Physics Undergraduate Program Advising

This document has been assembled by a variety of faculty and students within the department of physics at the Colorado School of Mines (CSM). The intent is that this will be a "living document" and as such will be updated regularly as new and relevant information becomes available. If you notice any errors or would like to make suggestions, please feel free to contact Alex Flournoy at aflourno@mines.edu. Our suggestion is that any student considering pursuing a physics degree at Mines should read through this document in its entirety at least once to get a broad outline of what the four-year program will typically look like. Then, each semester prior to registration for the next, revisit the relevant portions. This document is organized by year with general comments for each year followed by details for each semester including Fall, Spring, Summer 1 and Summer 2. This document is NOT meant to replace advisement from your formal advisor or the physics group advising process, but rather to supplement these resources.

Freshman Year

Freshman year is pretty generic without much emphasis on physics track-specific courses. You will take most of your courses with students from across the campus. The exception are those students who are "advanced", i.e. entering with transfer/AP credit, as noted below. First-year students are formally advised through CASA (who controls their registration PINs), but are free and encouraged to attend physics group advising in the Fall and Spring semesters to seek further information. These faculty run sessions are held the week prior to registration and are well advertised throughout the physics building and in many classes. Additional advising opportunities with upper level physics majors are often organized and advertised prior to registration as well. Students are encouraged to attend Society of Physics Students (SPS) meetings to meet other physics majors, listen to speakers describing how they use their physics degrees, and get involved in outreach.

When considering your schedule of courses (at any point throughout the curriculum), there are two useful things to keep in mind:

1) The curriculum has certain "gateway" courses that are pre-requisite for many courses later in the program. Early examples include Physics 2, Modern Physics, Analog Electronics, Programming with Python, Introduction to Mathematical Physics, and Field Session. If you are attempting to get ahead of the normal schedule, it is useful to make sure these particular courses are completed as soon as possible as they can open up the option of taking many more courses. A simple way to identify gateway courses is to look through the course catalog and note which courses frequently appear as pre-requisites.
2) While many physics courses have co-requisite math courses (to be take concurrently), students have often found that it can be beneficial to have completed the relevant math course prior to taking the associated physics course. For example, completing Calculus 3 prior to Physics 2 could benefit some, as would completing Differential Equations prior to taking Physics 3 or Analog Electronics. That said, it’s important that you don’t set yourself back by waiting to take a physics course in order to complete a math course. Formally the curriculum is designed for these courses to be taken concurrently, so this is just a suggestion should you find yourself in a position to take advantage.

Fall:

- Advising is done through CASA.
- Typical courses (Calculus 1, Chemistry 1, Nature and Human Values, Freshman Success Seminar, Distributed Science Elective, Physical Activity)
- Advanced students are typically taking courses from later in the curriculum (Calculus 2, Physics 1, etc.)
- If taking Physics 1, consider applying to be a Physics 1 TA for the Spring semester.

Spring:

- Advising is done through CASA.
- Typical courses (Calculus 2, Chemistry 2, Physics 1, Introduction to Design, Physical Activity)
- Advanced students are typically taking courses from later in the curriculum (Calculus 3, Physics 2, etc.)
- Consider applying to be Physics 1 or Physics 2 (if appropriate) TA for the Fall.
- If you are interested in teaching, consider signing up to take Early Field Experience (Internships may be available) or other educational coursework. See a Teach@Mines advisor for individual advising (https://www.mines.edu/teacherprep/).

Summer 1:

- Typical courses (None)
- Advanced students with the pre-requisites should consider taking Physics Field Session. (PHGN384). You can read more about the Physics Field Session in the Summer 1 section of the Sophomore year information below. This can open up many opportunities like: two summer research experiences during your time here, taking Junior-year courses earlier, making study abroad and/or co-ops easier, possibly finishing in 3 years, completing a combined program in 4.5 years.

Summer 2:
• Typical courses (None)
• If you are already settled on a combined program track, you might consider taking some of the earlier non-physics courses, e.g. Statics or Programming Concepts.
Sophomore Year

