**Undergraduate Researcher Guide and Expectations**

By Prof. David Warsinger

**Role**

You are a researcher, engineer, and scientist who happens to be an undergraduate student.

**COURSE DESCRIPTION**

This course is an independent mentored laboratory research experience. Students will have at least one graduate mentor to aid them in their progress. ME 498 is the initial introduction to the lab performing guided research (Enrollment info [here](https://engineering.purdue.edu/ME/Undergraduate/ResearchOpportunities), forms here [1](https://www.purdue.edu/registrar/documents/forms/Form-VT.pdf?_ga=2.85174681.1223317425.1609695156-830832258.1594323649),[2](https://engineering.purdue.edu/ME/Undergraduate/Files/researchContract)). Students taking 2 or fewer credits enroll in ME 497, and Sophomores take ME 297 instead. As students progress to be more independent scientists and engineers and become comfortable in the laboratory setting, they take ME 499 in subsequent semesters for additional research credits. Each research experience is defined by the project needs and goals set out by the research mentors (graduate researchers, staff research scientists, and faculty) and the individual student. Students are expected to make progress in their projects, maintain good laboratory practices, develop scientific inquiry skills and learn about the research in the lab and in their respective project fields. Alternative course credit numbers are

**Course Goals and Learning Outcomes**

The main program goal is to give students hands-on experience working directly in a laboratory setting while aiding the research progress of ongoing projects.

*Objective 1* – Understand and practice the research competencies necessary to be successful engineer and scientist in a laboratory setting.

*Objective 2* **–** Become familiar with the safety, instrumentation, and methods used in a research laboratory.

*Objective 3* **–** Develop effective engineering solutions to unmet research challenges that address real-world technological and environmental constraints.

*Objective 4* - Students will also learn and apply the principles of effective multicultural teamwork, creative brainstorming, as well as professional and intercultural communication.

**Required Supplies**

Laboratory notebook (supplied), pen, computer/USB drive

**Pre-Lab Preparation**

Before working in the lab, students must have done the assigned reading, viewed the required videos, and completed any required safety training (see orientation checklist)

# ASSESSMENT (GRADING)

The majority of each grade is determined by research progress, as evaluated in a biweekly progress report and final presentation and report of the overall semester’s progress. Additionally, proper safety training, evidence of spending time and effort on the project/in lab, proper documentation in the form of a lab notebook and data storage on the shared research drive, as well as being a good lab citizen by attending weekly meetings and keeping lab space clean also contribute to the grade. Significant weighting will be done on the strength of scientific contributions for these components, which goes into the progress report etc scores, but more importantly, plays a major role in academic opportunities such as paper coauthorship.

|  |  |
| --- | --- |
| **Component** | **Percentage** |
| Documentation (e.g. Lab notebook | 10% |
| Data in shared drive | 10% |
| Time in lab/on project | 20% |
| Weekly progress reports | 25% |
| Weekly lab meetings | 5% |
| Final presentation | 10% |
| Final progress report | 15% |
| Lab cleanup | 5% |
| Total | 100% |

**Safety Training:** Everyone who works in the laboratory must receive both building and lab-specific safety training. Major equipment in the lab and in collaborator’s spaces also requires specific training for use as well as using an equipment calendar. Please check with your graduate mentor for these additional training requirements.

**Documentation/Lab Notebook:** Provide key summary documents explaining experimental methods, research notes, experiments summaries, raw data, analyzed results, conclusions, and future work. You should provide key summary documents to transfer information to grad students and future undergraduates.

**Data in Shared Drive:** Keep a copy of all protocols, raw data, photos, progress reports, analyzed results and conclusions in the lab’s shared drive.

**Spend time in lab/on your project:** Students are expected to work efficiently on their projects throughout the semester. Students should schedule regular times to be working on the project, and put that on a google calendar shared with their graduate student or PostDoc mentor. When they have to miss times in lab, their mentor should be informed, and their calendar should be updated.

* For typical 3 credit hours, 10-12 hours should be put in to the project.
* For summers, minimum 10 per week per credit hour

**Biweekly Progress Reports**: During each weekly meeting with the instructor and graduate mentor, students will provide a short progress report including the project introduction, experiment purpose, work done the previous week(s), current work, and future plans. This should include annotated results of major experiments/designs with figure captions. Each report is weighted equally towards the final progress report grade. These will be stored in the lab’s shared drive.

* Project Introduction – 1 paragraph
  + Updated as information learned/literature search performed
* Experiment Purpose – 1 paragraph
  + Updated as needed
* Previous Work done including methods, results, conclusions:
  + 1 Paragraph per week
  + Separated by project if multiple projects
* This week done including updates to methods, results, conclusions:
  + Separated by project if multiple projects
  + Move to previous work done for next week’s report
* Next week plans: - 1 paragraph
  + Separated by project if multiple projects

We are often iterating on how these reports are done and shared, so please check with your grad mentor.

**Final Presentation:** At the end of the semester, each student will give a 10-minute presentation of their research experience summarizing their work during the past semester. The presentation will be followed by a 5-minute question and answer session on the research. These will be stored in the lab’s shared drive.

* Project introduction – 1 slide
  + Real-world motivation
  + Larger lab project you’re involved in
* Methods – 1 slide/method
  + Major methods used
* Results – 1 slide/set of results
  + Results from major experiments
  + e.g. 3 replicates with statistical significance determined
* Conclusions – 1 slide
  + Major findings
  + How these relate to overall lab/project goals
* Future work – 1 slide
  + Goals for next semester
* Lessons learned during the semester – 1 slide
  + What worked well/didn’t work for you

**Final Project Report:** At the conclusion of the semester, each student will provide a final report on their research experience summarizing their work during the past semester. These will be stored in the lab’s shared drive.

