

Weekly Schedule at-a-Glance and Activities

Summer Research Experience for Undergraduates (REU) Site: **Hardware, Embedded Software, and Analytics for Environment Quality Monitoring**

June 5 - August 11, 2023

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The program activities are listed in Table 1. These activities are planned such that they support and facilitate the immersion in research. They will expose and engage the REU students in activities that graduate students conduct routinely, with the goal of motivating and preparing students for life-long learning as researchers and practitioners. The goal of these activities is to engage students in: 1) conducting hands-on research, 2) attending talks and interacting with speakers who may become role models, 3) observing researchers and engineering practitioners in the workplace, and 4) communicating results.

Table 1: Program activities for REU students in support of research immersion.

Frequency	Program Activity	Type	Program Weeks
Daily	Conduct research in faculty labs	Conduct, hands-on	1-10
Weekly	Meeting with faculty mentor and graduate student	Listen, learn	1-10
1	Orientation	Learn	1
4	Online technical training, self-paced	Conduct	Per-need basis
5	Environment monitoring colloquium & lunch with speakers	Listen	3-8
10	Machine Learning (ML) BootCamp	Learn	1-5
6	Entrepreneurship BootCamp	Learn	4-6
4	Visit and tour local high-tech companies	Observe	2,4,6,8
3	Technical writing and communicating science BootCamp (covers ethics as well)	Communicate	7-9
1	Graduate school seminar	Listen, Learn	7
1	Poster session	Communicate	10

1 Online technical training, self-paced

Conducting research most often requires the use of integrated design environments and programming skills including data structures, algorithms, and debugging for example in embedded C and Python. A repository with collections of online tutorials for these programming topics will be created and made available to the REU students to take as needed at self-paced, in the first weeks of the program, in order to bring students up-to-speed rather quickly. This activity will prepare and help students do better in other related activities, such as the Machine Learning (ML) BootCamp, which uses Python.

2 Machine learning BootCamp

Because environment monitoring involves the generation of a large amount of data and due to the recent surge in machine learning (ML) techniques in most application domains, one of the program activities is the *ML BootCamp*, which will provide an understanding and the skills necessary to manage and analyze data. For this purpose, the REU students will take the online free Edx course “Machine Learning with Python: A Practical Introduction”. This course introduces students to the basics of machine learning using Python and covers topics about Supervised versus Unsupervised Learning, how statistical modeling relates to machine learning. It explores many popular algorithms

including classification, regression, clustering, and dimensional reduction and popular models such as train/test split, root mean squared error and random forests. The course length is 4-6 hours per week for 5 weeks. Being trained in ML, students will engage in research faster and will recognize when ML techniques are applicable to a specific project.

3 *Technical writing and communicating science BootCamp*

Successful research goes hand-in-hand with verbal and written communication, needed to explain and disseminate the problems addressed, the solutions proposed and tested, and the interpretation and reporting of the results. To help the REU students understand the importance of communication (highlighted in the latest IEEE/ACM guidelines for Computer Engineering Curricula) and to improve their communication skills, several writing workshops will be implemented. The objective of this workshop series is to teach students to better report their findings while writing research manuscripts and creating posters. These workshops will be two-hour each and will be taught by qualified faculty. Students will also be given additional writing tools and resources provided by the Marquette University Ott Memorial Writing Center.

4 *Entrepreneurship BootCamp*

Synergetic with existing efforts at Marquette, we will implement an entrepreneurship bootcamp whose objective is to help students create connections between their research and opportunities of deploying their research results into the real world as potential start-ups. Marquette is an active member of the KEEN network, which is a national partnership of universities with the shared mission to graduate engineers with an entrepreneurial mindset so they can create personal, economic, and societal value through a lifetime of meaningful work. The meetings of this bootcamp will be organized by the PI as informal two-hour sessions with open discussions and presentations on how to write a business plan and how to seek funding from entities such as YCombinator. A closely related effort at Marquette is the Kohler Center for Entrepreneurship, which we use as an additional resource. The center is a recently launched open space dedicated to promoting entrepreneurship among students. A de facto tech-incubator, the center helps students and faculty develop an entrepreneurial mindset, develop skills, and grow their networks through activities such as Silicon Valley experiences, after hours speaker series, coffee & conversation, workshops, branding support, think-big office hours, university innovation fellow program, and GCEC (Global Consortium of Entrepreneurship Centers).

5 *Environment monitoring colloquium & lunch with speakers*

To help REU students acquire a global picture of where their specific project fits in the grand scheme of environment monitoring science, they will attend five (5) colloquia where the speakers are faculty from the ECE, ME, and CCEE departments. The speakers will present highlights of their current research and discuss with students the research questions they address and how their solutions weave into the grand scheme. Each presentation will be followed by a group lunch with the speaker, where the students will have additional opportunities to ask questions, get feedback on their projects, and brainstorm in general. Aside from pointing out the need for convergent and interdisciplinary research across departments, these colloquia will expose students to successful role models and therefore strengthen the students' motivation and desire to participate in this kind of research.

6 *Visits and tours at local companies*

A closely related activity will be visits to local companies to meet and talk to engineers and to participate in organized company tours. Experiential learning opportunities such as these visits are effective in exposing students to the real-world research and development in the workplace and preparing them to transition into the workplace.

7 *Graduate school seminar*

One of the objectives of the REU program is to encourage undergraduate to pursue graduate studies towards earning M.S. and Ph.D. degrees, thus effectively increasing the recruiting pool for the graduate program. Towards that objective, the students participating in this seminar will learn to identify graduate programs that best fit their research interests and relevant NSF graduate fellowship programs.