SUPPLEMENT IV: COURSE DESCRIPTIONS

IV.1 20ENED 1020: ENGINEERING FOUNDATIONS

COURSE DESCRIPTION: The ENED 1020: Engineering Foundations course serves as an introduction to all fields of engineering for incoming freshman. A common curriculum is implemented across all sections of ENED 1020 offered in the College of Engineering and Applied Science (CEAS) to achieve the same Student Learning Outcomes (SLO’s), which are given below:

1. Describe their program’s curriculum and co-op requirements and its experiential learning and career opportunities.
2. Describe the other CEAS disciplines and the career opportunities those disciplines provide.
3. Demonstrate the ability to design and conduct experiments, as well as to analyze and interpret data.
4. Demonstrate the ability to identify, formulate, and solve engineering problems.
5. Demonstrate the ability to communicate effectively and work in teams.
6. Demonstrate an understanding of professional and ethical responsibility.

To achieve these learning outcomes, the course includes lectures as well as "hands-on" experimental modules. The lectures provide a background for the experimental modules, explain to students the importance and basics of in engineering ethics, and discuss the importance of strong professional skills such as communication, teamwork, problem-solving, and synthesis. The “hands-on” experimental modules enable students to explore mechanical, chemical, and electrical systems by conducting four required laboratory investigation projects in teams of 2 to 3 students. Some of these are modeled to illustrate the "Engineering Design Process" (EDP), shown in Figure II.1 below, to the students. These are also designed to illustrate application-driven just-in-time engineering math instruction as an immediate solution to math-related attrition (~ 48%) in engineering during the freshman year1. The math skills learned will include data, regression and numerical analyses. Special laboratory equipment and four kits allow students to conduct the laboratory investigation related to electrical systems, solar and fuel cells, thermodynamics/heat transfer, and bridges. Students are guided to perform these experiments by teaching assistants (TA’s: typically trained junior and senior undergraduates), with one TA support for every 3 to 4 teams. Each student completes a report for each lab using a prescribed format. In addition, students complete a fifth project, called the “Choice Project,” in which the students are asked to design their own experimental investigation, different from the ones completed, using the knowledge and equipment from the four required experiments. Usually, teams extend one of the required projects for the Choice Project, for example, doubling the energy production from a fuel cell. As for the required projects, each student submits a written report for the Choice Project as well. The end of the course culminates with each team researching and then presenting their findings about one of the fourteen Grand Challenges identified by the National Academy of Engineers (NAE). The students are given a lecture on how to make presentations and then are guided by the Teaching Assistants during one recitation class on how to make a PowerPoint presentation. The second week of this project involves the students giving their presentation in front of the entire class describing their review of one of the Grand Challenges. In addition to these requirements representatives from degree-programs in CEAS and from industrial organizations are invited throughout the semester to provide additional information concerning career opportunities in engineering to the students.

Proposed Change for the ENED 1020: Engineering Foundations Section for the IUSE Project:
In the IUSE project the “Choice Project” and final presentation will be replaced by a “Choice Research Project (CRP),” launched at the beginning of the semester and executed during the last four weeks of the semester along with other requirements of the course. The CRP is designed to provide an experiential learning opportunity in the “Engineering Research Processes” (ERP) by addressing one of the fourteen

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Grand Challenges for Engineering identified by the National Academy of Engineers (NAE)\(^2\). The CRP will address SLO #s 3, 4 and 5 of ENED 1020, mentioned earlier, and following two additional SLO’s: After completion of the CRP, students will be able to:

7. Explore, analyze, and discuss the concept of the “engineering research process.”
8. Understand the purpose, opportunities and expectations of the BS-MS-ACCEND program in CEAS.

