

Advising Notes for Physics Majors

Version date: Spring 2019 (3/22/19)

We put together these notes to help you get the most out of your major, especially when planning your courses. Please look over them carefully, as failure to follow some of these guidelines may prevent you from taking desired courses or even from graduating on time. For a full listing of the requirements for the Physics major, see the UC Merced Academic [Catalog](#).

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1 Welcome to the Physics Program

Physics is the study of nature at its most fundamental. Its scope covers everything from the tiniest particles of matter—such as atoms, electrons and quarks—to the structure of the entire universe, encompassing innumerable galaxies and stars. At UC Merced, our areas of expertise lie in Atomic,

Molecular, and Optical Physics; Biological and Soft Matter Physics; Nanosciences and Condensed Matter Physics; and Solar and Energy Sciences.

1.1 Emphases

In addition to the Physics, B.S., there are currently four emphases: 1) Atomic, Molecular, Optical, Condensed Matter, 2) Biophysics, 3) Mathematical Physics, and 4) Custom Emphasis. There is no requirement to have an emphasis; the philosophy is that it helps students focus on a particular interest within a major. The Physics, B.S. requires all the core courses, a minimum of 2 additional electives of your choice, and senior research and thesis. The emphases, require a minimum of three electives that specialize in the specific emphasis. The research and senior thesis are also aligned with the emphasis. The [Catalog](#) lists the electives with each of our emphases. The custom emphasis must be approved at least two semesters prior to finishing your degree. (A common custom emphasis focuses on Engineering.) The courses and when they're offered are given in Section 3.

1.2 Advising

As of Fall 2018, all first year students receive academic advising through the [Bobcat Advising Center](#). Afterward, you'll be working the physics academic advisor, listed in Section 6 or check [Natural Sciences Advising](#). All physics majors are also assigned a physics faculty advisor. Your *physics faculty advisor* offers you disciplinary expertise on course content; advice for timing courses; and advice for pursuing research, internships, and a physics-related career. Your *academic advisor* offers guidance on meeting all campus, School, and Major requirements for graduation. We recommend students meet with their physics advisor before enrolling in spring courses. Majors are **required** to meet with their physics faculty advisor before enrolling in Fall courses; a hold is placed on your registration for fall course until you meet with your faculty advisor.

When these notes are distributed via the physics majors email list, you should also receive a list of physics faculty advisor assignments. If you cannot locate this, contact the physics undergraduate lead (see Section 6). Check this list to find your physics faculty advisor. All majors participate in research; once you have a research advisor, they typically also become your physics faculty advisor.

1.2.1 Timing for Meeting with your Physics Advisor

The course schedule is usually available a month before registration opens. In general, registration for spring classes opens in early November, and early April for fall classes. Contact your physics faculty advisor for a meeting well before registration opens. Faculty schedules are busy, so it's in your best interest to schedule an appointment with as much advance notice as possible. If your physics advisor is on sabbatical, another faculty member will meet with you; check the list.

1.3 Registering for courses

You should register for your physics courses when your registration window opens. We're one of the smaller majors in the School of Natural Sciences. Although most of our upper-division courses have not reached maximum enrollment, there have been cases where a course has been cancelled

due to low enrollment because students assumed there were no consequences for waiting to enroll. For upper-division courses (100's), a minimum of 8 students needs to be enrolled to keep a course from getting cancelled. If a course is conjoined with a graduate course, (cross-listed with 200's, e.g. 180/280), the minimum enrollment is 4.

2 Notes by Year

2.1 General Considerations

The required number of electives for the major are the minimum needed to graduate. We highly recommend you take as many physics and math courses reasonably able to fit into your schedule. See the tables in Section 3 for information on when classes are offered and when you should take them. Starting research in your second or third year (rather than waiting until fourth year) is an additional way to prepare for graduate school and/or further immerse yourself in the field. If you're pursuing a physics emphasis, the timing of electives is important as they are currently offered every other year. We also encourage all majors to take advantage of summer internship opportunities and clubs such as the Society of Physics Students.

