# Modern Physics Lab

**Course Website:** *Moodle*: https://moodle.augsburg.edu

**Course Overview:** This course is designed to usher students into the broader community of scientists. Simply by learning and applying scientific tools, you have belonged among scientists since the start of your academic careers, but in this class we will delve into what it means to be a scientist through the context of a computational physics research. In the first 2/3 of the class, we will split our time between discussions of what it means to be a physicist (based on the writing of physicists) and hands-on activities that build computational research skills (based on my own experience of computational research). These activities will culminate in calculations of the thermoelectric properties of a known system. Over the final 1/3 of the class, you will perform a condensed research project, where you develop a question, formulate a hypothesis, perform a computational experiment, and share your results with the scientific community. Through an authentic experience of scientific research, you will gain skills

**Course Outcomes:** Upon completion of this course, students will (broadly) be able to:

1. Observe and pose scientific questions about natural phenomena.
2. Develop a hypothesis, plan for testing, and carry it out based on a well formed question.
3. Work collaboratively in teams/groups.
4. Use density functional theory to compute structural, electronic, and thermoelectric properties of materials.
5. Generate, share, and communicate scientific content using plotting software found in professional research.
6. Describe the interests, attitudes, and values of the broader physics community.

## Instructor:


| | |
|---|---|
| Instructor: | Prof. Daniel Hickox-Young (he/his) |
| Contact: | Hagfors Center 135 |
| | ☎ 612-330-1012 |
| | ✉ hickoxyo@augsburg.edu |
| | https://augsburg.zoom.us/my/hickoxyo |
| Office Hours: | Tues. and Wed. 3-5pm in HC 135. |
| | Drop by whenever my door is open (no appointment necessary). |
| | If you like appointments, feel free to set one with calendly or by email. |
| | I am also happy to meet via Zoom. |


**Course Structure:** This course consists of one three-hour meeting per week.

We will engage in a variety of activities during our meetings, including some lecture, in-class activities, and discussion. However, our primary practice will be hands-on practice of computational physics research techniques, culminating in a guided independent research project.

## Class Meetings:

**Lab:** Tuesdays from 8:20-11:20am, Hagfors 109

**Course Materials:** There is no textbook for this class. Readings (including research articles, textbook excerpts, etc.) will be provided via *Moodle* as necessary.

Note that although we will be focusing on computational research techniques, you are still strongly encouraged to maintain a lab notebook.

**Student Assessments:** Assessments are outlined below. Grades will be updated regularly on *Moodle*.

| Activity | Weight | Notes |
|---|---|---|
| Engagement | 10% | Constructive participation during lab. |
| Reflections | 20% | Based on thoughtful completion, once per week. |
| Lab Activities | 35% | Completed primarily during lab. Lowest grade dropped. |
| Research Project | 35% | Completed in pairs over the last several weeks. |

**Attendance/Engagement:** In-person engagement with colleagues is one of the cornerstones of science and therefore central to our course outcomes. In addition, meeting only once per week only adds to the significance of attendance for each lab session. Even so, I realize that there may be a day in which you need to prioritize some aspect of your life outside of class. If you need to be absent, please *let me know at least one hour prior to class* so that I know not to expect you and so that we can arrange a time to meet and make up the content you missed. **The first absence with advance notice** will not count against your engagement grade. Additional absences, and any absence without notice, will result in no engagement credit for the associated session. Exceptions due to emergency or extenuating circumstances will be considered on a case-by-case basis.

Engagement is different for every student, so this is not a "one-size-fits-all" category. Engagement might be asking questions, speaking up in full-group discussion, working diligently on activities, or helping a classmate with a task. So long as you are present and involved in lab activities, I will know that you are working toward our course outcomes and you will receive full credit.

