Thermal Systems Affiliated Research Groups

Thermal Hydraulics Laboratory (THL)
Solar Energy Laboratory (SEL)
Cryogenics Engineering Lab (CEL)
Multi-phase Flow Visualization & Analysis Lab (MFVAL)
Energy Systems Optimization Lab (ESOL)
Laboratory for Energy Transport + Storage (LET+S)

Welcome to the College of Engineering at the University of Wisconsin-Madison!

As a member of the thermal systems research teams, you will be a part of discovery and innovation that moves the boundaries of energy systems and related technologies forward. While you are here, you will gain a world class education while pursuing a Master of Science or a Doctorate degree. We know you will find research opportunities with the thermal systems research labs both challenging and rewarding.

The broad goals of our research program

Our group undertakes research projects that aim to improve the efficiency, safety, and cost-effectiveness of energy systems and the allied technologies that are essential to support global socioeconomic growth. Whether your research objective is to optimize the design or operations of large-scale solar thermal power plants, improve the end-use energy efficiency of building mechanical systems, or evaluate strategies to enhance the power production and safety of small-scale next generation of nuclear power systems, the impact of your research is determined, in large part, by you. Don't be intimidated, because you won't be working alone; rather, you will have the support of collaborating faculty, research scientists, and other graduate students.

What you can expect from your faculty advisor(s)

Each graduate student in our labs will have one or more faculty advisors. Our role as your faculty advisor is to help you successfully navigate the waters of graduate education and provide you with the tools and experience that position you for intellectual leadership, whether you pursue a faculty role, become an engineering professional in industry, or undertake research at a national laboratory. You can expect your faculty advisor(s)[1] to meet regularly with you on a weekly or bi-weekly basis. During these advisor meetings, we review and discuss the progress you are making in your research efforts and the challenges you are experiencing so you can take appropriate next steps and move forward on your project. We do our best to answer questions that you have and help you solve problems that will, inevitably, arise during the course of your research. It is important that you keep in mind that conducting research is not easy, and you will face pitfalls, challenges, and setbacks – this is the nature of research. Although your faculty advisor(s) are committed to help you minimize counterproductive difficulties, they still can (and often do) happen. You must provide the grit, determination, and perseverance needed to overcome these challenges, to ultimately succeed in completing your degree, and to leave prepared for the next steps in your career. You can expect your faculty advisor(s) to **be your advocate**. If you have a problem, come and see us. We will do the best we can to help you solve it.

Your faculty advisor(s) are committed to:

- **Setting the overall scientific direction and providing the means for you to pursue that direction**. This will include identifying a research topic, writing grants to fund your research, and maintaining the necessary university protocols to conduct your research. Additionally, we will seek out collaborators for this work in order to further your opportunities.

[1] Many research projects will have two collaborating faculty advisors.

- **Mentoring you now and in the future.** We are committed not only to your graduate education and training at the UW-Madison, but also to preparing you to successfully transition to a future career in academia, lab research, or industry.
- **Encouraging you to attend scientific meetings and facilitating the funding of these activities.** These meetings are important to showcase your work, and they provide essential networking opportunities as you pursue positions after your time at UW-Madison.
- **Be available for regular meetings and provide timely response to reviews of research.** As noted above, we will meet with you regularly and maintain an open-door policy. Please be aware that there will be times when we will not be readily available due to other obligations. For abstracts and small data questions, we will generally review in 1-2 days. For papers and theses, plan on a review period of 1-2 weeks. In the event of a lab emergency, contact us immediately by cell phone.
- **Providing a work environment that is intellectually stimulating, supportive, safe, and free from harassment.** We take seriously the health and civility of our academic environment and any difficulties you experience in relationship to this statement. Robust intellectual exchange and advancement of knowledge flourishes among individuals with diverse perspectives, backgrounds, and problem-solving approaches who value each other's contributions. If conflicts arise with another member of the lab (student, staff, or faculty), please inform your advisor or, if that is not appropriate, another faculty in the lab and we will work with you and the other lab member to find a resolution. We will strive to understand your unique situation and are open to your suggestions on how to improve your experience in the lab.