2.2 First Year

Enroll in the introductory physics (PHYS 8 and 9) and calculus sequence (MATH 21 and 22) as early as possible. PHYS 8 and 9 are the only physics courses offered every term, including the summer session. And we encourage majors and minors to enroll in the honors introductory sequence (PHYS 8H and 9H) rather than the regular versions; you will benefit from smaller classes, more personal attention, and greater access to our research faculty! The School of Natural Sciences has an early progress policy that states all NatSci majors need to pass their first math and chemistry courses within their first year. If you're deciding between taking chemistry or physics in your first semester, take physics and save chemistry for later!

Ideally, you should complete these 4 math and physics courses during your first year so that there is no delay enrolling enrolling in PHYS 10 (Modern Physics), which is only offered in fall terms and requires MATH 24 as a pre-requisite. PHYS 10 is a pre-req for PHYS 137 (Quantum I), which is a pre-req for PHYS 138 (Quantum II), 144 (Modern Atomic, Molecular, and Optical Physics), 172 (Quantum Information Science), etc. All of our core upper-division courses are only offered in one semester each year; our electives are only offered one semester every *other* year. So timing is important. *Warning!* There have been cases where students have gotten permission to take PHYS 9 and 10 concurrently. MATH 22 is a co-requisite for PHYS 9, and MATH 24 is a co-requisite for PHYS 10. However, MATH 22 is a *pre-requisite* for MATH 24, which could prevent you from taking PHYS 9 and PHYS 10 concurrently.

Get to know your fellow physics majors as well as other fans of physics by checking out the Society of Physics Students (see Section 5.1). Fellow students can give you great advice on classes and navigating your way at UC Merced. Pay attention to emails from the undergrad lead; that's how

we make announcements about social events, exciting seminar speakers, internship opportunities, on-campus job opportunities, etc.

2.3 Second Year

Ideally, take PHYS 10 in the Fall of your second year instead of postponing it to your third year. PHYS 10 is a pre-requisite for PHYS 137 (Quantum I), which is a pre-requisite for additional courses. Postponing PHYS 10 may set you back a year and increase your time to graduation. And, PHYS 10 is only offered during the fall semester. By the end of your second year, you should have completed your core calculus sequence: MATH 21, 22, 23, and 24.

Consider starting research with a faculty member (see Section 5.2.1) or a summer internship (see Section 5.2.3). For those students using PHYS 195/196: Senior Research & Thesis as their capstone, the best theses and research presentations coincide with more time doing research with a faculty member. Doing research with faculty during the academic year and internships at other places during the summer is common in our program. Research with faculty and summer internships are great ways to explore whether a research-oriented career and possibly graduate school would be a good fit for you.

Speaking of careers, it's never too early to prepare for life after UC Merced. The Center for Career and Professional Advancement (CCPA) offers workshops, hosts information sessions and panels with employers, career assessments, help on resumes and cover letters, in addition to a number of other resources. The Society of Physics Students offers the [Careers Toolbox](#) to help physics majors succeed landing a job in the workforce. Did you know that approximately 35% of bachelors students work in the engineering field and 27% work in Computer or Information Systems?¹

If you love physics and possibly foresee a career in engineering, consider enrolling in ENGR 97: Engineering Service Learning, a 1-2 unit course where you'll join a multi-disciplinary team of students to work with community organizations on real-world problems. Also, the custom emphasis can be geared towards engineering!

2.4 Third Year

It's time to focus on what electives you want to take over the next two years. Our electives are offered every other year. We're working towards a standard schedule to help you plan, but we're also working to add additional electives (see Section 3).

Although graduation is a few years away, it's a good time to explore options. Starting or continuing research with a faculty member—in anticipation of doing the PHYS 195/196 capstone—aligns with research-oriented careers and preparing for graduate school. Participating in Engineering Service Learning opportunities—in anticipation of the ENGR 193/194 capstone—prepares you to for an engineering-related career track. Don't hesitate to explore both options to find out what truly inter-

¹<https://www.aip.org/statistics>

ests you.

Timing for finishing up core courses: If you're considering graduate school in Physics, you should take the Physics GRE in the fall of your fourth year, so (1) try to complete your core courses in your third year and (2) engage in research with faculty *early*. The more Physics you take in your third year, the better prepared you will be! **Before the end of your third year**, make sure that you have found a faculty member with whom you can complete your senior thesis if using PHYS 195/196 as your capstone (even if you plan on starting research in the fall of your fourth year).

