



COLLEGE of  
CHARLESTON

PHYSICS AND ASTRONOMY  
DEPARTMENT

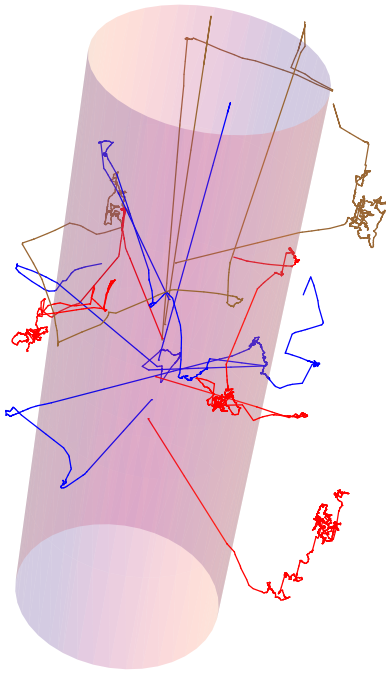
# Handbook for Students

Edited by Jeff Wragg

11 January 2017

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## 1 Introduction

Greetings and Welcome to the Department of Physics and Astronomy at the College of Charleston, one of the most vigorous undergraduate programs in the nation. We offer degrees in physics, astronomy, astrophysics and meteorology, as well as concentrations and minors in energy production, biomedical physics, computational neuroscience, operational meteorology, atmospheric physics, and meteorology.

A degree in physics opens up a world of career options in areas such as engineering, space exploration, computers, energy, medicine, design and development, military, communications, economics, law, teaching, management and administration, to name a few. Our goal, within

the liberal arts culture, is to offer the highest quality undergraduate physics/astronomy-affiliated education to our students. We offer a vigorous undergraduate curriculum across many disciplinary and interdisciplinary areas. Students acquire excellent mathematical, computational, and analytical skills during the coursework so that they become professionally competent to solve complex problems in virtually any field. We are strongly driven by the core values of excellence, academic freedom, integrity, collaboration, diversity, mutual respect, fairness, justice, and service.

Our award winning department has been growing steadily in the number of its students and faculty with teaching and research interests spanning a broad range of topics from nanostructures to the intricacies of the universe. Students have opportunities to undertake cutting-edge research (paid/unpaid, experimental/theoretical/computational) with our committed and diverse internationally-recognized faculty members. In addition, internship opportunities are also available in industrial settings. We are happy to speak with prospective students. Look over our programs and contact the faculty member that is aligned with your interests.

We offer a solid BS degree programs in physics and astrophysics for the most rigorous technical preparation, for example to enter PhD programs. We have BA programs in physics and astronomy that allow you the flexibility to pursue goals such as medicine, education and law. Our BA in meteorology can prepare you for entry into public and private sector meteorology positions, or into meteorology or atmospheric physics graduate programs.

In addition to the core majors we offer formal concentrations in energy production, computational neuroscience, operational meteorology, atmospheric physics and minors in biomedical physics, and meteorology.

What can you do with a degree from us? There are two simple cases, you can either get a job or keep going to school. Our graduates are roughly evenly divided between the two. It is our aim to prepare you academically and to help you with the details of pursuing your goal, whether it is entering the job market, pursuing a graduate degree in physics, astronomy, or a related field, or getting into medical school or other professional schools.

This handbook is a line of communication intended to guide, advise, and inform you about things here. It is NOT a substitute for the official College of Charleston Catalog.

### 1.1 Location and Access

During the renovation of Hollings Science Center, the Department is largely located on the second floor of the JC Long Building, at the corner of St. Philip and Liberty Streets. The Department office, room 216, is open for

business from 8:30–5:00 M-F. The office contains mailboxes for the faculty.

## 1.2 Jobs in the Department

The Department has job opportunities for students as teaching or research assistants or other help. Faculty often have funds for students to participate in ongoing research programs, and there are positions as assistants in introductory physics and astronomy labs. If you are interested in a position please contact the Physics Lab Manager, Philip Ladd (laddpa@cofc.edu) or the Astronomy Lab Manager, Chris True (truec@cofc.edu). You can make your best case for such a position. Experience in the class you want to help with is usually, but not always, necessary. Of course good grades and faculty recommendations always help. Check with individual faculty members for research position openings.

## 1.3 Awards, Honors, and Scholarships

Students in the Department are generally eligible for one or more awards and honors.

- **Outstanding Graduate.** All aspects of a graduating student's role as a major in the department are considered by the faculty when selecting the recipient of this annual award. Consideration will be given to students having a gpa of at least 3.4 in the major. The award is decided each May. Eligible students are those who have graduated since the previous May graduation or will graduate in the current May graduation.
- **Departmental Honors.** To be eligible, graduating students must have earned a GPA in the major of at least 3.5 and completed a minimum of 12 semester hours of exceptionally fine work (as evaluated by the faculty mentor) in any combination of seminar, independent study, or bachelor's essay.
- **Outstanding Undergraduate Research Award.** Graduating seniors who have done research in the Physics and Astronomy Department are eligible to be nominated for this award. Nominated students must give a formal 10-15 minute presentation to the faculty prior to the May graduation ceremony. Two awards are given each year, one for research in Physics and one for research in Astronomy/Astrophysics.
- **Outstanding Service Award.** Each academic year the department may select a student to receive this award in recognition of outstanding service that year to the department, college and/or community.
- **Faculty Honors List.** Each semester the Office of the President publishes the faculty honors list. To be named to the list a student must have completed at least 14 hours and earned a GPA of 3.60 (distinguished) or 3.80 (highly distinguished).
- **Sigma Pi Sigma** is a national Physics Honor Society recognizing outstanding scholarship in physics. To be eligible a student must have completed phys370 and/or astr377 and have a departmental GPA of at least 3.5.

### 1.3.1 Monetary Awards

Departmental and School opportunities. Details are subject to change.

- The **Bob Dukes Scholarship** for incoming astrophysics majors, is a renewable \$2500/year award. Recipients must maintain a minimum gpa of 3.2 in the major to retain the scholarship. It is not automatically renewed. It is meant to attract strong aspiring astrophysicists to the department. It may go to a current student if there are no suitable incoming freshmen. Qualified applicants must submit a personal statement outlining their professional goals and means of attaining those goals and the latest unofficial transcript.
  - The **J. Fred Watts Scholarship** (\$1000) may be awarded annually to a major who is pursuing teaching certification in physics or astronomy. Applicants must submit a one-page typed essay that outlines their educational and professional goals and means of attaining those goals. Essays must be submitted to the Chair of the Department. The scholarship is renewable; however, the student must re-apply for the scholarship and submit a revised essay that outlines what actions he or she has taken to achieve the goals.
  - The **Horatio Hughes Memorial Scholarship** was established in memory of Dr. Horatio Hughes, class of 1905, and distinguished professor of chemistry and physics. It may be used to recruit exemplary freshman, but generally will be awarded to students already in the program. Students may apply for the summer research scholarship or the academic scholarship. It should be noted that the Horatio Hughes awards may not be given every year, depending on how many are already being held.
- For the summer research scholarship, qualified applicants must have a 3.0 gpa or higher and must submit a two-page typed essay to the Chair of the Department's Resources Committee. The first page of the essay should outline the student's professional

goals and means of attaining those goals. The second page should outline the proposed summer research project. Applicants for the summer research scholarship must have a letter of recommendation submitted on their behalf by the faculty member supervising the research project.