What we expect from you

You will take ownership of and responsibility for your educational experience

- You will **work safely in the lab**. Before beginning any experimental work in a lab setting you must complete requisite safety training, and you will be expected to renew that training as necessary. You must follow all safety procedures defined in our lab protocols and immediately communicate any safety concerns to your advisor(s). Part of working safely is also taking care of equipment, reporting any issues, and communicating with other users of affected equipment if there is an unresolved problem.
- You will **determine the requirements for your individual graduate program** and are responsible for ensuring that you **comply with department and graduate school requirements**. As you progress, we will work with you to select courses, complete qualifying exams, and select thesis committee members.
- You will **keep us updated on your research**, including progress, plans, and challenges**.**
- You will normally work in the office or lab, particularly during core[2] hours of the day unless you are attending class or have prior approval from your advisor to work remotely. If you are not feeling well, inform your advisor and do not come into the office or lab. The intent of this policy is for you to be around and available to interact with your peers and advisors and others in the department on a regular basis. Hallway and office interactions have significant positive benefits in your tenure as a graduate student.
- To earn your degree, you will **transition towards independence**. We will work together to track this process, but you ultimately need to attain research outcomes that meet the requirements of the degree you are pursuing – it is not simply a matter of putting in time or completing coursework.
- You will **seek out professional development opportunities**. Being a successful scientist involves more than being good "at the bench." You must communicate well in both writing and speaking (presentations, papers, grants), develop personal skills (time management, project management, safety, mentoring of new students), maintain high ethical standards, and (for a faculty career,) teach

[2] An example of core hours would be 9 am – 3 pm. Some students start their day earlier and end earlier while others start later and end later. The idea is to have some period during the core of the day when everyone is in the lab or office.

effectively. These opportunities must be balanced with the most important element of your career development – research progress towards your thesis.

- You will **collaborate and act professionally with colleagues and grant monitors –** many of the funded projects that are used to support your stipend and tuition require regular meetings with industry, laboratory, and university partners and with the sponsors (e.g., the Department of Energy). Graduate students are involved and often present their progress during these meetings. As such, we expect all students to be prepared, professional, and effectively engage with sponsors. Your involvement reflects on the lab in general, and maintaining good relationships and reputation are important for obtaining future project funding. In addition, funding agencies will have specific requirements to meet project milestones and deliverables. This means you need to communicate candidly and constructively with your advisors if research progress lags project goals. We expect you to be proactive and initiate discussions on lagging progress toward research goals in a timely manner so that corrective action can be taken or alternate solutions collaboratively sought.

You will develop your personal research skills

- **Reading the scientific literature** is a core component of research and scientific inquiry. You will develop literature search and review skills to both understand your technical field and identify gaps in existing knowledge that your research can fill. Throughout your time here, and thereafter, you will find value in **routinely** searching, organizing, and distilling literature for use in formulating research plans or for reducing the latest advancements to practice. We recommend you subscribe to relevant electronic tables of contents (eTOCs) to help regularize and facilitate the literature search process.
- Learn how to **plan your experiments or analyses** so that they help you progress toward the overall goal(s) of your project. Maintaining clear and consistent communication with your advisor(s) will help ensure your experiments or analyses are designed to address the key question(s) related to your project. We will guide you to develop specific task plans with a mix of short, medium, and long-term goals.
- Keep **detailed notes** – these lab or analysis notebooks are essential to turn your hard work into a finished paper or thesis. Your notes should allow your work to be reproduced (i.e., they must be clear and meaningful when read by people other than yourself) and will help to establish credit for authorship. Detailed contemporaneous notes are required by funding agencies and for any potential patents. You are required to leave the originals behind when you leave the lab so that others can build upon your work.
- **Write and archive computer code following common best-practices**. Like your laboratory notebook that documents work in a reproducible manner, computer code must be easily understandable and executable by people other than yourself. Code must be thoroughly documented using in-code comments, and you should make use of version management tools to preserve a record of development for code that is of direct significance to your research outcomes. You are required to leave the originals behind when you leave the lab so that others can build upon your work.
- Develop your **writing and presentation skills**. As you make progress on your project, begin outlining a paper's figures and drafting the text. Be prepared to go through rounds of revisions before submitting an abstract, paper, or thesis chapter. Although the availability of travel funds will vary, you are encouraged to work with your advisors to submit your work for presentation at relevant conference(s) and/or to attend other conferences related to your research area. **Attend relevant seminars** – we suggest you attend 1-2 seminars/month in addition to the SEL seminar (which you should make every effort to attend, and if you cannot attend notify your advisor) to both expand your scientific knowledge and to learn how to give a good talk. You will also be able to present your research during one or more of the weekly seminars we hold for graduate students in our labs.
- Develop your **mentoring and management skills**. You may have the opportunity to mentor undergraduate or newer graduate researchers during your time here. Mentoring is an honor and this honor comes with responsibility. In a mentoring role, you are not expected to do work for those you