EXECUTION OF THE “CHOICE RESEARCH PROJECT (CRP)”

The CRP will be introduced to the students during the second week of the class using the Challenge-Based Learning (CBL) teaching method. The flipped lesson documents, practice quizzes and homework will be made available to the students in the Blackboard Site for the course of which all enrolled students are aware of. Their availability will be formally announced to the students by email and in the first class period. For executing the CRP, the students will work in the same teams as structured for the required four laboratory investigation projects. CBL is an active learning environment that engages students to plan their own learning. It is a structured model for course content delivery with a foundation in earlier strategies, such as collaborative problem- or Project-Based Learning (PBL). CBL is different from PBL in that instead of presenting students with a problem to solve, it offers general concepts from which the students determine the challenge they will address. The faculty member’s primary role shifts from dispensing information to guiding the construction of knowledge by his or her students around an initially ill-defined problem. Grounded in student learning outcomes, students are introduced to a relevant “big idea” based on the “engineering discipline” of the majority of the students enrolled in the particular section. This big idea is an item of global, regional and/or local significance – something a student can readily relate to his or her life. Once the big idea is introduced by the instructor during lecture, the next step is to collaboratively develop - with the students in the class - an overview of the big idea and the related “essential questions” and choose one that sets the broader context and foundation for the work that will follow. Students in teams identify the essential questions that clarify the big idea and helps establish the boundaries of the challenge. The class then identifies a suitable “challenge” or is guided to select the challenge for one essential question selected by consensus. This establishes the context for the “challenge” selected for the CRP. Throughout the performance and writing of the four “Hands-On” experimental modules, the students will identify and formulate their “guiding questions.” Then during the CRP the students will use the Engineering Research Process (ERP) to answer their guiding questions and ultimately guide them to their solution of the challenge topic. In summary, for the CRP, the CBL methodology is used to frame the challenge and its guiding questions for the big idea selected. In our approach, we will require the whole class to first collectively define the ERP challenge, individually, and then each student team to define their guiding questions which they think when answered will lead to the solution for the ERP challenge. The CBL model used for executing the CRP is illustrated in Figure II.2 on next page. The ERP which guides and informs the solution of the challenge is illustrated in Figure II.3 on next page.

After completion of each required laboratory project, each team reflects and documents, as part of their lab report, how the knowledge and testing skills learned is planned to be used, if any, in for their CRP challenge. Thus, the student teams progressively plan their CRP as they complete the four required laboratory projects.
laboratory projects. They are fully prepared to execute their CRP and prepare and submit the project deliverables during the last four weeks. The project deliverables include (1) a typed project report (following a specified format), and (2) give a 10 minute PowerPoint presentation defending their challenge solution and showing how the ERP helped in coming up with their solution. Each team report is evaluated by the teaching assistant (TA) using a rubric. Each team presentation is evaluated using a rubric by all other students, TAs, and the course instructor.

The change proposed to be implemented in the ENED 1020 will greatly enhance the current class structure because the students will no longer just be presenting what the NAE Grand Challenges are, but instead they will be trying to solve a part of a NAE Grand Challenge using ERP.

**EXAMPLE OF A “CHOICE RESEARCH PROJECT (CRP)” IN ENVIRONMENTAL ENGINEERING:**

1. **Big Idea Given to the Class:** Providing access to clean water, a worldwide crisis that affects 750 million people, or approximately 1 in 9 people worldwide.\(^3\) To ensure that students came to class with appropriate preparation and expectations, the class in which CBL was implemented was “flipped.” The flipped classroom consisted of a homework assignment that was provided a week

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in advance and which, to ensure completion, was assessed with a short quiz at the beginning of the CBL class period. The assignment for the flipped classroom consisted of a reading assignment on: how a flipped classroom works, the CBL process, basics of water treatment, and an overview of the big idea. The assignment also required the students to brainstorm possible essential questions, and list three, prior to meeting in-class.