Timing for electives: Especially if you have an Emphasis, pay attention to the timing of electives that satisfy it as well as necessary pre-requisites. Our schedule is designed to offer every elective every two years.

2.5 Fourth Year

The capstone experience is a year-long sequence typically in the fourth year. Thus far, it has been satisfied with PHYS 195/196: Senior Research & Thesis. Starting in Fall 2019, students will be able to satisfy the capstone experience with ENGR 193/194: Engineering Capstone Design I/II. If your post-UC Merced plans include graduate school, we recommend PHYS 195/196. If you are more interested in an engineering career, we recommend the Engineering Capstone Design.

PHYS 195/196: Senior Research & Thesis. Typically, students sign up for 2 units of research each semester with their thesis advisor. Senior year research is broken up into two different course numbers because your thesis is due at the end of PHYS 196. Also, these four units of research must be taken for a letter grade. Note that PHYS 195 is a pre-requisite for PHYS 196; the faculty will no longer approve co-enrollment in PHYS 195/196.

ENGR 193/194: Engineering Capstone Design I/II. The Engineering Capstone is a 5-unit sequence. Starting ENGR 193 in Fall 2019 will be the first offering eligible to satisfy the physics capstone requirement.

2.6 Beyond the Fourth Year

There are a number of reasons why students may graduate after their fourth year. Please work with your academic and physics advisors to plan for graduating. It may also be an opportunity for you to take additional electives, pick up a minor, or experience an additional summer internship.

2.7 After UC Merced

Take the next step by researching graduate programs, professional programs, and/or job opportunities as soon as you begin taking upper-division course. Graduate applications are typically due in late Fall. Career Services has a number of resources, including a STEM Career Specialist, to help prepare for the job market.

3 Physics Courses: Timing and Additional Information

Table 1 shows when our courses are offered, projected through AY2022-2023. Since we are a small but growing major, our classes are not offered every term. Required (aka Core) courses are offered every year. Electives are generally offered once every two years. We're working to offer a reliable schedule of electives so that students can better plan when to take electives, especially those that are needed for an emphasis. These requirements correspond to the 2018-2019 General Catalog, with the addition of the ENGR 193/194 option for the capstone.

Minimum enrollment It's important to enroll in your physics courses early. For lower-division courses (course numbers less than 100), 12 students must be enrolled for a course to be offered. For an upper-division course, the minimum number is 8. For a course conjoined with a graduate course (e.g. PHYS 141/241), 4 students must be enrolled. There are cases where a course that does not meet minimum enrollment may still be offered. For example, PHYS 196: Senior Thesis is a core course; it is offered every fall and spring term. An elective necessary for an emphasis requirement for students to graduate may still be offered. Purely general elective, such as PHYS 161, are likely to be cancelled.

PHYS 10 labs The labs occur approximately every other week and last 6 hours. This allows us to offer multiple lab sessions without the previous section interfering with a following section's lab setups. Starting in Fall 2019, we will try to match the Physics 160 schedule with a 1-hour break halfway through the lab session.

PHYS 108: Thermodynamics Multivariable calculus (MATH 24) is strongly recommended as a pre- or co-requisite for Phys 108.

PHYS 161: Astrophysics & Cosmology Our program has had difficulty offering this course regularly since none of our current faculty has the background. It is not unusual for this course to be cancelled after students have enrolled in the course (but before the semester begins).

PHYS 195 & 196: Senior Research & Thesis To enroll in either PHYS 195 or PHYS 196, fill out an [Independent Study Form](#).

- If you are doing research with a faculty member outside of Physics, contact the Undergraduate Physics Lead so that your advisor can have a section listed in the course and you get the proper credit for the course. (This comes up with students doing a double-major and/or a custom emphasis.)
- Note that PHYS 195 is a pre-requisite to enroll in PHYS 196. The Physics department is no longer approving exceptions so that students can co-enroll in PHYS 195 and 196.
- If you make arrangements with your research advisor to take PHYS 196 during the summer there is no seminar component; it is recommended you take PHYS 196 during the fall or spring semester.