Sophomore year is where things start to get interesting. Physics track-specific content comes into play, and you will become better acquainted with your fellow physics majors. You should formally declare yourself a physics major (https://inside.mines.edu/Major-Declaration) and in doing so you will be assigned an advisor within the Department of Physics. Henceforth you will be required to attend the group advising sessions each Fall and Spring in order to receive your registration PIN. Again, these are well advertised and run the week before registration. It is also time to start considering your eventual track, e.g. straight physics, combined program, teacher prep, etc. Identifying your eventual track early allows you to go ahead and start taking the relevant courses. For example, many of the combined programs require Statics, and though this course could be taken later in the curriculum, it is strongly encouraged to go ahead and complete as soon as possible. For most students this is typically more important during the Spring semester than in Fall, though advanced students might find themselves able to get a head start in the Fall. Opportunities to TA typically become an option. Advanced students will likely be looking for useful courses to fill out their schedule and get advice from their faculty advisor or during the group advising sessions. Students should consider attending the physics department colloquia regularly in order to expose themselves to the latest directions in research. Colloquia are talks aimed at a broad audience and are often more accessible than more technical seminars. Students are also encouraged to attend Society of Physics Students (SPS) meetings which often have speakers describing their work at even more accessible levels. SPS meetings are also a great place to meet other physics majors and get involved in outreach activities. If you are considering a dual degree, you should discuss this option with your advisor as this can be a rather involved process that may or may not be to your advantage. On the other hand, if you are considering a minor, then two relatively straightforward and/or useful ones are Math and Computer Science. Physics students often end up taking quite a few advanced courses in these programs anyway, so it is often a small stretch to complete the minor requirements. For the interdisciplinary minors such as McBride, Energy, and Humanitarian Engineering, some 200 and 300 level courses are available in both Spring and Fall. For instance ENGY200 is offered in both Spring and Fall and can be taken by first-year students.

Fall:

- Typical courses (Calculus 3, Physics 2, Engineering Design 2, Global Studies, Physical Activity)
- Advanced students are typically taking courses from later in the curriculum (Differential Equations, Linear Algebra, Modern Physics, Python Based Computing (CSCI250), etc.)
• Engineering Design 2 comes in several varieties and all are acceptable for our degree. While there is a physics specific variety of this course, our majors have also enjoyed the "space" version as well.

• If a student has no prior programming experience, you might consider taking either Introduction to Computer Science (CSCI101) or Programming Concepts (CSCI261) which will better prepare you for the required Python-Based Computing course to be taken in the Spring.

• Modern Physics is offered in two forms, 300 in the Fall and 310 in the Spring. Advanced students may consider taking the 300 version in the Fall. While both versions are accepted for our degree, it is strongly encouraged that physics majors take the 310 version offered in the Spring. This version is the more rigorous of the two and geared specifically towards physics majors, while the 300 version is designed for a broader campus-wide class.

• Consider applying to be a Physics 1 or Physics 2 TA for the Spring.

• If you are planning to pursue a Combined Program track, declare your intent by filling out the combined program part of the "Change of Major/Advisor" form (https://inside.mines.edu/Major-Declaration). Be ready to begin combined program specific courses in Spring.

• Nuclear Engineering and Mechanical Combined Program would take Statics CEEN241, AMS and EE would take CSCI261.

• If you are interested in teaching, consider signing up to take Early Field Experience (Internships may be available) or other educational coursework. See a Teach@Mines advisor for individual advising (https://www.mines.edu/teacherprep/).

Spring:

• This is when the typical student will begin courses specific to the physics track.

• Typical courses (Modern Physics, Analog Electronics, Differential Equations, Linear Algebra, Python-Based Computing, Physical Activity)

• Some students in the electrical engineering combined program should sign up for Electrical Circuits (EENG282) rather than Analog Electronics (depends on track).

• Advanced students will often be looking to fill their schedule with relevant courses. Some math courses that are particularly useful in physics include Complex Analysis (Math454) or Partial Differential Equations (MATH455).

• If you are interested in teaching, consider signing up to take Early Field Experience (Internships may be available) or other educational coursework. See a Teach@Mines advisor for individual advising (https://www.mines.edu/teacherprep/).
• Consider applying for an Undergraduate Research Fellowship (https://www.mines.edu/undergraduate-research/undergraduate-research-fellowship/).

Summer 1:

• Typical courses (Physics Field Session)
• While we do not describe the content or intent of many of our courses in this document, the Physics Field Session is an exception. This intensive experience will benefit you in a variety of ways: First and foremost, you will progress through a series of modules designed to teach you a variety of useful laboratory and research techniques including vacuum systems, optics, machine shop, electronics, computing and contemporary fabrication. The primary idea is to ready you for entering research as soon as the completion of the course, and at the very least to give you valuable tools that you can bring to your eventual Senior Design project. This Physics Field Session experience is unique compared to physics programs throughout the country and is often cited as a favorite part of our curriculum by alumni. Additionally, through six weeks of 7 hour days, you will become very familiar with your fellow physics majors as well as many of the physics faculty. In fact the Physics Field Session is where students really begin to feel like an integrated part of the physics community at Mines.