2. Essential Question Selected by Class Consensus: Due to the flipped class assignment, a majority of students came to class with EQs that they brainstormed at home. This allowed for the class to move quickly into a small group brainstorming session where students, in groups, presented their EQs to each other and then each group, with consensus, decided on two EQs. After this, student groups presented their EQs to the class and recorded them in the public view by writing the EQs on the dry-erase “walls.” This was especially useful for the instructor and students as due to the small classroom space everyone could quickly scan all student-generated EQs. Finally, with discussion, the instructor synthesized the student-generated EQs into one comprehensive EQ for the class that integrated the important aspects and common themes of the student-generated EQs. This final step was necessary to unify the class and allow for progression through the rest of the CBL process. The important criteria when leading the discussion to develop the class EQ were: (a) All student groups must have representation in the final EQ; (b) The class EQ should be comprehensive and contain the most important themes of the student EQs as determined by the instructor and students; and (c) The class must provide consensus and be permitted to modify the EQ if necessary. In this implementation the final EQ selected through class discussion was: How do social and geographic issues impact access to clean drinking water?

3. Challenge Selected by Class Consensus: The challenge was developed through class discussion in a similar manner to the EQ. The selected challenge was: Develop a technology or process that can sustainably produce clean drinking water. The students were free to pursue any type of water treatment method to treat water contaminated with either clay (particulate contamination) or a food coloring dye (organic contamination). Students were permitted to use materials from the preceding non-CRP experiments, and were also allowed to bring simple materials from home. Development of a test method for determining the degree of treatment efficiency was also required.

4. Example Student Team Selected Guiding Questions:
   i. What are some materials which remove particulates but allow water to flow through?
   ii. Do any of these materials release more particulates into the water?
   iii. What is an effective way to layer many of these materials to allow for multi-step filtration?
   iv. How can we create an efficient system for cleaning and purifying contaminated water?
   v. What defines “clean” water?
   vi. What visual methods are available to assess the cleanliness of water?
   vii. What impurities/contaminants are found in water?

5. Example of Excellent Student Team Solution
   i. Title: The Aqua Floca Filter
   ii. Overview
   The student team selected to use a combination of household materials and simple laboratory supplies to develop a filtration device to remove particulate contaminants (clay) from water. Additionally, the students developed and calibrated a methodology to visually determine the particulate concentration in the influent and effluent water. The students were able to achieve a minimum 3-log removal of the influent particulates.
   iii. Experimental Elucidation of Answers to Guiding Questions
      1. Guiding Question # 1
      What is an effective way to layer many of these materials to allow for multi-step filtration?
      Hypothesis
A filter device with the layer order from bottom to top of gravel, course sand, activated carbon, course sand and gravel will remove more clay than a filter device of the same layer pattern excluding activated carbon.

Result
Inconclusive, all conditions increased the turbidity of the water. This led to students to design a new experiment to test another guiding question.

2. Guiding Question # 2
Do any of these materials release more particulates into the water?

Hypothesis
Dust from the pebbles increase the turbidity of the water sample.

Result
Inclusion of pebbles increased turbidity, while the use of fine sand and a cotton filter were shown to decrease turbidity. After this result the students could revisit their first guiding question.

3. Guiding Question # 3
What is an effective way to layer many of these materials to allow for multi-step filtration?

Hypothesis
A filtration device containing filtration materials in the order of t-shirt, fine sand, coffee filter, cloth, sand and coffee filter will effectively decrease the concentration of contaminants in the water sample.

Result
The constructed filter was tested for filtration efficiency using the student-designed turbidity test method and found a minimum 3-log removal of the influent clay particulates.

6. Example Photos of a Team Solution to the Challenge:

i. Progression of developed filter from beginning to end.

![Progression of developed filter](image1)

ii. Calibration developed by students to measure filtration efficiency.

![Calibration curve for turbidity test](image2)
IV.2 20ENED 2010: RESEARCH METHODS (3 Credits)

COURSE STRUCTURE: The course has two components: 1) Research Methods and 2) Training Program for Writing. Each component has unique course description, objectives (learning outcomes), course mechanics, and grading which are presented separately for each component.

COURSE DESCRIPTION:

For Research Methods: This goal of this component of the course is to help students to develop methods and skills necessary to create, develop and execute a successful research project. The material covers an introduction in the scientific method and engineering research method, similarities and differences between the two, and an in-depth discussion of case studies from several topics in different engineering disciplines.