For the academic scholarship, qualified applicants must have a 3.0 gpa or higher and must submit a one-page typed essay to the Chair of the Department's Resources Committee. The essay should outline the student's professional goals and means of attaining those goals. The academic scholarship may be renewable up to four years if the applicant maintains a 3.0 gpa or higher.

The award winners will be announced at the end of the semester. The due date for both awards will be set by the Chair of the Department's Resources Committee early in the spring semester.

- The **Harry E. Ricker, Jr. Endowed Award** was established by Dr. Harry E. Ricker, Jr., class of 1965.

The Ricker award of \$500 will be used to assist a rising sophomore, junior, or senior major in physics. The student must have a strong academic record and demonstrate the need for financial aid. Recipients will be selected by the Department. The award will be presented at the College's annual graduation weekend Awards Ceremony.

Qualified applicants must submit a one-page typed essay to the Chair of the Department's Resources Committee by a date set early each spring semester. The essay should outline the student's professional goals and demonstrate the need for financial aid. Qualified applicants must also submit an unofficial student transcript.

- **Boeing Scholarships** are administered by the School of Sciences and Mathematics (SSM). They are made possible by generous donations from Boeing Corporation located in North Charleston. Recipients will be awarded \$2500 each for the academic year.

Qualifications:

- Full-time student
- GPA of 3.2 or better
- Excellent leadership and communication skills
- Strong interest in pursuing a career in the aerospace industry
- Boeing Scholars will be encouraged to pursue internships in the aerospace industry, specifically with the Boeing Corporation.

Past recipients are eligible to apply. Applications are generally due to the Office of the SSM Dean in

April. Special attention will be given to students with backgrounds that are typically underrepresented in the aerospace industry.

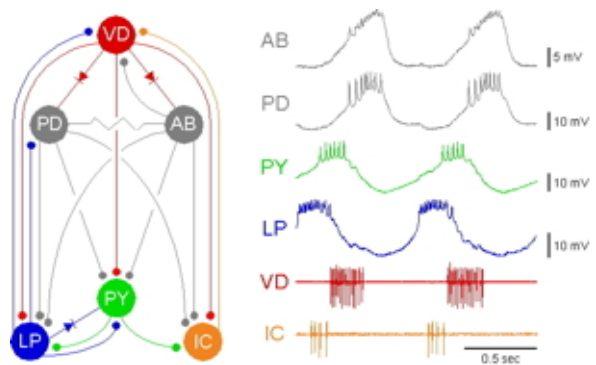
- **Quattrochi Merit Scholarships** were created by Peter Lawrence Quattrochi and Jane Elizabeth Quattrochi '93, for students at the College of Charleston. The scholarship is awarded on the basis of academic merit and an original essay.

Qualifications:

- Full-time student
- Participate in a minimum of two CofC organizations
- Rising juniors or seniors majoring in Sciences and Mathematics
- Minimum cumulative GPA of 3.5

To apply, fill out the online application- <https://alumni.cofc.edu/student-programs/scholarships> which includes the following:

- List of extracurricular activities in school, community or church, including high school activities for currently enrolled students.
- In 500 words or less, describe your most significant volunteer or leadership activity and why it is meaningful to you.
- How will the Quattrochi Scholarship make a difference in your academic experience at the College of Charleston? (500 word limit)
- Why are you the best candidate to receive the Quattrochi Scholarship? (500 word limit)
- What are your career goals and how will receiving the Quattrochi Scholarship impact those goals? (500 word limit)



## 1.4 Philosophy

Physics is the present day equivalent of what used to be called natural philosophy, from which most of modern science arose. It investigates the properties, changes, and

interactions of matter and energy. Physics is the most fundamental and all-inclusive of the sciences, both life and physical, because its subject matter is at the root of every field of science and underlies all human experience.

The study of physics does not involve following a specific recipe or set of rules, rather it entails developing an attitude or way of looking at phenomena and asking questions. Physicists seek to understand how the physical universe works, no matter what the scale of observation—from quarks to quasars, from the time it takes a proton to spin around to the age of the cosmos. The answers to these questions are summarized into statements called laws. We live in the age of physical law. Awareness of the beauty, harmony, and interplay of the laws of physics greatly enhances our understanding and appreciation of our environment.

Courses available from the Department of Physics and Astronomy offer a student the opportunity to examine the physical universe from electricity and magnetism to subatomic particles, from stars to dust grains; from sound and music to laser spectroscopy. Laboratory and research experiences enable the student to develop abilities in experimental techniques, data gathering and analysis, and presentation. While class work is concerned mainly with learning basic facts, laws and problem solving methods, there is ample material for discussion of real-world problems and the role of physics in society.

We expect you to mature as you continue through the program. Students entering upper level courses are expected to be more independent, self-motivated and responsible than in previous courses. By the time you are a junior you should be thinking of yourself more as a professional. Your attitudes and actions in classes, research, and as you represent the College and Department should reflect this advancement.

The Department has assembled a list of educational objectives for its majors. These objectives are gathered under the following categories: communication, experimental physics, theoretical physics and history and biography. Graduates should be able to communicate effectively through written and oral presentation. All graduates should be able to assemble appropriate equipment and to perform measurements that enable them to analyze physical phenomena. Students should possess the skills and techniques (mathematical, statistical, graphical, computer and writing) necessary to successfully interpret and analyze their experimental data. Critical examination of experimental results should lead to improved experimental design. Theoretical course work should enable majors to solve problems in diverse fields such as astrophysics, mechanics, electricity and magnetism, optics, quantum mechanics, thermodynamics, and statistical mechanics depending on the specific course work completed. This analytical

ability is grounded on an extensive set of mathematical tools acquired in appropriate mathematics courses (specified by course prerequisites). Graduates should be aware of the ideas and linkages implicit in the history and biography of physics.

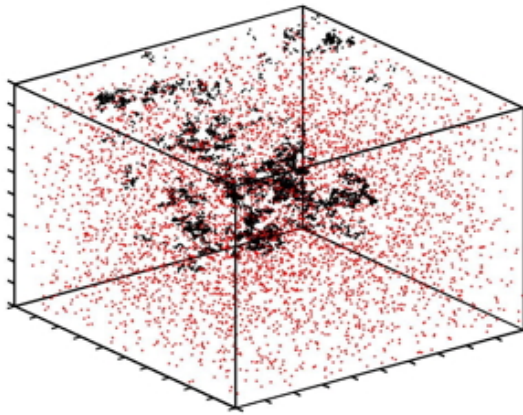
#### **A bachelor-level physicist should be able to**

- understand physical laws and principles
- apply physical knowledge to understand how things work
- conduct laboratory research (design and execute experiments)
- solve problems (theoretical and practical)
- conduct data analysis
- write comprehensive reports and make oral presentations
- address important scientific issues that we encounter as individuals and a society
- conduct literature research
- use a computer as a tool for all of the above

The major programs achieve educational goals through course sequencing. Depth is provided through a spiraling visitation to a broad subject core. Study begins with the two-semester introductory sequence. This gateway course surveys the entire discipline and provides direct experience with physical phenomenon through the laboratory. Fluency in mathematics, the language of physics, is necessary to continue and to complete the major. The degree of mathematical proficiency needed depends on the exact course sequence followed. Course selection in turn depends on whether a student seeks a bachelor of arts or a bachelor of science degree. Many advanced courses require mastery of at least calculus through multivariable calculus and vector analysis and differential equations. Writing assignments are integral to all labs and to many courses.