Summer 2:

• Typical courses (None)
• Looking ahead to the very busy junior year, it is reasonable for students to consider taking Introduction to Mathematical Physics in order to lighten their junior course load.
• Students may consider joining research efforts. You are encouraged to reach out to individual physics faculty about their research, and Chuck Stone in particular for a broader suggestion of opportunities and connections.
Junior Year

This is the most challenging year of the sequence largely due to the nature of the coursework. Expect larger time commitments to homework and consequentially better connection to your peers (which is one reason it is good to get to know them through field session). During the junior sequence of courses, you will encounter integration of your computing background and more advanced mathematics will come into play. This is also when students (who haven't already) should start thinking seriously about research, either in pursuing a Research Experience for Undergraduates (REU) (https://www.nsf.gov/crssprgm/reu/list_result.jsp?unitid=69) or other summer experience like those found at https://www.compadre.org/student/research/ for the summer after junior year, and/or seeking a research position with faculty that could extend into Senior Design. In considering courses, give consideration to classes that are only offered every other year, e.g. Particle Physics and General Relativity, since you might not get to take these during your senior year. Combined program students need to pay careful attention to required classes. Students are now eligible for the physics honor society, Sigma Pi Sigma.

Fall:

- Typical courses (Advanced Physics Lab I, Introduction to Mathematical Physics, Digital Electronics, Intermediate Mechanics, HASS elective)
- If you are interested in teaching, consider signing up to take Early Field Experience (Internships may be available) or other educational coursework. See a Teach@Mines advisor for individual advising (https://www.mines.edu/teacherprep/).
- Investigate and apply for summer research experiences.

Spring:

- Typical courses (Intermediate Electromagnetism, Quantum Mechanics, Advanced Physics Lab II, Thermal Physics, Principles of Economics)
- If you are considering doing your senior design project with a particular faculty member, it is a good idea to contact them to make them aware of your ambition and to make sure that they are going to be offering projects. If possible, discuss the opportunity to begin work on the project as soon as summer after the junior year. See more Senior Design information in Summer 2.
- Consider applying to TA Field Session, and asking faculty if they need TAs for Junior-year classes in the Fall.
- If you are interested in teaching, consider signing up to take Early Field Experience (Internships may be available) or other educational coursework. See a Teach@Mines advisor for individual advising (https://www.mines.edu/teacherprep/).
• If you are planning to continue on to graduate school, you should look into scheduling/preparing for both the General
(https://www.ets.org/gre/revised_general/about/?WT.ac=grehome_greabout_a_180410) and the Physics Graduate Record Examination (GRE)
(https://www.ets.org/gre/subject/about/content/physics). Exams must be taken in time for scores to be ready for graduate school application deadlines (typically Fall of senior year).

**Summer 1:**

• Typical courses (None)
• Many students find being a TA for field session a rewarding experience. If interested, make sure you apply during the Spring prior.
• Some students will be relocating to other schools for an REU (https://www.nsf.gov/crssprgm/reu/list_result.jsp?unitid=69). Make sure to check well in advance for application deadlines.
• Other students may begin/continue research with physics faculty that can lead into a Senior Design project.

**Summer 2:**

• Typical courses (None)
• Just prior to Fall, a list of Senior Design projects will be made available to all enrolled students. You should contact the professors for projects you are interested in and continue to do so until you are accepted for a project, i.e. do not assume that contacting a professor means that you are taken as a student.
• If you are part of the Physics Combined Program, then your Senior Design advisor will likely be your graduate thesis advisor.
Senior Year

The senior year can be less course intensive, but this is to allow you time to focus on your Senior Design research project. You should also use this time to explore elective courses (Nuclear, Laser, Materials, Solid State, Particle, General Relativity, Processing Lab etc.) that will broaden your background and provide you with insight to help decide what to pursue beyond Mines. For those students who are bound for graduate school, the Fall of senior year is an ideal time to attend a conference and present a talk/poster in order to enhance your visibility to graduate programs. Additionally, attending general conferences including PhysCon (https://www.sigmapisigma.org/sigmapisigma/congress) and CUWiP (https://www.aps.org/programs/women/workshops/cuwip.cfm) and any professional conferences is a great way to learn about eventual opportunities in physics.

Fall:

- Typical courses (Senior Design Principles I, Senior Design Practice, Advance Electromagnetism, HASS elective, Free Elective I, Free Elective II)
- Senior Design is delivered in two components. The principles course will cover effective team organization, project planning, time management, literature research methods, record keeping, fundamentals of technical writing, professional ethics, project funding and intellectual property. The practice course will be a research/design project with your Senior Design advisor.
- Students interested in graduate school should be taking the GREs no later than Fall of the senior year.
- Students who plan to continue to graduate programs should anticipate investing significant time in selecting schools and preparing applications.
- Students should discuss with faculty recommendation letters for graduate programs or references for industry positions.
- If you are interested in teaching, consider signing up to take Early Field Experience (Internships may be available) or other educational coursework. See a Teach@Mines advisor for individual advising (https://www.mines.edu/teacherprep/).

Spring:

- Typical courses (Senior Design Principles II, Senior Design Practice, HASS Elective, Engineering Science Elective, Free Elective III, Free Elective IV)
- Senior Design
- If you are interested in teaching, consider signing up to take Early Field Experience (Internships may be available) or other educational coursework. See a Teach@Mines advisor for individual advising (https://www.mines.edu/teacherprep/).