For Training Program for Writing: The goal of this component of the course is for students to establish the groundwork of a competitive application for a prestigious national honor in their field—in this case, the Goldwater Scholarship—through intensive writing, self-reflection, and peer assessment. All students will prepare an application for the Goldwater Scholarship, and eligible students will submit their applications when appropriate. Decisions to apply will be made in consultation with the student’s faculty, research mentors, and UC’s Office of Nationally Competitive Awards (NCA) staff, and will be based on the eligibility factors outlined by the Barry Goldwater Scholarship and Excellence in Education Program. These include: 1) year in program (generally students can apply in their second or third year); 2) intention to pursue a research-based PhD and subsequent research career; and 3) amount and intensity of previous research experience. The training program will be delivered by NCA staff in conjunction with the disciplinary professors of the Research Methods class.

PREREQUISITES:

For Research Methods: Standard first-year mathematics, models, and science courses required for the BS degree program being pursued.

For Training Program for Writing: Standard first-year English course required for the BS degree program being pursued.

REQUIRED TEXTS:


For Training Program for Writing: None.

LEARNING OBJECTIVES:

For Research Methods: The Overall Objective of this component of the course is to prepare you to participate meaningfully in scientific and engineering research. In addition, S-STEM scholars should identify faculty with whom they are interested in working, and ideally should have a research mentor identified with whom they will work through their senior year. The Specific Course Objectives are that students successfully completing this component of the course will be able to:

1. Explain the meanings of the following terms: scientific method; methodological naturalism; hypothesis; theory; law; explanation; causation; inductive reasoning; deductive reasoning; meta-analysis.
2. Describe the steps of the research process (including but not limited to the scientific method).
3. Develop methodologically sound strategies to test hypotheses.
4. Identify potential legal and ethical issues in engineering research in general.
5. Complete a literature review on a research topic of interest.
6. Prepare a proposal for a research project.
7. Conduct a short research project (4-6 weeks), using appropriate statistical tools to analyze results.
8. Present research results in a paper.
9. Present research results in a poster.
10. Present research results in an oral presentation.

**For Training Program for Writing:** Upon completion of this component of the course, students will be able to:

1. Engage in self-reflection in order to connect their research experiences to date with their longer-term academic and professional plans;
2. Articulate in writing their past academic and research accomplishments, and their future goals and plans for research;
3. Establish a mentoring relationship with faculty and research supervisors;
4. Practice acceptable etiquette for approaching potential professional references to ask for letters of recommendation;
5. Learn how to read an award application for its potential success through the lens of a reviewer by evaluating the effectiveness and quality of their peers' written drafts; and
6. Produce a complete application that meets the standards and requirements of the Goldwater Scholarship Foundation.

**COURSE MECHANICS:**

**For Research Methods:** Most of your effort in this course will be focused on completing a small, simulation-based research project. We’ll spend the first few weeks identifying projects of interest to you; during this time, you will also be assigned reading from the textbook as the basis for a weekly group discussion. Once you’ve identified a research topic, you’ll do a literature search and prepare a brief research proposal. Once your proposal is approved, you’ll spend a few weeks completing your project. You’ll prepare a written report, a poster, and an oral presentation – presentations will be held the last week of classes (which is also when your poster will be displayed). Your final written report will be due the last day of finals (submitted electronically!), but the instructor will review at least a first draft well before then.

Since this course is required for MS-ACCEND students, you will also be asked to identify at least three faculty members in the department your degree program resides who are conducting research you find interesting and meet with those faculty members to discuss their research. Ideally, you will have identified by the end of the semester your undergraduate research mentor, with whom you will work through your senior year MS-Thesis.

**For Training Program for Writing:** The purpose of the Barry Goldwater Scholarship and Excellence in Education Program is to provide a continuing source of highly qualified individuals to academic study and research in the fields of science, engineering, and math. The Foundation awards undergraduate scholarships to students who have outstanding potential and intend to pursue research careers in mathematics, the natural sciences, or engineering. The Goldwater application consists of an application questionnaire, transcripts, and essay. The application questionnaire requires students to provide demographic and personal data, and also to express their career and professional aspirations, to articulate an experience that has clarified or strengthened their motivation for a research career, and to describe previous research activities, including purpose and products of research. Students must also identify three faculty and research mentors who can provide letters of recommendation.