## **2 Computer Proficiency**

We expect incoming students to have a set of proficiencies when it comes to computer use. This proficiency is a moving target. Every year students enter with higher levels of experience, and the curriculum makes increasing demands on it. Generally speaking any entering freshman considering a technical field for a major should be comfortable with a wide variety of computer skills.



Along the road to your degree you are expected to hone your incoming skills and acquire more skills. For example, you will learn to use Mathematica™ in phys230, L<sup>A</sup>T<sub>E</sub>X in phys370 or astr377, MATLAB™ in phys394 and perhaps other important computational tools such as Python and IDL™. These tools are useful in coursework, research, and your future job.

### 3 Research and Internships

The Physics and Astronomy Department strongly encourages students, particularly those bound for graduate school, to get involved in research. The experience you gain in research is valuable, even if the particular research project isn't something you expect to make your life's work. Clearly the more advanced students will be the most marketable when trying to fit into a research environment, so don't be discouraged if there aren't any openings when you are a freshman or sophomore. Taking more courses, and doing well in them will make you attractive to research programs.

Research experiences may be gotten informally or via courses such as phys390 and phys420, as paid or unpaid research assistants to department faculty, or by participating in external research programs. Research experiences may be summer, academic year, or both.

There are two primary paths to take for summer research opportunities—internal and external. Our faculty have both multi-year research programs and shorter term research projects in which you may participate. In either case you should keep in touch with the faculty so that you know what opportunities exist. Students have also done research with faculty in other departments, particularly in mathematics, chemistry, and geology.

Externally there are a host of research opportunities beyond the College. One of the largest and most widely known is the REU program (Research Experiences for

Undergraduates) that is funded by the National Science Foundation (NSF). It is primarily, but not exclusively, targeted to students between their junior and senior years of study. They typically employ you for 8-10 weeks over the summer and pay attractive salaries. The REU program is extremely broad, and you should peruse it to get a sense of the program's offerings—[http://www.nsf.gov/crssprgm/reu/reu\\_search.jsp](http://www.nsf.gov/crssprgm/reu/reu_search.jsp). Also, ask other students and faculty about opportunities for internal and external summer research.

Typically, applications are made to REU programs in the late fall, but cut-off dates vary, and many extend well into the spring. To help your chances of getting an REU slot, plan ahead, get relevant courses under your belt, flesh out your resumé, and get research experience.

Internships are a valuable mechanism to get experience and training for a career. We have a course, phys381, that allows an internship to receive academic credit which may apply to your major or general course requirements. Appendix G has information about the program.



#### 3.1 Astronomy Facilities

Though some of the department's astronomical equipment is in storage because of the renovation of the Rita Hollings Science Center, we still have abundant oppor-

tunities for astronomical observation and research. The department has several large, portable instruments including a 16-inch Newtonian on a Dobsonian mount, a 14-inch GPS computer-controlled Ritchey Chretien instrument mounted on a transportable pier, a 10-inch computer-controlled Schmidt Cassegrain instrument on an alt-azimuth mount and a tripod-mounted Vixen 25 x 125 binocular telescope.

Through various granting agencies, our students and faculty have consistently obtained data access and observing time on world class instruments including the Hubble Space Telescope in low Earth orbit, the Subaru telescope on Mauna Kea in Hawaii, Chandra, BATSE (archival) and Spitzer.

While our fleet of 8-inch computer-controlled telescopes are in storage during the building renovation, we still maintain at a temporary location for twenty-four 8-inch polar-mounted Schmidt Cassegrain telescopes used in our beginning and advanced astronomy labs.

The College is a member of the Consortium for Astronomical Research and Education (CARE) at the University of the Virgin Islands Etelman Observatory (<http://www.uvi.edu/academics/science-math/research-and-outreach/etelman-observatory1/>), located at St. Thomas in the US Virgin Islands. In partnership with the University of the Virgin Islands, we upgraded the facility to a fully automated, robotically-controlled and queue-driven 0.5-meter research-grade telescope that gives our students and faculty access to more of the southern sky. This site is the eastern-most observatory in the Americas allowing observations of objects that are below the horizon in Charleston or any other North American observatory. Department research teams use the telescope for astronomical research that spans a variety of topics, including rapid-response follow-up observations of gamma-ray bursts as part of the NASA Swift (<http://swift.gsfc.nasa.gov/>) Follow-up Team.

Our advanced computing lab in room 221 JC Long has computers used for astronomical research and telescope control.

### 3.2 Physics Facilities

Research opportunities in both experiment and theory are continuously expanding. Get to know the faculty and your fellow students to see what research opportunities are open and interesting to you.

We have research labs for biomedical optics, critical point fluids, photo-acoustic spectroscopy, resonant ultrasound spectroscopy, and computational biophysics/neuroscience. Special instrumentation includes an FT-IR Spectrometer, spectrophotometers, and both a

scanning electron microscope (SEM) and an atomic force microscope (AFM). We also have a gamma-ray spectrometer with alpha- and beta-counting capability.

We have a research lab in soft condensed matter (liquids, colloids, granular materials, and a number of biological materials) and image processing. We conduct low angle scattering experiments on nanocolloids and perform image processing to enhance and de-noise data and then characterize the concentration induced fluctuations that take place in colloids. The lab also shares and analyzes unique experimental data on supercritical fluids recorded in micro-gravity through a collaboration with Ecole Supérieure de Physique et Chimie Paris Tech and Institut de Chimie de la Matière Condensée de Bordeaux, France.



### 3.3 Meteorology/Atmospheric Physics

Four faculty members are involved in atmospheric physics and meteorology research. This field includes analyzing and modeling the earth's atmosphere on scales from nanometers to megameters. Our faculty and students do this through theoretical, computational, and experimental investigations.

The College of Charleston is an Academic Affiliate of the University Corporation for Academic Research, UCAR, which runs NCAR, the National Center for Atmospheric Research, one of the most prestigious institutes for environmental research in the world.

We are one of the few meteorology programs with direct computer access to current National Oceanic and Atmospheric Administration (NOAA) weather data through the UNIDATA program. We have meteorology instrumentation such as photometers (for cloud investigation), and a micrometeorological particulate laboratory. Finally, we closely cooperate with the local National Weather Service (NWS) office, where many of our undergraduates have assisted.

