FMSC110S: Families and Global Health

*These were just selected from courses offered this past fall semester. Scholars should be allowed to take other courses outside of this list as long as it is approved by the advisor

5. Social consciousness:
Deepen social consciousness and motivation to address societal problems, often gained through service learning, because serving people is the vision served by the Grand Challenges.

Students must take:
  a) **ENME 467: Engineering for Social Change** (3 Credit Hours); or
  b) Lead and/or participate in a service learning experience
     a. Students should complete between 100 hours of service learning,(EWB, MDSE, Alternative Spring Break)

Students can earn service learning hours through the following programs:

- WIE Outreach events
- CMSE Outreach events
- EWB, Maryland Sustainability Engineering (MDSE)
- Alternative Spring Break (ASB)/ Weekends
  (http://thestamp.umd.edu/leadership_community_service-learning/programs/alternative_breaks)

*Students who do service learning abroad should be able to count that experience toward competency 4 as well.

Two service learning programs offered by the UMD Study Abroad Office include:
**Winter term**

**Chile: Chilean Literature, Democracy and Social Change**
- Participants team up with twenty students from a local Elementary School for a week of companionship and mentorship.

**Summer**

**Cameroon: A Case Study in European Colonialisms**
- Participants work on capacity-building projects for one or more associations of HIV positive young people in northern Cameroon.

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**6.0 Assessment and Tracking of Scholars**

GC Scholars will work with their departmental mentor to devise a Plan of Study to be cleared by the steering committee. Each semester, every GC Scholar must meet with their mentor at least once to give an update of their progress. The student’s Plan of Study will be a dynamic document to account for unforeseen adjustments in the curriculum. The Plan will be finalized in the second to last semester before the student’s graduation. At that point, the document will outline the fulfillment of all the criteria set forth by the GCS Program and a GC Portfolio will be created by the student to thematically combine the components. The Portfolio will include a document relating their activities to a GC theme (or multiple themes), documentation of how the student completed the components, and the student’s Plan of Study.

In order to keep students connected to other GCS alumni, GC Scholars will be recommended to attend the annual NAE Grand Challenges Summit in order to network with their peers, industry leaders, and members of academia. Direct financial assistance for attendance is not available through the university, however, the College of Engineering helps support those with unmet financial need.

Students graduating with GCS distinction will receive a Grand Challenge Scholars Letter from the National Academy of Engineering and will receive a transcript designation of “NAE Grand Challenge Scholar” upon graduation.
7.0 Appendices:

a) Diagram illustrating University of Maryland GCSP w/ course requirements
b) Notional Four-Year Grand Challenge Scholars Program Plan
c) Sample Student Curriculum GCSP, Option A
d) Sample Student Curriculum GCSP, Option B
e) WorkSheet for Advisors
f) WorkSheet for Students
APPENDIX A: UMD GCSP COURSE REQUIREMENTS FOR 5 COMPETENCIES

- Global Leadership Component (ENES 317)
- Entrepreneurship & Tech Mngt (e.g. BMGT 210, BMGT 289E)
- Social Consciousness Component (ENME 467)
- NAE Grand Challenges (ENES 181)
- Interdisciplinary Component (TBD)
- Research Component (ENXX 3XX/4XX)
- Clark School Grand Challenge Scholars Program (GCSP)
APPENDIX B: Notional Four-Year GCSP Student Program Plan

FIRST YEAR
ENES 181 (1) Engineering and the NAE Grand Challenges
ENES 100 (3) Introduction to Engineering Design (credits DSSP Designation)
Attend program orientation and community building meetings during the First Year

SECOND YEAR
Entrepreneurship and Technology Management: (Take 1 of the following courses)
ENES 140 (3) DISCOVERING NEW VENTURES (DSSP)
ENES 462 (3) Marketing High-Technology Products and Innovations
ENES 461 (3) Advanced Entrepreneurial Opportunity Analysis in Technology Ventures