The essay for the Goldwater application, which will be the focus of this course segment, requires students to articulate a research question that interests them and to develop plans to engage in that research. The prompt for the 2-page essay is as follows:

Your essay should discuss a significant issue or problem in your field of study that is of particular interest to you. Your essay must include a description of the issue or problem, discuss an idea for research that could have significant impact on the issue or problem, describe an aspect of the research in which you would be involved, and explain the relevance of the issue of problem to you as a mathematician, scientist, or engineer. The content and style of your essay will be important to the success of your scholarship application. Assume that your reader is knowledgeable in mathematics, science, and engineering, and will have the expertise to read, review, and understand the complexities of your field of specialty. If your essay involves research in which you are or were involved, please indicate it
you are or were the sole researcher or if you collaborated with another individual. Include bibliography, references, or illustrations, when appropriate, as part of the essay, which will be included in your two pages.

The activities for this component of the course will include the following:

1. 20-minute writing workshop. This guided writing activity engages students in active planning for their future. Students are encouraged to develop long-term goals (in this case, related to research) and to think critically about what they have done and can do in the future in order to develop themselves towards reaching those goals. The activity includes writing in response to specific prompts, followed by small and large-group discussion, and it is a valuable starting point for students to articulate future plans.

2. Goldwater essay draft and peer evaluations—Students will prepare a draft of the essay, based on the prompt, outside of class; in class, they will be paired with another student to review each other’s essays and evaluate their effectiveness based on a provided rubric.

The assignments for this component of the course will include the following:

1. Students will submit a complete application form and essay for a graded assignment. Extensive feedback will be provided by the professor and NCA staff.

2. Students must identify potential letter writers and interview them to learn what the letter writer would require in order to write a good letter of recommendation for them. Students will follow a standard protocol for the interview process including appropriate preparation and follow-up. Obtaining actual letters of recommendation is not required. A report from the student on the student’s experience must be submitted for a graded assignment.

GRADING POLICY:

For Research Methods (67\% of course grade): The total grade assigned for this component of the course will by-itself be distributed as follows:

- Quizzes/Homework 10\%
- Literature Review and Proposal 15\%
- Research Project 25\%
- Paper 15\%
- Poster 10\%
- Oral Presentation 15\%
- Faculty Interviews 10\%

For Training Program for Writing (33\% of course grade): The total grade assigned for this component of the course will by-itself be distributed as follows:

- Completed Application and Essay 60\%
- Report on interviews with potential letter writers, 40\%
IV.3 20ENED 3020: UNDERGRADUATE RESEARCH I (UGR I) (1 Credit)

COURSE COORDINATOR (CC): Dr. Urmila Ghia, Co-PI, Professor, Mechanical Engineering, CEAS, UC.

COURSE DESCRIPTION:

The course has three components, each with a specific goal:

1) Research Skills Development Workshops. Goal: to train the participants to become proficient disseminators of research through written reports, papers, posters, and oral presentations.

2) Research Enrichment Seminars. Goal: to introduce the students to the role of interdisciplinary research in modern society and the opportunities it creates.

3) Mentee Training Program. Goal: to empower student mentees to become pro-active and seek the mentoring relationships they need to be successful. This is particularly important for underrepresented groups, as studies show they are less likely be offered mentoring opportunities compared to the majority population.

PREREQUISITES: 20ENED 2010: Research Methods, and acceptance in MS-ACCEND Program.

LEARNING OBJECTIVES: Students will acquire training in various aspects of the research process, including research dissemination, ethical responsibility and research conduct.