Equipment for meteorology and atmospheric physics research includes an air quality laboratory being outfitted now, plus current equipment including 3 turn-key

weather stations (one with piezoelectric drop sensor and one with a small radar), 3 optical particle counters, 21 laser precipitation monitors, a 2-dimensional video disdrometer, and a large number of data acquisition and data processing computers.

### 3.4 Computing Facilities

The Department maintains a computer lab in room 218 and a more advanced lab in room 221. The 218 lab is for general student use, including non-majors who are taking physics classes. The software includes both general purpose and special research and technical productivity software. Ask for help if you need an introduction to the computers or the software. It is under the supervision of Mr. True and Dr. Wragg. There is an adjacent small library and study area for our majors. The advanced computing labs in room 221, host special hardware and software primarily for research groups. Speak with individual research faculty for access to those computers.

The College maintains a research-grade parallel Linux computer cluster. The cluster has 4 sets of nodes (with a total of 340 AMD Opteron 64-bit processors): 10 2-CPU, 2.0 GHz nodes; 16 4-CPU, 2.0 GHz nodes; 8 8-CPU, 2.9 GHz nodes, and 8 24-CPU, 2.1 GHz nodes. All of the nodes share a common file system, with over 10 TB of total storage capacity. It is heavily used by Dr. Fragile and his team for studies of material flow near black holes.

For teaching biophysical modeling and signal/image processing courses we use 17 MacBookPro laptops. Computational biophysics and signal/image processing research resources include

- One quad-core HP server, 64 GB RAM, 8 TB of network storage.
- Two 6-core and one 12-core MacPro, with 24 TB of network storage.
- Two customized systems (16- and 32-cores).

Computational simulations of atmospheric radiative transfer by Dr. Larsen's research group relies on several customized systems for doing video-card based computation. These systems include:

- 8 video-card, 12-core system with 144 GB of RAM
- 4 video-card, 12-core system with 64 GB of RAM
- 2 video-card, 48-core system with 512 GB of RAM

The rules for computer use are fairly common-sense. Use them, don't abuse them. Please do not load software applications without specific permission from the overseers.

### 3.5 Senior Research—phys420/499

Reasoning critically, planning, making decisions, analyzing, drawing conclusions and working independently are valuable, marketable assets. For most careers these abilities are a requirement as important as teamwork. Your course work has helped to develop and hone these skills. The final polishing and capstone experience of your undergraduate training in the Physics Department will be your senior research project. This is your opportunity to show what you can accomplish—self education through careful library research, conceive a workable project of your own or connect with a faculty member's research, plan every detail and present the results in a professional and scholarly fashion in writing and orally. Of course, you will have the guidance of your project advisor.

The following guidelines and requirements will help you prepare for your senior project. In phys419 you will, among other things, prepare a formal proposal which describes the research project you will undertake in phys420 or phys499 (the year-long version of 420 undertaken mostly by students in the Honors College).

The general flow is—you find a research advisor and a project (in either order) with the support of the 419 instructor. In close consultation with the advisor and with guidance from the 419 instructor, you write the proposal. The 419 instructor serves as the reviewer of the proposal, since it is a formal part of 419. Once the reviewer is satisfied with the proposal you, your advisor, and the 419 instructor sign a Special Enrollment Form that will stay with the proposal. The signed form and the proposal are presented to the Chair who can sign it and forward it to the Registrar for enrollment of the student in 420. The Chair *may* have questions or choose to require further development. It is YOUR responsibility to follow up on things, to make sure you are enrolled officially in phys420/499. Check on-line to make sure you are enrolled. See Appendix C for the evaluation criteria, purchasing procedures, and expectations.

The advisor and project need not be in the Department. It is common to do research in other departments or outside organizations. If so, you still need to have an internal departmental advisor, who is responsible for assigning a grade, in consultation with your actual research advisor.

The intent of the proposal is to help you develop a professional approach to a project, and a template for professional progress through the project. The department expects a good faith effort to execute the research that was proposed. Research projects, by their very nature, require frequent re-evaluation during their execution. Deviations from your proposed plan are to be expected, but you should justify them to your advisor's satisfaction.

The department does not expect the proposal itself to be an exhaustive production, but you must make it



clear what you are trying to do, and that you have the resources to do it—expertise, advising, equipment, space, money, time. . . . A well-written proposal could make this justification in as few as 3 pages.

Below are the basic issues that we ordinarily expect to be addressed in a proposal.

1. Who is doing it (student, advisor, collaborators)?
2. What is the problem being investigated, and how will it be investigated? Is it theoretical, computational, experimental, a combination? A brief background/motivation is usually appropriate, to clarify to the reviewers what aspect of the project the student will be responsible for.
3. Timeline: A list of expected interim tasks and their approximate dates of accomplishment.
4. Resources and Budget: what space, equipment, computing facilities, consumables etc. you expect to use, and an explicit list of things you expect to buy, and their costs.
5. Outcome: What will the research produce? How will your project be evaluated?

We expect a professional looking proposal, with a title page, abstract, and details. All proposals should be of the highest quality—professional form, layout, grammar, illustrations, references, narrative, etc.

Note also that your advisor and the phys419 instructor do not approve budgets, but rather evaluate them as reasonable. They have no spending authority and no authority to obligate funds. The department chair does.

At some point in your studies it is expected that you will present a poster at the SSM Poster Session (<http://ssm.cofc.edu/additional-programs/poster-session/>), and present a talk at a national, regional or local venue. Your 420/499 project is often a good choice, and in many cases, the only practical opportunity for you to make these professional presentations.

There may be cases where a student needs to get a proposal approved outside of the usual phys419 experience. For example, if a previously approved proposal becomes impossible because the advisor got killed by a meteor, and the student needs a completely new project. The approval process and requirements are essentially the same. The student, in concert with the new project supervisor will prepare a proposal, which must be approved by the current or most recent (if there is no current 419 class) 419 instructor. It then goes to the department Chair for final approval. All the paperwork is the same as for the usual approval and enrollment process.

Appendix C has information regarding the procedures to follow if you need to make purchases of approved

items for your project. There is also a brief section that codifies and clarifies some of the standard expectations you need to meet. These are things that often enter in to the grading scheme. Please note that they are a guide only, and the actual details should be clarified between you and your advisor before you begin the project. The form provided is merely a suggested template.

### 3.5.1 Considerations

When writing the proposal you should keep in mind the following items which are generally considered by reviewers of proposals of any kind.

Title: Is it descriptive and appropriate?

Abstract: Does it encapsulate the project? What, if anything, is missing or extraneous?

Background: Does it give theory and history such that the reader is brought into the project?

Goals: Are the project and its goals clearly defined and reasonably achievable? Are appropriate criteria for evaluation included?

Figures: are diagrams, figures, and illustrations clear, well labeled, sufficient and well done?

Approach: Is the approach to the research clear?

Budget: Is the budget clear and realistic?

References: Are references appropriate in number and scope?

Workload: Is the project realistic in terms of the expected workload and time constraints?

Resources: Are suitable facilities, equipment and expendables available?

Timeline: Is there a clear plan with due dates for intermediate accomplishments?

Appearance: Are the layout and typography professional?

Clarity: Is the proposal clearly written?