OR CHOOSE FROM ONE OF THE FOLLOWING:
ENES 210 (3) ENTREPRENEURSHIP OPPORTUNITY ANALYSIS (DSSP & I-SERIES)
ECON 200 (3) INTRO TO MICROECONOMICS (DSHS)
ECON 201 (3) INTRO TO MACROECONOMICS (DSHS)
ECON 111 (3) THINKING LIKE AN ECONOMIST (DSHS, SCIS)
BMGT 110 (3) INTRODUCTION TO THE BUSINESS VALUE CHAIN
BMGT289E (3) ENTREPRENEURIAL THINKING FOR NON-BUSINESS MAJORS (DSSP, SCIS)
BMGT289I (3) WHY GOOD MANAGERS MAKE BAD DECISIONS (DSSP, SCIS)
ENES 190H (3) INTRO TO DESIGN AND QUALITY – ALSO OFFERED AS BMGT190
ENES 390H (3) SYSTEM THINKING FOR MANAGERIAL DECISION MAKING -ALSO OFFERED AS BMGT 390
ENES 490H (3) QUEST CONSULTING AND INNOVATION PROACTICUM - ALSO OFFERED AS BMGT 490

Global Leadership Component:
ENES 317 (3) INTRO TO GLOBAL LEADERSHIP (DSSP)

THIRD YEAR
Research Component:
ENXX 3XX/4XX (3) credits of research for NAE Grand Challenges (Should be acceptable for all majors)

Interdisciplinary Component:
A PRE-APPROVED THREE CREDIT COURSE OFFERED BY THE FEDERAL OR GLOBAL FELLOWS PROGRAM, or other COURSE APPROVED BY THE CSP/GCSP FACULTY Director

FOURTH YEAR
Social Consciousness Component:
ENME 467 (3) ENGINEERING FOR SOCIAL CHANGE – No Gen Ed designation and fall only course

POTENTIALLY a minimum of 6 credits could be added on to the student’s degree program while providing functionality to each of our majors as well as flexibility to each students so that they may select areas of interest. 
() credit hours in parenthesis.
APPENDIX C: Sample Student A Proposed Plan

Grand Challenges Scholars Program
Three Year Student Plan

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APPENDIX D: Sample Student B Program Plan

Grand Challenges Scholars Program
Three Year Student Plan

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<td>Depth of Engagement</td>
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| In-Depth Research Component (2) | • Senior Capstone  
• ENSE 3XX/4XX Research: Equivalent of 150 Hours of Research Work, or 1 Semester of Research.  
• Present a UMD Undergraduate Research Day | • Complete ≥ 1 Approved Course per approval of Faculty Director  
• Semester on Capital Hill or in the State Dept. | • Participating in a Business Plan Competition  
• Participating in the QUEST, EIP or Hinman’s Honors Prog.  
• Significant Involvement in Entrepreneurship  
• Complete 1 Approved Course | • Long term Study Abroad experience  
• ENES 317 Global Leadership | ENES 467 and 100 hrs of Service Learning |
| Medium-Depth Component s (2) | Complete 1 Approved Course per approval of Faculty Director: | Participating in the QUEST, EIP or Hinman’s Honors Prog.  
• Complete 1 Approved Course from list | Short term Study Abroad experience  
• ENES 317 Global Leadership | | ENES 467 or 100 hrs of Service Learning |
| Minimum-Depth Component (1) | Complete 1 Approved Course from list | | Complete Approved Course:  
• ENES 317 Global Leadership | | ENES 467 or 100 hrs of Service Learning |
APPENDIX F: WORKSHEET FOR STUDENTS

<table>
<thead>
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<th>Work Sheet for Students</th>
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<tbody>
<tr>
<td>Student Name:</td>
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<tr>
<td>Engineering Major:</td>
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<tr>
<td>GC Focus:</td>
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<td>GC Faculty</td>
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<th>Interdisciplinary Research</th>
<th>Interdisciplinary Curriculum</th>
<th>Entrepreneurship</th>
<th>Global Component</th>
<th>Service Learning</th>
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