COURSE CONTENT: The course workshops, seminars and training will cover the following topics:

1) Research Skills Development Workshops:
   1. Safety Training
   2. Technical Writing and Presentation (Written and Oral)
   3. Online Literature Search
   4. Project Documentation: Photography & Video Recording
   5. Public Speaking and Communications
   6. Poster Making
   7. Statistical & Uncertainty Analysis in Research

2) Enrichment Seminars:
   8. Ethics in Engineering Research
   9. Group Problem-Solving Skills
   10. Taking Research from Lab to Real World

3) Mentee Training Program: Adapted from a webinar training for minority faculty by the National Center for Faculty Development and Diversity (www.facultydiversity.org), this program, accomplishes three objectives. First, it coaches the students to overcome self-limiting behavior that may reduce their professional opportunities. Second, it outlines the needs of young researchers, and assesses their present mentor network to address those needs. Third, the group brainstorms and shares ideas for expanding their mentor network to meet their professional development needs. This training will be done by Dr. Margaret Hanson, Professor of Physics and Associate Dean, Arts & Sciences; she has extensive experience with presenting this workshop.

GRADING POLICY: The total grade for the course will be based on a 500-word (± 20 words) Reflective Summary for each of the 10 Research Skills Development Workshops and Enrichment Seminars. The students must cover the following in each Reflective Summary:

1. A minimum of three elements pertinent to your educational and professional growth.
2. Important Take-Aways from the Presentation, that is,

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a. New things learned from the presentation.
b. An item that you will still want to know more about from the presentation.
c. An “AHA! I get it!” moment in the presentation.

3. A minimum of two items/benefits pertinent to your:
   a. Education, and
   b. Future professional career.

Each Reflective Summary will be worth 10% of the grade, for a total of 100% of the course grade.
IV.4  **20ENFD4020: UNDERGRADUATE RESEARCH II (UGR II) (1 Credit)**

**COURSE COORDINATOR (CC):** Dr. Urmila Ghia, Co-PI, Professor, Mechanical Engineering, CEAS, UC.

**COURSE STRUCTURE:** The course has two components: 1) Mentor-Mentee Workshop, and 2) Research Experience for Undergraduates (REU) Program.

**COURSE DESCRIPTION:** Students will build on previously acquired training in the research-process (in 20ENED 2010: Research Method) and its dissemination (in 20ENED 3020: Undergraduate Research I). The Goal of UGR II is to provide a semester-long opportunity in conducting research under the supervision of a faculty member (Research Advisor: RA) and disseminating it to a jury via the following deliverables: Technical Paper, Poster, Presentation, and a 5-page Research Project Summary Report.

**PREREQUISITES:** 20ENED 3020: Undergraduate Research I.

**LEARNING OBJECTIVES:** Students will develop an ability to conduct research on a topic of their interest, and share the outcomes of their research with the relevant technical community.

**COURSE CONTENT:**

**Mentor-Mentee Workshop:** The course will begin with a Mentor-Mentee workshop for the Research Mentors (or Research Advisors) and the research mentee students. The objectives of this workshop will be: 1) Learn how to establish expectations, goals and responsibilities of mentors and mentees; 2) Develop strategies to open and improve communication between mentor and mentee; and 3) Set a plan to successfully achieve the training expectations of the mentee. This workshop will be given by Dr. Margaret Hanson, Professor of Physics and Associate Dean in the College of Arts and Sciences at UC. At the end of the workshop, each Mentor-Mentee Team will complete a Road Map, in which they will discuss, define and write the expectations, time commitment, pre-preparation training, mentorship format, and research process - a mutual contract to produce the research deliverables (paper/report, poster, and presentation). They will revisit this contract at least twice each semester, and update the "Road Map" as their research advances, and jointly submit it to the student’s E-Portfolio after each update. Thus, the Road Map will be a dynamic document which lends an opportunity for reflection as the mentor-mentee research relationship gets better defined and understood to all parties concerned.

**Research Experience for Undergraduates (REU) Program:** The objective of the proposed research is discovery through actual construction, experimental testing, and/or computer simulation, observing and recording, synthesizing the data collected, and possible generalizations. The research experience provides an opportunity for individual growth and challenge to the young and inquisitive mind. For 14 weeks during a semester, a student participant will work on a research project, specifically carved out for the proposed REU Program from ongoing research of a faculty mentor designated as the Research Advisor (RA).