Editorial: General editorial issues (grammar, style, punctuation. . .)

Technical Issues: Any technical problems foreseen that could have a major impact on the project?

## 4 Degree Requirements

122 Hours are required to graduate. Please refer to the college catalog for the official requirements and listings. These things are subject to change. Also be aware that not every course listed in the catalog is offered every year, or even regularly. Scheduled classes may be cancelled due to under-enrollment, or for other reasons.

For all of our degree programs, under special circumstances, with department approval, phys101 and 102 (with associated labs) together with math120 and 220

may replace phys111 and 112 for our majors. In addition to requiring a grade of at least B in the phys101/102 courses other restrictions may apply.

With department approval, phys499 may be substituted for phys420. This does not decrease the number of hours of electives required for the major, it only substitutes for phys420.

#### 4.1 B.S. in Physics

The BS in Physics consists of 43 hours of coursework in physics, 28 required + 15 elective hours, plus math prerequisites. The elective hours may be chosen with department approval from astr306, and any 300- or 400-level physics or astronomy course with a maximum of six credits total from phys381, phys390 and phys399.

Required courses for the BS in physics are:

phys111/112 General Physics I, II (4+4)  
 phys230 Modern Physics I (3)  
 phys301 Classical Mechanics I (3)  
 phys370 Experimental Physics (4)  
 phys403 Quantum Mechanics I (3)  
 phys409 Electricity & Magnetism I(3)  
 phys419 Research Seminar (1)  
 phys420 Senior Research (3)  
 + 15 elective hours

Additional courses **Strongly** recommended to prepare you for advanced study:

phys404 Quantum Mechanics II (3)  
 phys405 Thermal Physics (3)  
**and from other departments:**  
 math423 Partial Differential Eqns (3)  
 chem111/112 Princ. of Chem (4+4)  
 csci220 Computer Programming

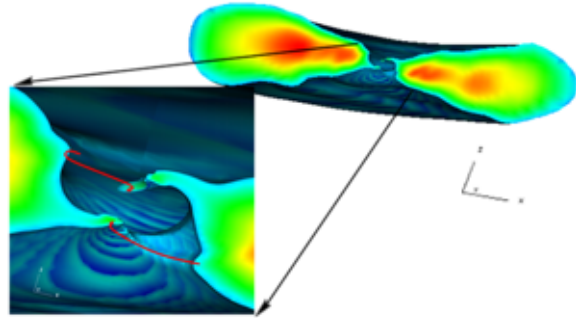
#### 4.2 B.A. in Physics

The BA in Physics requires 30 hours in physics, 19 required + 11 electives, plus math prerequisites. Electives: 11 additional hours in physics to be selected by the student, with the approval of the department, with a maximum of three credits each from the two groups (phys260/260L/460L), and (phys381, phys390, and phys399).The department expects the program to be cohesive in design, rather than a haphazard collection of courses.

Required courses for the BA in physics:

phys111/112 General Physics I, II (4+4)  
 phys230 Modern Physics I (3)  
 phys370 Experimental Physics (4)  
 phys419 Research Seminar (1)

phys420 Senior Research (3)  
 + 11 elective hours



#### 4.3 B.S. in Astrophysics

The BS in Astrophysics consists of 43 hours of coursework in physics and astronomy, plus math prerequisites.

Required courses for the BS in astrophysics are:

phys111/112 General Physics I, II (4+4)  
 phys230 Modern Physics I (3)  
 phys301 Classical Mechanics I (3)  
 phys403 Quantum Mechanics I (3)  
 phys405 Thermal Physics (3)  
 phys409 Electricity & Magnetism I(3)  
 phys419 Research Seminar (1)  
 phys420 Senior Research (3)  
 astr231 Intro to Astrophysics(3)  
 astr377 Experimental Astronomy (4)

Plus 9 credits from the following, with at least 6 from those in **bold**.

**astr306 Planetary Astronomy (3)**  
**astr311 Stellar Astronomy and Astrophysics (3)**  
**astr312 Galactic/Extragalactic Astronomy (3)**  
**phys412 Special Topics (in astronomy) (3)**  
**astr413, Astrophysics (3)**

phys390 Research (in astronomy) (3)  
 phys394 Digital Signal and Image Processing... (3+1)  
 phys404 Quantum Mechanics II (3)  
 phys407 Nuclear Physics (3)  
 phys410 Electricity & Magnetism II (3)  
 phys415 Fluid Mechanics (3)  
 astr410, Black Holes (1)  
 astr/geol/phys460L, NASA Mission Design Leadership Lab (1)

Plus  
 Demonstrated skill in analytical computer programming (e.g. math245/246, or suitable experience)

Note that except for the substitution of astr377 for phys370, this qualifies for the B.S. in Physics. If the student takes astr377 and phys370, then they have a double

major in Physics and Astrophysics.

#### 4.4 B.A. in Astronomy

The BA in Astronomy consists of 30 hours of coursework in physics and astronomy, plus math prerequisites.

Required courses for the BA in astronomy are:

phys111/112 General Physics I, II (4+4)  
astr231 Intro to Astrophysics (3)  
astr377 Experimental Astronomy (4)  
phys419 Research Seminar (1)  
phys420 Senior Research (3)

Plus 11 additional hours from the following, with at least 6 from those in **bold**.

**astr205 Intelligent Life (3)**  
**astr306 Planetary Astronomy (3)**  
**astr311 Stellar Astronomy and Astrophysics (3)**  
**astr312 Galactic Astronomy (3)**  
**phys390 Research (in astro) (3)**  
**astr413 Astrophysics (3)**  
**phys412 Special Topics (in astronomy)**  
**astr413, Astrophysics (3)**

astr210 Black Holes in the Universe (3)  
astr/geol/phys260 NASA Space Mission Design (2)  
astr/geol/phys260L NASA Space Mission Design Lab (1)  
astr410 Black Holes (1)  
astr/geol/phys460L NASA Space Mission Design Leadership Lab (1)  
geol206 Planetary Geology (3)  
geol412 Crustal Geophysics (3)  
phys225Climate (3)  
phys230 Modern Physics I (3)  
phys298 Special Topics (astro related)  
phys301 Classical Mechanics (3)  
phys340 Photonics (4)  
phys394 Digital Signal and Image Processing... (3+1)  
phys403 Quantum Mechanics (3)  
phys404 Quantum Mechanics II (3)  
phys405 Thermal Physics (3)  
phys407 Nuclear Physics (3)  
phys409 Electricity & Magnetism (3)  
phys410 Electricity & Magnetism II (3)  
phys415 Fluid Mechanics (3)

#### 4.5 B.A. in Meteorology

The BA in Meteorology consists of minimum of 38 hours of coursework in meteorology, physics and math. Minimums from each category follow.