**Reflections:** Each week we will engage in a practice of intentionally reflecting on how course content impacts our daily experience of the world. In particular, we will consider what it means to be a physicist as we learn about the topics that matter most to physicists. These reflections will also sometimes offer an opportunity for me to collect feedback on the course climate and structure. While there is no strict length minimum or maximum, I will communicate a general expected response length with each assignment. Reflections will generally be *due Monday nights at midnight*.

**Lab Activities:** Over the first 8 weeks or so we will be acquiring computational research skills through hands-on laboratory activities. Each of these sessions will have a deliverable associated with it (i.e. answers to a list of questions, perhaps sometimes in the form of a figure and/or a few lines of code). Although the goal will be to make this achievable within our lab time, I will accept submission of lab deliverables up until the following *Friday afternoons at 5pm*. See below for policy on late work. Note as well that *the* ***lowest lab activity grade*** *will be dropped at the end of the semester.*

**Research Project:** Over the course of the first 2/3 of the term, we will develop the skills necessary to perform first principles simulations of the thermoelectric properties of materials. Over the last 1/3 of the course, you and a partner will perform a research project in which you investi-

gate and original question regarding the relationship between crystal structure and thermoelectric performance. Our last several meetings will be dedicated to check-ins regarding progress toward completion of this final project, culminating in a final oral presentation and written report of your findings due on the last day of lab.

**Late Submissions:** Assignment deadlines have been set with students in mind, so that the benefit you derive from this class is maximized when work is submitted on time. However, I realize you have other classes, other obligations, and various other unexpected challenges which may arise during the semester. As a result, I have a simple "no-call, no-show" policy for late work. If you will not be able to meet a deadline, simply *notify me via email* ***at least one hour*** *before the deadline* and we will arrange an extension, no justification necessary. I will trust you to make your own decisions about when to prioritize your work outside of class. If you communicate that the deadline isn't going to work, we will sort out a new one and you will still be eligible for up to full credit. *Any work submitted late without prior notice (i.e. a "no-call, no-show") will no longer be eligible for full credit*, but can be submitted any time for up to 70% of the credit it would have received if turned in on time. Exemptions to this policy due to emergency (i.e. sudden onset of symptoms of illness, family emergency, etc.) will be considered on a case-by-case basis.

**Grading Scale:** Final grades will be assigned using the usual grading scale:

| Letter | F | D | C- | C | C+ | B- | B | B+ | A- | A |
|---|---|---|---|---|---|---|---|---|---|---|
| Score | $< 59.\bar{9}$ | $69.\bar{9}$-60 | $73.\bar{9}$-70 | $76.\bar{9}$-74 | $79.\bar{9}$-77 | $83.\bar{9}$-80 | $86.\bar{9}$-84 | $89.\bar{9}$-87 | $93.\bar{9}$-90 | $> 94$ |

Depending on the results of the course, a curve may be applied to the grading scale. Note that I will NEVER curve grades downward, only upward and only if necessary to account for my misjudgement of the degree of difficulty of an assessment.

**Modifications to the Syllabus:** I reserve the right to change any part of the course during the term, including assignments, grading structure, due dates, and schedule. Any changes will be communicated to students verbally and *via Moodle*. Please check *Moodle* regularly to keep informed of any changes and announcements.

**Inclusion Statement:** Augsburg University values the diversity of persons, perspectives, and convictions. Critical thinking, rigorous analysis, and open discussion across a full range of ideas lie at the heart of the University's mission as an institution of higher learning. Essential to the University in living out its mission of educating students to be "informed citizens, thoughtful stewards, critical thinkers, and responsible leaders" is that the foundation be one of diversity, inclusion, equity, and intercultural competency.

I expect everyone to contribute to creating an inclusive environment. At a minimum, this means affirming the identities we bring to the classroom by using each other's names and pronouns. Beyond this foundational necessity, I believe each class should have the opportunity to shape their own community guidelines. To help create a space in which the diverse backgrounds, perspectives, and approaches will enrich our discussion without causing harm, we will spend some time on our first day of class crafting community agreements to unpack what that means to us.