Each student will provide a weekly e-log using Blackboard®, for reflecting on the week’s activities. These logs will be reviewed by the RA, Course Coordinator (CC), and Project Coordinator (PC). Additionally, each biweekly Friday, each RA and REU participant will complete an online Biweekly Progress Report Survey Form, to provide the number of weekly meetings held, aggregate progress made towards overall goals, and strategies implemented to enhance productivity. Survey results will be tabulated by PC and shared with all constituents at the start of the following week, to ensure transparency. Biweekly summary reports of the e-log book entries will be conveyed by the CC to the RA's. Any concerns will be promptly discussed by the CC with the appropriate RA. Typically, at least once a week, preferably twice a week, the RA will hold a meeting with their student in which the student will present the work planned and any problems encountered. The RA will address these problems, and make sure that the students are on track. Meeting minutes will be logged by the student in Blackboard®. Students will participate in mentored longitudinal writing assignments, oral presentations, and a juried final Research Project Summary Report, Poster, PowerPoint, and Technical Paper presentation. After the REU Program, the RA will help students to condense their technical paper for publishing and presentation in the UC UG Research Conference, other national conferences, journals, or student paper competitions.
Targeted Progress: On the first class period following the Mentor-Mentee workshop, the CC, PI and the RA’s will collectively discuss the nature and scope of their research projects, expectations, semester-end and post-REU deliverables, timeline of activities, and introduce general lab safety rules. The semester weekly calendar; checklist of deliverables, date and time; and naming of electronic documents will be shared with the students to ensure transparency and timely compliance. Students will research the pertinent literature given to them and additional available literature. At the end of 6 and 12 weeks, each student will submit a written progress report and give an oral PowerPoint presentation. When the research project is nearing completion, using the biweekly reports, each student will prepare a technical paper and a display poster, with assistance of the RA. Each student will give a final 20-minute PowerPoint presentation, which along with the Technical paper and Poster, will be judged by an invited panel of external judges using evaluation rubrics. The Technical Paper will be delivered to the judges 2 days prior to the presentation. The Research Project Summary Report will be used for disseminating outcomes of research projects completed in the Project Website and for NSF reporting.

Targeted Timeline: The weekly time schedule for the REU Program planned for UGR II is as follows:

Weeks 1 to 4:

- **Orientation Workshop:** Co-PI Ghia, CC will give a presentation on “An Overview of the REU Program Planned for UGR II, Personnel, Timeline, & Expectations;” this will include: general semester REU schedule; biweekly reports and presentations schedule; research content training seminars; project deliverables, evaluations to be conducted; final day presentations; and activities beyond the UGR II REU Program. PI Kukreti will also give a presentation on “Laboratory Safety,” to inform the students about the general safety rules for use of the laboratory facilities, if involved in their project.
- **Road Map:** At the end of the Mentor-Mentee Workshop session, the RA and student will complete (hand-fill) the Road Map, and submit it to the PC.
- **Research Content Training Seminars:** These are custom-designed seminar sessions offered by each RA, and include assigning reading materials, and discussions and lectures covering topics such as: theories and basic principles; lab and/or computer methods; lab safety; experimental or simulation design, testing, and data collection and recording procedures; and data analysis and interpretation techniques. These seminars are designed with the full understanding that no prior knowledge is expected from the student about the project content topic.
- **Project Plan Presentation:** At the end of the first month, each student will give a 5-minute presentation covering: Goals, Objectives, Research Tasks, and Timeline. All project team members and faculty mentors will attend these presentations, ask questions and provide feedback. This will constitute the first presentation by the students.

Weeks 5 to 12:

- Devoted to conducting the research and producing the Progress Presentations to be given in Weeks 6 and 12.