17 hours of core meteorology

*Base Experience\*\**: (if the second option is taken, two will also count as electives below)

phys105, Introduction to Meteorology

Or three of the following four classes\*\*

geol438, Hydrogeology

phys405, Thermal Physics

phys415, Fluid Mechanics

phys459, Cloud and Precipitation Physics

*Emphasis Experience*

(phys210, Introduction to Air Pollution

Or

phys215, Synoptic Meteorology

if both are taken, one will count as an elective )

and

phys225, Climate

phys370, Experimental Physics

phys419, Research Seminar\*

phys420 or phys499 Capstone Research

*8 hours of introductory physics*

phys111/111L/112/112L, General Physics or

hons157/157L/158/158L, Honors Physics or

phys101/101L/102/102L, Introductory Physics [a minimum grade of C- in each of the four courses is required; this option cannot be used if the operational meteorology concentration is desired]

*8 hours of mathematics*

math120, Introductory Calculus

math220, Calculus 2

Or

math229, Vector Calculus with Chemical Applications

[note that math229 cannot be used for the operational meteorology concentration]

*Minimum of 5 hours of electives selected from*

astr129, Introduction to Astronomy

astr129L, Introduction to Astronomy Lab

astr306, Planetary Astronomy

biol204, Man and the Environment

biol342, Oceanography

chem101, General Chemistry

chem101L, General Chemistry Lab

chem111, Principles of Chemistry

chem111L, Principles of Chemistry Lab

chem112, Principles of Chemistry

chem112L, Principles of Chemistry Lab

comm104, Public Speaking

csci220, Computer Programming

csci220L, Computer Programming Lab  
 engl334, Technical Writing  
 envt200, Introduction to Environmental Studies  
 envt352, special topics\*  
 envt395, seminar\*  
 geol213, Natural Hazards  
 geol288, Global Change  
 geol291, Water Resources  
 geol438 Hydrogeology\*\*\*\*  
 geol442, Remote Sensing  
 geol449, GIS  
 hons390, special topics\*  
 math250, Statistical Methods  
 phys106L, Exercises in Weather and Climate  
 phys210, Introduction to Air Pollution\*\*\*\*  
 phys215, Synoptic Meteorology\*\*\*\*  
 phys230, Modern Physics  
 phys298, special topics\*  
 phys301, Classical Mechanics  
 phys320, Electronics  
 phys340, Photonics  
 phys350, Energy Production  
 phys381, Internship\*, \*\*\*  
 phys390, research\*, \*\*\*  
 phys394: Digital Signal and Image Processing with Biomedical Applications  
 phys394L: Digital Signal and Image Processing with Biomedical Applications Lab  
 phys399, tutorial\*, \*\*\*  
 phys405, Thermal Physics\*\*\*\*  
 phys409, Electricity and Magnetism  
 phys410, Electricity and Magnetism 2  
 phys412, special topics\*  
 phys415, Fluid Mechanics\*\*\*\*  
 phys425, Mesoscale Meteorology  
 phys457, Satellite Meteorology  
 phys459, Cloud and Precipitation Physics\*\*\*\*

**Notes:** Some of the elective courses require prerequisites that will not count towards the major unless they are on the list above.

Topics in these courses must involve meteorology and must be approved by the meteorology program director and the department.

\*Students may replace phys105 with any three of the following four courses (phys405, phys415, phys459 and geol438). Replacing one introductory course with three senior-level courses may be desirable for students pursuing a concentration in operational meteorology or a certificate in consulting meteorology or a degree in physics.

\*\*Maximum of 3 hours each of phys381, 390 or 399 may be applied to the major.

\*\*\*If not used as a core course

#### 4.5.1 Certificate in Broadcast Meteorology

The American Meteorological Society offers a Certificate in Broadcast Meteorology. Students will fulfill the requirements for a certificate in Broadcast Meteorology from the American Meteorology Society if they complete the following coursework, in addition to those required by the concentration in operational meteorology and the B.A. in meteorology:

chem111/111L, Principles of Chemistry  
 csci220/220L, Computer Programming  
 math250, Statistical Methods

Plus one of the following:

biol204, Man and the Environment  
 envt200, Intro to Environmental Studies  
 geol213, Natural Hazards  
 geol288, Global Change

Also, comm104, engl334 and phys457 are recommended

#### 4.5.2 Certificate in Consulting Meteorology

Students will fulfill the requirements for a certificate in Consulting Meteorology from the American Meteorology Society if they complete the following coursework, in addition to those required by the B.A. in meteorology:

A. 7 hours minimum of additional math:  
 math221 and  
 either (math203 and math323) or phys272

B. 15 hours minimum of meteorology:  
 Core Courses (0 to 3 hours):  
 phys215, Synoptic Meteorology (not additional to the BA if 215 is selected as the emphasis area) and,

C. Complete 3 of the 4 tracks:

Track 1:  
 phys459, Cloud and Precipitation Physics

Track 2:  
 phys230, Modern Physics, and  
 phys405, Thermal Physics

Track 3:  
 phys415, Fluid Dynamics

Track 4:  
 geol438, hydrogeology (prereqs of geol105/105L and 103/103L), and  
 phys105, Intro to Meteorology

Note: Students may NOT use phys101/102 to satisfy the requirement of a year in introductory physics if they wish to obtain this certificate.

The National Weather Service also offers careers in operational meteorology. To qualify

A. Students must fulfill the federal civil service requirements in operational meteorology. These require students to complete the BA degree in meteorology and the concentration in operational meteorology.

B. Students are expected to have some appropriate experience, such as phys381, Internship.

## 4.6 Concentrations

A concentration is a focused area of study within your major. We offer concentrations in energy production, computational neuroscience and meteorology.

### 4.6.1 Energy Production

A concentration in energy production consists of a minimum of 18 hours of coursework, which includes a core of chemistry and physics and a selection of electives.

Required Courses (8 credits)

chem111 General Chemistry I with lab (4 cr.)  
phys350 Energy Production with lab (4 cr.)

Electives (10 credits, at least two courses from group I)

Group I-

phys320 Introductory Electronics (4 cr.)  
phys340 Photonics (4 cr.)  
phys405 Thermal Physics (3 cr.)  
phys407 Nuclear Physics (3 cr.)  
phys408 Solid State Physics (3 cr.)

Group II-

phys210 Introduction to Air Pollution (3 cr.)  
phys225 Climate (3 cr.)  
phys381 Internship (energy related) (1-3 cr.)  
phys390 Research (energy related) (1-3 cr.)  
phys409 Electricity and Magnetism (3 cr.)  
phys412 Special Topics (energy related) (1-3 cr.)  
phys415 Fluid Mechanics (3 cr.)  
phys419 Seminar (1 cr.)  
phys420 Senior Research (energy related) (3 cr.) or  
phys499, but only count 3 credits of its 6 credits toward the concentration  
geol320 Earth Resources (3 cr.)  
chem341/341L Physical Chemistry (4 cr.)  
chem528 Nuclear and Radiochemistry (3 cr.)

### 4.6.2 Computational Neuroscience

The CNS concentration targets those Physics/Mathematics/Computer Science/Discovery Informatics majors who are interested and have the adequate background to successfully pursue a mathematical and computational neuroscience program. The program requires a minimum of 18 hours of coursework, and there may not be double-counting towards other concentrations or minors.