are mentoring; rather, you might help someone fulfill their academic requirements, make progress toward research goals or help out in other ways when needed. Mentoring will take some of your time but you will be developing skills that all technical professionals need in their careers. If you are supervising an undergraduate student, you will be expected to set expectations for their work, train them appropriately, provide them with experimental guidance, and ensure that they operate in a safe and respectful manner in the lab.

- Consider **applying for fellowships, traineeships, and travel grants**. Not only will an award help your career and the overall lab funding situation, the experience of writing the proposal will help you think about what you are doing more deeply.
- Learn how to **accept and utilize constructive feedback, including criticism**. The feedback you receive from your advisor(s), campus colleagues, thesis committee members, and faculty teaching your courses is intended to improve your work. Critical feedback is an integral part of the scientific method and helps position your research more favorably for your thesis defense and publication in literature. When you submit a paper for publication, expect to receive critical feedback from reviewers on the content of your paper. Your advisor(s) will work with you to determine what revisions are required to address reviewer comments. Conversely, learn how to offer constructive feedback for other students, advisors, and members of the lab.

You will contribute to the lab and be a good lab citizen

- Graduate students with more experience are a critical resource to help to assimilate incoming graduate students in a variety of areas from life in the lab and at the UW to life in Madison. This may include understanding lab safety, policies, procedures, how individual/group meetings work, literature searching, etc. **Science is a community** - many people will help you along the way and you should return the favor. Share your insider knowledge of techniques with others when you become the seasoned graduate student. Be positive, helpful and understanding of others perspectives.
- **Data belongs to the lab, not to any one individual** – as a result, you will be expected to leave your original notebooks, code, and computer files with us when you leave the lab. In addition, there will be times when you will be asked to assist your advisor(s) in submitting grant applications to appropriate funding agencies such as DOE/NREL/NSF/etc. This activity benefits you in the short term with project funding and in the long term with valuable experience in preparing proposals.
- While we try to shield you from what might seem as irrelevant tasks, it is possible that you could have a **designated lab job** such as ordering, general maintenance, taking care of or learning how to use specific instruments, managing computer systems or software packages, specific lab hygiene officer, etc. Taking ownership of and sharing these types of tasks is a part of being a good lab citizen. Everyone is expected to help with “doing the dishes” making sure supplies do not run out, that labs are clean and safe, that problems with equipment or computational resources are reported to the person in charge, and that general lab housekeeping is honored.
- You will **keep lab protocols and safety procedures up-to-date**- Each physical lab has a chemical hygiene plan that contains lab chemicals, and safety procedures for the lab and experiments. You will need to keep this up-to-date as you build or modify experiments so that everyone in the lab can be safe.
- If you work as a guest in the labs of other investigators, be particularly polite, neat, and gracious. Always follow their rules. If something breaks during your use, report it immediately to the appropriate person.

Be respectful, tolerant, and collegial with laboratory colleagues: respect individual differences in values, personalities, and work styles.

Nuts and Bolts

Hours and Vacation

There is not a timeclock in the lab to track your hours. Recognize that research is not a 9-to-5 proposition and that you may find yourself working nights and weekends to make progress or meet project milestone deadlines. Before finalizing a planned period of absence for vacation, please communicate with your advisor(s) to ensure your absence is not adversely impacting project deadlines or others that may be relying on your work. You will be expected to satisfactorily complete all assigned research duties prior to your planned departure. Details on leave and benefits are provided at: https://hr.wisc.edu/policies/gapp/. As of December 2023, the university vacation policy applicable to a graduate student on a 50% RA corresponds to 90 hours (11.25 days) of vacation leave annually. You can use this as a guideline. (Note, that vacation is time away from the office/lab while not on university approved paid travel or sick leave, unless otherwise agreed to by your advisor). You must notify your advisor as soon as possible if you must take sick leave.