General Activities Dispersed Over Weeks 1 to 12

- **Biweekly Progress Reports:** The student and the RA will independently complete the Biweekly Progress Report Form made available to them on SurveyMonkey. This form includes questions seeking information for number of biweekly meetings held, aggregate progress made towards overall goals, and strategies implemented to enhance productivity. Results will be tabulated by the PC and shared by the CC with all constituents to ensure transparency. If disparities and issues are noted between the information supplied the student and faculty mentor pair, then a meeting will be scheduled with the faculty mentor to resolve the issue immediately.
- **Two Intermediate Progress Presentations:** Each student will give a PowerPoint presentation in Weeks 6 and 12 (first one for 15 minutes and second one for 20 minutes) reporting the work completed and the status of their project deliverables. The PI, CC, PC and all RA’s will attend these presentations. Each presentation will be followed by 3-5 minutes questions and answers.
session, and feedback will be provided to each student on progress made, strengths, and areas of improvement.

**Weeks 12 to 14:**
- Will be devoted to production of the deliverables, review and critique, and approval of final deliverables by the RA. The students will submit hard copies of the Final Technical Paper during Week 13 for delivery and evaluation by the judges, and the Final Poster for printing to the PC. The cover page of the Final Technical Paper will be signed by the RA, indicating approval of the document for review. Final PowerPoint Presentation and Research Project Summary Report will be due by mid-week of Week 14.

**Final Day Presentations and Evaluations:**
- The Final Poster and PowerPoint Presentation will be presented to a panel of external judges in Week 14 at a day and time convenient to all. The final deliverables (Technical Paper, Poster and PowerPoint Presentation) of each student will be evaluated by at least 4 judges using the evaluation rubrics. These evaluations will be shared with the RA also.
- After the Final-Day Presentations have ended, all REU students will assemble in a computer lab to complete the online *Project Satisfaction Survey Questionnaire* and the *Post-UGR II REU Program Rating Survey*. The *Project Satisfaction Survey Questionnaire* is designed to assess the success of the different programs, experiences and activities executed in the REU Program based on the feedback received from the students on the last day as the culminating activity of the program. The *Post-UGR II REU Program Rating Survey* consists of following three parts:
  - Research Advisor Rating Scale
  - Research Training Environment Scale
  - Self-efficacy and Attitudes Scale

Collectively the questions included in the *Post-UGR II REU Program Rating Survey* are created to address the following research questions, grouped in four constructs:

- **R. Research:** What impact did the research environment have?
- **E. Expectations:** What was the impact of the training in research?
- **M. Motivation:** What parts of the support structure impacted the student motivation and to what extent?
- **G. Guidance:** How well did the support structure meet the needs of the students?

For each construct (R, E, M and G), evaluation questions or scales are framed. Cronbach’s Alpha Reliability\(^5\) Coefficient is used to validate the mapping and contribution of the scales considered for each construct and to assess the overall contribution of the scales considered for a construct towards answering the research question posed in the construct.

**GRADING POLICY:** Grades will be based performance as measured by relevant assessment instruments for the following deliverables in the format supplied:

1. Research Project Summary Report
2. Interim reports and PowerPoint presentations (2 per semester)
3. Final Technical Paper
4. Final PowerPoint Presentation,
5. Final Display Poster

The final grade for the course will consist of two components: 50% for meeting all course requirements, and 50% for quality of deliverables. The grade will be assigned by the CC, with pertinent input from the RA.

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IV.5 COURSE REQUIREMENTS FOR GRADUATE CERTIFICATE IN
ENTREPRENEURSHIP (Total = 12 Credits)

12 semester hours to be earned by completing following courses:

- MGMT 7035 Management of Innovation: 3 credit hours
- ENTR 7005 New Venture Creation (Syllabus included in Supplemental Material): 3 credit hours
- ENTR 7089 Capstone in Entrepreneurship (Syllabus included in Supplemental Material): 3 credit hours
- One ENTR Elective (3 credit hours); possibilities include, but are not limited to:
  - MGMT 7012 Leadership and Organizations
  - ENTR 7025 Global Entrepreneurship
  - ENTR 7035 Management of Closely Held/Family Business
  - MKTG 7021 Design Thinking for Business