Required Courses (11 credits)

CSCI 220 Computer Programming I (3)  
CSCI 220L Computer Programming I Lab (1)  
biol 396/phys 396, Biophysical Modeling of Excitable Cells (3)  
phys 394, Digital Signal and Image Processing with Biomedical Applications (with lab) (3)  
phys 394L, Digital Signal and Image Processing with Biomedical Applications Lab (1)

2. Electives (Complete minimum 7 credit hours from the following electives. Each elective must be from a different group.)

Group I-

biol305 Genetics (3)  
biol312 Molecular Biology (3)  
biol313 Cell Biology (3)  
biol321 General and Comparative Physiology (4)  
biol343 Animal Behavior (4)  
biol351/psyc351, Principles of Neurobiology (3)  
biol352/psyc352, Neurobiology and Behavior (3)  
biol446/psyc446, Special Topics in Neuroscience: Techniques in Neuroscience (4)  
biol447/psyc447/NSCI 447, Seminar in Neuroscience (3)  
psyc213 Conditioning and Learning (3)  
psyc214 Behavioral Neuroscience (3)  
psyc215 Cognitive Psychology (3)  
psyc216 Sensation and Perception (3)  
psyc221 Abnormal Psychology (3)  
psyc318 Comparative Psychology (3)  
psyc353 Hormones and Behavior (3)  
psyc386 Behavioral Pharmacology (3)  
psyc387 Neuropsychology (3)  
psyc464 Advanced Behavioral Neuroscience with Lab (3)  
psyc466 Advanced Sensation and Perception with Lab (3)  
psyc468 Advanced Cognitive Psychology with Lab (3)

Group II-

math207 Discrete Structures I (3)  
math307 Discrete Structures II (3)  
math245 Numerical Methods and Math. Comp.(3)  
math246 Mathematical Computing and Prog. Lab (1)  
math445 Numerical Analysis (3)  
math451 Linear Programming and Optimization (3)  
math452 Operations Research (3)

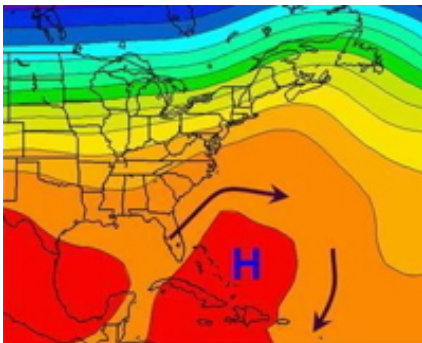
math470 Mathematical Modeling (3)  
 math440 Statistical Learning I (3)  
 math441 Statistical Learning II (3)  
 csci221 Computer Programming II (3)  
 csci230 Data Structure and Algorithms (3)  
 csci334 Data Mining (3)  
 csci360 Software Architecture and Design (3)  
 csci362 Software Engineering (3)  
 csci380 User Interface Development (3)  
 csci470 Principles of Artificial Intelligence (3)  
 csci480 Principles of Computer Graphics (3)

Group III-

phys203 Physics and Medicine (3)  
 phys270 Nanotechnology in Medicine (3)  
 phys298 Special Topics\* (1-3)  
 phys320 Intro to Electronics (4)  
 phys340 Photonics (4)  
 phys381, Internship\* (3)  
 - or - (Not both!)  
 phys390, Research\* (3)  
 phys390 Special Topics\* (3-6)  
 phys390 Research\* (1-3; repeatable up to 6)  
 phys399 Tutorial\* (3; repeatable up to 12)  
 phys405, Thermal Physics (3)  
 phys407, Introduction to Nuclear Physics (3)  
 phys408, Introduction to Solid State Physics (3)  
 phys412, Special Topics\* (3-4)  
 phys415, Fluid Mechanics (3)  
 phys420 Senior Research\* OR (3)  
 phys499 Bachelor's Essay\* OR biol448/psyc448/nsci448,  
 Bachelor's Essay in Neuroscience (6)

Note: Credit will not be awarded for both Senior Research (phys420) and Bachelor's Essay (phys499/biol448/psyc448/nsci448).

\*Must be CNS related and conducted under the mentorship of a neuroscience faculty from the C of C or co-mentorship with MUSC faculty. Prior written approval must be obtained from the coordinator of CNS concentration.



**4.6.3 Operational Meteorology**

Students will fulfill the requirements for a Concentration in Operational Meteorology if they complete the following coursework, in addition to that required for the B.A. in meteorology. This coursework meets federal civil service requirements for employment in operational meteorology (e.g., National Weather Service).

*Physics and Meteorology Core Courses (18 credits)*

1. phys215, Synoptic Meteorology (3 cr.)
2. phys230, Introduction to Modern Physics (3 cr.)
3. phys405, Thermal Physics (3 cr.)
4. phys415, Fluid Mechanics (3 cr.)
5. phys425, Mesoscale Meteorology (3 cr.)
6. phys459, Cloud and Precipitation Physics (3 cr.)

*Mathematics Cognate Core (7 cr.)*

Additional mathematics course that are required in concentration (but not underlying BA program)

7. math221, Calculus III (4 cr.)
8. math323, Differential Equations (3 cr.) or phys272 Methods of Applied Physics (3 cr.)

*Electives (6 Credits)*

- phys409 Electricity and Magnetism (3 cr.)
- phys340 Photonics (3 cr.)
- biol342 Oceanography (3 cr.)
- chem111/111L Principles of Chemistry (4 cr.)
- csci220/220L Computer Programming (4 cr.)
- geol438 Hydrogeology (3 cr.)
- math250 Statistical Methods I (3 cr.)

**4.6.4 Atmospheric Physics**

The Atmospheric Physics Concentration within the Physics B.S. degree will consist of 18 hours (9 core credits and 9 elective credits).

*Core Courses (all required) (9 credits)*

1. phys405 Thermal Physics (3 cr.)
2. phys415 Fluid Mechanics (3 cr.)
3. phys459 Cloud and Precipitation Physics (3 cr.)

*Electives (at least 9 credits from the following list)*

- astr306 Planetary Astronomy (3 cr.)
- envt352\* Special Topics in Environmental Science (1-4 cr.)
- geol442 Geological Application of Remote Sensing (4 cr.)
- geol449 Geographical Information Systems (4 cr.)
- hons390\* Special Topics (3-6 cr.)
- phys210 Introduction to Air Pollution (3 cr.)
- phys215 Synoptic Meteorology (3 cr.)
- phys225 Climate (3 cr.)
- phys298\* Special Topics (1-3 cr.)

phys320 Intro to Electronics (4 cr.)  
 phys340 Photonics (4 cr.)  
 phys350 Energy Production (4 cr.)  
 phys381\* Internship (1-4 cr.)  
 phys390\* Research (1-3 cr.)  
 phys394/394L Digital Signal and Image Processing with Biomedical Applications (4 cr.)  
 phys399\* Tutorial (3 cr.)  
 phys410 Electricity and Magnetism 2 (3 cr.)  
 phys412\* Special Topics (1-3 cr.)  
 phys420\* Senior Research (3 cr.)  
 phys425 Mesoscale Meteorology (3 cr.)  
 phys457 Satellite Meteorology (3 cr.)