Table 1: *Tentative* Schedule of Physics Courses, projected through Academic year 2022-2023. Core courses are listed first, then elective courses. Core courses are offered every year and marked with an ‘X’ to indicate the term offered. Also shown are recommendations for the year we recommend you take the course—based on a 4-year plan. Electives are offered every other year in the same term. The emphasis is indicated, if applicable. Pre = Pre-requisite courses, Co = co-requisite courses, and Rec = courses recommended as prerequisites. P=PHYS, M = MATH, C = CHEM

| Core Courses | Pre, (Co), [Rec] | F | S | Year | Notes |
|------------------------------------------------|-------------------------|----------|----------|-------------------------|-----------------|
| P008 ¹ , 8H ² : Intro I | (M21) | X | X | 1st | |
| P009 ¹ , 9H ² : Intro II | P8, (M22) | X | X | 1st | |
| P010: Intro III | P9 ³ , (M24) | X | | 2nd | |
| P105: Mechanics | P8, (M23, M24) | | X | 2nd | |
| P108: Thermo | P9, [M24] | X | | 2nd ⁴ or 3rd | |
| P110: E&M I | P9, M24 | X | | 3rd or 4th | |
| P115: E&M II | P110 | | X | 3rd or 4th | |
| P126: Sp. Relativity mini | P9, [P110] | | X | 2nd | |
| P137: Quantum I | P10, M23, M24 | X | | 3rd or 4th | |
| P138: Quantum II (mini) | P137 | | X | 3rd or 4th | |
| P160: Modern Lab | P10 | | X | 3rd | |
| P195 ¹ : Ugrad Research | 3rd, 4th year student | X | X | 3rd/4th | or ENGR 193/194 |
| P196: Thesis Research | P195 | X | X | 4th | or ENGR 193/194 |
| Electives | | F | S | Year | Emphasis |
| P095 ¹ : Ugrad Research | 1st, 2nd year student | X | X | | no emphasis |
| P104: Biophysics | P8, P9 | F20, F22 | | Even years | Biophysics |
| P109: Soft Matter | P10, P108 | | S19, S21 | Odd years | AMO/CM |
| P112/212: Stat. Mech ⁵ | P108 | | X | | no emphasis |
| P116: Math. Methods | P9, M23, M24 | F19, F21 | | Odd years | Mathematical |
| P141: Condensed Matter | P10 or C112 | F19, F21 | | Odd years | AMO/CM |
| P144: Atomic Matter | P137 | | S20, S22 | Even years | AMO/CM |
| P148: Modern Optics | P9, M23, M24 | F20, F22 | | Even years | AMO/CM |
| P161: Astrophysics | P9, M22 | | S20, S22 | Even years | no emphasis |
| P172: Quantum Info. Sci. | P137 | | S21, S23 | Odd years | AMO/CM |
| P180: Non-Linear Dyn. | P9, M23, M24, [P105] | | S19, S21 | Odd years | no emphasis |

¹ Offered during summer session as well.

² P008H only offered during Fall semester; P009H only offered during Spring semester.

³ You may take PHYS 9 and 10 concurrently, but see the **Warning** under First Year. If possible, it is better to take PHYS 9 or its equivalent over the summer.

⁴ Preferred.

⁵ If P112 is not offered, sign up for P212

4 Administrative Considerations

Hold on Registration To ensure you meet with your physics faculty advisor before enrolling for Fall courses, in Spring semester there is a hold placed on your registration. This is lifted only after meeting with your physics advisor. Your physics faculty advisor fills out an online form and the registration hold is lifted within one business day.

General Catalog A student is subject to the policies in the [General Catalog](#) in effect when they initially enroll. Through that link, you can access the current and archived copies of the Catalog. Students may also petition to adopt the policies in a newer catalog. *If possible, we recommend that students adopt changes made to the physics program.* Contact your physics and academic advisor if you have questions about adopting changes.

Requirements for the Physics Major The requirements for the major as well as the various emphasis tracks are listed in the General Catalog. Sample Plans of study are also on the SNS website.