1. Project introduction ½ to 1 page
   1. Real-world motivation
   2. Larger lab project you’re involved in
   3. How your project related to at least 3 relevant papers in the field
2. Methods – major methods used
3. Results – analyzed/synthesized and annotated results from major experiments (not raw data)
4. Discussion/Conclusions – major findings, how these relate to overall lab/project goals
5. Future work – goals for next semester

**Lab cleanup:** Prior to the last day of the semester, students will clean up their lab space, ensure that their graduate mentor has access to all materials used in the research including the lab notebook.

**Expectations and Traits to Hone**

* Responsibility – Take ownership of your work, be trusted to take charge
* Independence – Solve problems on one’s own, seek guidance appropriately. Don’t wait to be fed work to do (like a baby bird): learn project objectives and execute plans to achieve them.
* Proactivity – Actively innovate and solve issues with foresight and the big picture in mind
* Responsive – reply to email (or texts) promptly
* Regularity – Adhere to doing research on regular schedule as the default. Inform us if you can’t make it
* Reliability – not needing any reminders to get work done. Meets deadlines.
* Creativity – Provide novel solutions and new ideas. This is a crucial strength of UROP’s, as young minds are more creative, and approaching new work makes their thinking more flexible
* Collaborative – Aid in the work, training, and development of others. Identify others with expertise and equipment to tackle your problems. Be helpful. Be social. Be empathetic.
* Learning – Read literature and seek out experiences to improve one’s skills
* Contribute Scientifically – Come up with novel ideas and share frequently. The ideal undergraduate student should strive to perform like a graduate student.
* Organization – Plan schedules and projects and complete them on time. Hones self-management skills and tools
* Self-development – List and pursue improvement in skills and abilities. Seek feedback.
* Feedback – Provide input on what is making them happy/unhappy, and explain what they would like to ensure they commit enthusiastically and for long time periods
* Problem Solving – Identify good research problems, learn which methods can be used to address it, combine these, and identify experts to question and work with
* Empathy – Always treat others kindly, and take care to respect and aid the needs, interests, and priorities of others.
* Integrity – The most important trait of a researcher. All studies must be honest, repeatable work, all sources must be cited, text cannot be copied from other work, etc.

**Tailoring the Work for you**

Let us know the skills you want to develop, the types of projects that interest you, and what you find motivating or are passionate about.

Skills we can help you develop:

learning of particular subject matter, experiment design, experiment building, planning and running scientific experiments, technical writing, making scientific contributions, patent basics, oral presentations, numerical modeling, scientific diagrams, data analysis, scientific graphing, learning software (e.g. SolidWorks, LaTeX, EES, FLUENT, etc)

Subject Matter

Desalination, energy efficiency, heat transfer, fluids, thermodynamics, water-borne disease, chemistry, fouling, superhydrophobic surfaces, nanotechnology, and for side projects: dinosaurs, space travel, cooling systems, and developing work issues including preventing hunger, start ups,

**Day-to-day details**

* If you are missing a scheduling time in lab, or planning on being out of town, please inform your mentor.

**Learning Material**

The group’s shared folders provide extensive training documents on how to do science, ranging from how to write papers, review papers, make good scientific graphics, increase citations, etc, as well as background literature. Please spend time reading through this, your work will benefit. Also, the grad student guide (also posted on the website where this is) has valuable information on research expectations, which can help you understand more about what a scientist should do.

**Recognition & Resume Lines**

* Acknowledgements in journal papers, conference papers, and theses. Your name will appear in these documents and presentations when you work on these projects. Expect several acknowledgements earned per semester, we have a very productive group.
* Award Nominations: we nominate exceptional students for institute awards: one recently won the “Peter Griffith Prize for Outstanding Undergraduate Experimental Work”
* Coauthor on a Journal or Conference Paper: We try to offer this opportunity to our students, it normally takes 2 semesters of contribution to meet the criteria to be a coauthor. Coauthorship criteria includes: be able to understand and defend the work, and provide at least one of: critical data interpretation, numerical modeling, experiment design & running, and key intellectual contributions. They must participate in writing and revising the paper, likely beyond the UROP.
* Coauthorship on a patent may be possible for extraordinary students with very long time commitments. This includes a stake in any patent profits equivalent to all other coauthors. This will require understanding ideas thoroughly to make contributions to the state-of-the-art.
* Conferences: we try to provide the opportunity for long-term productive dedicated students to attend research conferences, usually with papers as coauthor. Recently we brought two UROP’s to a California conference and Disneyland
* Recommendation Letters: We will write thorough recommendation letters for jobs or graduate school. One UROP student we recently recommended got into MIT for graduate school

**Resources**

* Graduate and undergraduate students in this research group
* Papallardo and MechE grad machine shops, RK tool room
* MIT libraries: research guides, compendex search
* Documents created by group: how to do a publication search

**Role of Mentor**

* Teach material that cannot be learned online or in simpler ways
* Direct to safety resources and training
* Defines research objectives
* Give relative importance of tasks
* Lead with enthusiasm, inspiration,
* Assign achievable projects
* Effectively critique and provide useful feedback
* Celebrate ideas and successes of mentees
* Recommendations for reading of literature and other learning
* Foster a gregarious community among the lab with group events, solid introductions, lunches,
* Create custom learning material for mentees when needed
* Schedule regular meetings of the group and subgroups, with set agendas
* Help work towards professional, career goals of mentees
* Make goals clear so that the student can find sufficient work
* Foster ambitious goals for the student
* Make efficient use of very limited time by strategic managing and mentoring
* A good mentor is an encourager, empathetic, a good mentor, decisive, appreciative, good tempered, approachable, and trusting