Work Location(s)

As noted above in "What we expect from you", plan to be in person during core working hours in the office or lab so you can more easily interact with your advisor and fellow graduate students. Remote work should be coordinated with your advisor in advance. Your time in the office or lab does not need to be limited to research-related work, but you should use the time to be productive. If you find that something in your work environment is significantly hindering your ability to work productively, communicate with your advisor so that the issue can be addressed. Be mindful of your own impact on the working environment for your lab mates, avoiding excessive noise, uncontained messes in your own workspace or in common areas, and other potential distractions.

Advisor Meetings

Come prepared to discuss/present your recent research and next steps. A written agenda including what you have done and what you propose to do in the next week is a useful tool. It is also useful to bring your lab notebook or computer to each meeting along with any summary slides you may have prepared to discuss your progress/results. Think ahead about questions that you have. Be cognizant of the allotted meeting time and courteous of other students who may also be scheduled to meet with your advisor(s).

Annual Evaluations

Each year you will receive an evaluation. The annual evaluation is a tool to help us to identify things that are going well or areas that need improvement. As part of the evaluation process, you will reflect and prepare a self-evaluation that includes highlighting accomplishments during the past year, opportunities for future growth, and plans for the coming year. The evaluation is also an opportunity for you to communicate to us what we can do to help you succeed. Tell your advisor(s) if you feel that you need more guidance, more independence, to meet more often, etc. **If you have urgent concerns, do not wait until the annual evaluation, and let your advisor(s) know immediately**. Each year we will also try to have social programs and training to help everyone work in groups more effectively.

Authorship

One of the most important tasks in science is disseminating your research through publications and presentations; therefore, your authorship on these items is an important indicator to the outside world of your research achievements and specific role on a project. Authorship implies a significant intellectual contribution to a paper such as ideas that meaningfully contribute to the field. While the order of authors on a publication varies by specific field, our lab's general approach is for the student/post-doc who led in conducting the research and who drafted the paper to be listed as the first author, and advisors will typically be listed last. It is typical for a Masters student to be a major contributor or main author on at least one refereed journal paper and a Ph.D. to be a major contributor or main author on at least two refereed journal papers. However, publications are in your best interest and are major metrics used by potential employers evaluate candidates.

Working language of the laboratory

We have a fairly diverse set of individuals in the labs and at times there may be several people from different countries or whose native language is not English. We also might have visitors or colleagues that speak different languages. While we respect this and the potential interest from others in the lab to learn a different language, the working language of the laboratory is English. We encourage everyone to interact in English so that all can be included and participate. You will also be expected to be able to present your work and communicate to others outside the group in English. Please respect others and try to carry on conversations primarily in English.

Conflict Resolution

If a conflict arises with another lab member during your time here that cannot be resolved, inform your advisor or one of the other faculty in the SEL and we will work with you to find a resolution. If the conflict fails to be resolved or you do not feel comfortable involving your advisor(s), you can consult with the Mechanical Engineering Department Chair, the Chair of the Graduate Committee, or the University Ombuds office to attempt to settle the conflict.

Disclaimer

Please note that this document is not a substitute for university rules and regulations, and that those policies and any legal requirements supersede anything included in this document.

I have read, understand, and accept the above expectations:

Student Signature: _____ Date:_____

I have reviewed the above expectations with the above-signed student:

Advisor Signature: _____ Date:_____

Revision History

Ver. 1.0 – 10/8/20 – Initial version issue
Ver. 1.1 – 11/10/20 – Addition of expectations for working language in the laboratory
Ver. 1.2 – 1/5/24 – Addition of expectations for working in-person in the lab/office, expectations to attend weekly SEL seminar, mentoring, proactive communication with your advisor if your research progress is stalled, conflict resolution, and clarification on vacation.