Early Progress Policy Any Natural Sciences major must pass the first course in the Math and Chemistry sequences—MATH 005 (or MATH 011 or MATH 021) and CHEM 001 (or CHEM 002)—prior to the start of their third regular (Fall/Spring) semester. Any student failing to do so will be moved to undeclared status. Please see [Natural Sciences Advising](#) or your academic advisor if you have questions. **Understand that this does NOT specify that you must take Chemistry your first semester at UC Merced. If you're deciding between Physics 8 and Chemistry for the fall term, we advise taking Physics 8 in the fall and saving Chemistry for the spring term.**

Normal Progress to Degree UC Merced undergraduate degree programs are designed to be completed in eight semesters or four academic years. (Summer terms are not included in the semester count.) To meet the normal progress requirement, undergraduate students are expected to enroll in and pass an average of 15 units per semester, completing the 120 units necessary for graduation in four years. An extension of enrollment beyond nine semesters requires the approval of the student's School.

5 Beyond Classes

5.1 SPS: Society of Physics Students

The SPS Chapter #0922 holds weekly meetings, study sessions, organizes outreach events, and works on various projects throughout the academic year. We encourage all majors to check it out and meet fellow students also interested in physics. Find more information at [Physics website SPS](#) or [CatLife SPS](#).

5.2 Research

Physics is more than taking classes. Research allows you to explore a specialization in detail. We encourage students to engage in research before their senior year and there are multiple options. Below

are the most common pathways our majors have used to get undergraduate research experience.

5.2.1 Research with Physics Faculty

Doing research with a faculty member is a great opportunity for all our majors, not just those choosing the PHYS 195/916 capstone. To find a faculty member with which to work, we recommend looking on the faculty member's [website](#) to learn about their research areas. After identifying a couple of faculty members whose research interest you, introduce yourself in an email. Ask about research opportunities within their lab. You can also ask if they have other undergraduates doing research in the lab to get a peer's perspective on the experience. You can ask to attend a group meeting and/or visit the lab to find out if it would be a good fit. Each lab has its own culture. Some things to consider include whether you're interested in computational/theoretical or experimental research. Would you be working under the supervision of the professor, postdoctoral researcher, or a graduate student? What time commitment is needed to make progress on the project? (Does that fit with your course load and schedule?)

If you are going to be doing research for credit (PHYS 095 or 195), you will need to submit an [Independent Study Form](#). Research courses do not show up on the schedule. Note that you don't need to sign up for research credits in order to do research with a faculty member; contact them anytime throughout the year.

5.2.2 UROC

The Undergraduate Research Opportunities Center ([UROC](#)) is a great resource on campus and also runs the Summer Undergraduate Research Institute (SURI). UROC offers information sessions to help you submit applications for summer internships. It also posts UC Merced and UC-specific internships. For example, the UC LEADS program lasts 2 years, with one summer doing research at UC Merced, and the other summer doing research on another UC campus. Most programs advertised or organized by UROC have early spring deadlines.

5.2.3 Summer Internships

Summer internships are mostly *paid* internships and often include professional development activities. Our own [MACES](#) program includes summer and academic year research opportunities. Also check out the [CCBM](#) research opportunities.

Internships at other institutions are a great way to explore research areas we don't currently have at UC Merced, potential graduate programs, and/or potential career paths. The National Science Foundation (NSF) funds Research Experiences for Undergraduates ([REU](#)) at various universities. If you're considering graduate school and are curious about a particular school, see if they have an REU program. Use the [Physics Today Jobs](#) site to search for internships. [SACNAS](#), the Society for the Advancement of Chicanos/Hispanic and Native Americans in Science, also lists internships. [Pathways to Science](#) is another useful search engine for summer programs. The Department of Energy (DOE) offers internships at 17 national labs and facilities through their [SULI](#) program. [NASA](#) internships are highly competitive and have early deadline. CalTech's Jet Propulsion Laboratory

(JPL) has numerous opportunities. Federal Agencies, such as the National Institute of Science and Technology (NIST), will often list internships [here](#).

For especially competitive programs, it pays to submit your complete application well before the deadline.

6 Contact Information

- Physics Undergraduate Lead
 - Fall 2018 - Dr. Menke, cmenke@ucmerced.edu
 - Spring 2019 - Dr. Xu, jxu8@ucmerced.edu
- Physics Academic Advisor, Jenn Souza, souza5@ucmerced.edu
- SPS Leadership
 - President, Ulyses Alvarado Olvera, ualvaradoolvera@ucmerced.edu
 - Vice President, Victoria Arias, varias4@ucmerced.edu