**Academic Support and Accommodations:** Your success in this class is important to me. We all need accommodations at times because we all learn differently. If there are aspects of this course that prevent you from learning or exclude you, please let me know as soon as possible. Together we'll develop strategies to meet both your needs and the requirements of the course.

**Academic Tutoring**: Your tuition provides you free access to academic support resources. You can find a list of tutoring resources at Academic Advising.

**Writing Center**: Augsburg's Writing Center provides both in-person and online opportunities to get support and feedback on your written assignments. The Writing Center is in Lindell Library, Main Floor, just inside the street level entrance and to the left of the circulation desk or online at https://sites.augsburg.edu/writingcenter.

**Disability Accommodations and Accessibility:** If you need disability-related accommodations to have equal access in this course, please contact the CLASS Office (Disability Resources) at class@augsburg.edu or schedule a meeting with CLASS at www.augsburg.edu/class.

**Phone**: (612) 330-1053.

**Location**: Lindell Library, 216.

If accommodations are required, the CLASS Office will notify me privately about your needs. Please note that you will not be required to disclose your disability, only your accommodations. The sooner you let me know your needs, the sooner I can assist you in achieving your learning goals in this course.

**Health and Wellness:** As part of the University's support systems, you also have access to campus resources to maintain your safety, health, and well-being. We understand that as a student you may experience a range of issues that can cause barriers to learning. These stressful moments can impact academic performance or reduce your ability to engage. If you or someone you know are suffering from any challenges, you should reach out for support. For concerns about physical or mental well-being, the Center for Wellness and Counseling is located on the first floor of Anderson Residence Hall, 612-330-1707 or https://www.augsburg.edu/cwc/. Student Support Services maintains a Student Support Guide that lists a wide range of community resources for Crisis Support, Academic Support, Personal Concerns, Health Concerns, and Basic Living Needs.

**Academic Integrity:** It goes without saying that the entire academic enterprise is founded on academic honesty. All work submitted in this course should be your own and produced exclusively for this course. The use of sources (ideas, quotations, paraphrases) should be properly acknowledged and documented. We will discuss in more detail what this should look like for your final reports (I am not too concerned about proper citation on the reflections, since these should be primarily your own thoughts). Academic dishonesty can have serious consequences. You can review the full academic honesty standards and consequences by viewing the Augsburg Academic Honesty Policy and talk to me if you have any questions.

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*This syllabus was adapted using syllabi templates from Jon Emery at Northwestern University (2023), the Duke Flexible Teaching Syllabus Template, the Augsburg Center for Teaching  Learning (2023)), and Ben Stottrup at Augsburg University (2023).

**Course Schedule:** The course material is subject to change. The anticipated schedule is provided below and will be updated on *Moodle* as the course progresses.

| Week | Reading Topic | Day | Date | Description | Assessment/Event |
|---|---|---|---|---|---|
| 1 | - | Tu | 8/30 | First Week of Classes | NO LAB |
| 2 | - | Tu | 9/5 | Syllabus, Command Line Intro | |
| 3 | - | Tu | 9/12 | Intro to Materials Science and Crystal Structure | |
| 4 | - | Tu | 9/19 | Intro to HPCs, Electronic Structure, and Plotting | |
| 5 | - | Tu | 9/26 | Intro to DFT, Convergence | |
| 6 | - | Tu | 10/3 | Structural Relaxation | |
| 7 | - | W | 10/10 | Phonons | |
| 8 | - | Tu | 10/17 | Calculating Thermopower | |
| 9 | - | Tu | 10/24 | Putting it All Together | |
| 10 | - | Tu | 10/31 | Research Projects | |
| 11 | - | Tu | 11/7 | Election Day | NO LAB |
| 12 | - | Tu | 11/14 | Research Projects | |
| 13 | - | Tu | 11/21 | Research Projects | |
| 14 | - | Tu | 11/28 | Research Projects | |
| 15 | - | Tu | 12/5 | Final Presentations | |