\* = topics in these courses must involve atmospheric physics and must be approved by the department.

## 4.7 Minors

A minor is a focused area of study outside of your major. For example, if you are a geology major and are interested in geophysics you can get a minor in physics. There are currently four minors available through our department: Physics, Astronomy, Biomedical Physics, and Meteorology. Generally speaking minors require at least 18 credit hours from a specified set of courses in that field. At least 9 hours in the minor at the 200-level or above must be earned at the College.

### 4.7.1 Minor in Physics

Students must take a minimum of 18 hours in physics as listed below.

- Core courses: Phys111/112 (or honors physics, or may substitute 101/102 as described under the major)
- Electives: To add up to at least 18 hours. Most other physics courses, but must be approved by the Physics Minor Coordinator (Dr. Hakkila). Special topics, research, etc. must clearly be physics (not astro or meteorology). astr/geol/phys260, astr/geol/phys260L, and astr/geol/phys460L may be used as electives.

### 4.7.2 Minor in Astronomy

Students must take a minimum of 18 hours as listed below. At least nine hours in the minor at the 200-level or above must be earned at the College. A maximum of 3 courses at the 100-level. No credit towards the minor for both phys101 and phys111, phys102 and phys112, or astr129/130 and honors astronomy.

- Core courses: astr129/130, **or** one year of honors astronomy, **or** astr231, Intro to Astrophysics.
- Electives to add up to at least 18 hours. Geol206, hist251, phys101/102, phys111/112, astr205, astr210, astr/geol/phys260, astr/geol/phys260L, astr306, astr311, astr377, astr410, astr413, astr/geol/phys460L, phys225, phys298, phys301, phys340, phys 390, phys399, phys412, phys420, phys499. Special topics, research, etc. must be approved by the Astronomy Minor Coordinator (Dr. Hakkila).

### 4.7.3 Minor in Biomedical Physics

Students must take a minimum of 18 hours in physics and biology as listed below. A maximum of 3 credits of biology or chemistry courses at the 200-level and above may be counted toward the minor.

Core courses-

- phys102 Intro Physics II with lab (4 credits) OR phys112 General Physics II with lab (4 credits) OR hons158 Honors Physics II with lab (4 credits)
- biol112 Form and Function of Organisms with lab (4 credits) OR hons152 Honors Biology II with lab (4 credits)
- phys 203 Physics and Medicine (3 credits)
- phys 396/biol396 Biophysical Modeling of Excitable Cells (3 credits)
- Additional 4 credits from the following electives:
  - phys270 Nanotechnology in Medicine (3 credits)
  - phys320 Introductory Electronics (4 credits)
  - phys390/biol397/chem481/482 Research OR phys/biol/chem399 Tutorial(1-3 credits subject to approval by the minor coordinator and research adviser)
  - phys298 Special Topics (1-3 credits subject to approval by the minor coordinator)
  - phys412 Special Topics (1-3 credits subject to approval by the minor coordinator)
  - chem351 Biochemistry (3 credits)
  - chem354L Biochemistry Lab (1 credit)

Sample schedule:

Year 1: phys102 w/lab, biol112 w/ lab

Year 2: phys203, phys/biol396

Year 3: phys270

Year 4: phys390, biol397, or chem481

#### 4.7.4 Minor in Meteorology

Core course

phys105 Introduction to Meteorology

A minimum of two additional meteorology-based courses selected from:

envt352: Special Topics\*

hons390: Special Topics\*

phys106L: Exercises in Weather and Climate

phys210: Introduction to Air Pollution

phys215: Synoptic Meteorology

phys225: Climate

phys298: Special Topics\*

phys370: Experimental Physics

phys381: Internship\*

phys390: Research\*

phys399: Tutorial\*

phys412: Special Topics\*

phys425: Mesoscale Meteorology

phys457: Satellite Meteorology

phys459: Cloud and Precipitation Physics

\* = topics in these courses must involve meteorology and must be approved by the department.

Electives (if needed as students can take more than two courses in the category above):

astr129: Astronomy 1\*\*

biol204: Man and the Environment

biol342: Oceanography

chem101: General Chemistry\*\*

chem111: Principles of Chemistry\*\*

chem112: Principles of Chemistry\*\*

csci220: Computer Programming\*\*

engl334: Technical Writing

envt200: Introduction to Environmental Studies

geol213: Natural Hazards

geol240: Special Topics\*

geol288: Global Change

geol291: Water Resources

geol442: Remote sensing

geol449: GIS

phys101: Introductory Physics\*\*

phys102: Introductory Physics\*\*

phys111: General Physics\*\*

phys112: General Physics\*\*

phys157: Honors Physics\*\*

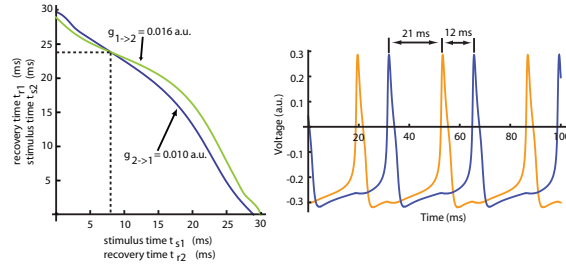
phys158: Honors Physics\*\*

phys350: Energy Production

phys394: Digital Signal & Image Processing

\*Must involve meteorology and must be approved by the meteorology minor program director.

\*\*Associated laboratory may also be used as an elective



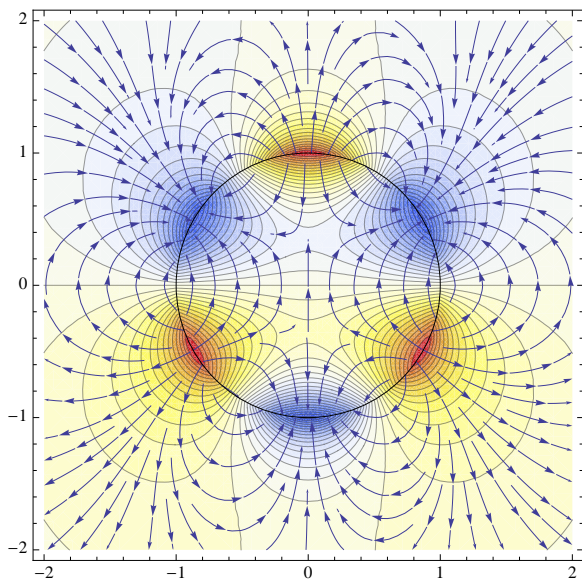
#### 4.7.5 Minor in Neuroscience

Computational Neuroscience is a relatively new interdisciplinary area of inquiry that links the information processing features of the nervous system with information processing of computer systems. The department participates in the Minor in Neuroscience—<http://neuroscience-minor.cofc.edu/> through the computational neuroscience research of Dr. Sorinel Adrian Oprisan. Courses integrate the key elements of both neuroscience and computing and will produce undergraduates uniquely able to converse in the languages of both disciplines. At the same time, course work in computational neuroscience can prepare students for graduate studies in neurobiology or psychology, or in the mathematical or engineering sciences. It can lead to either traditional academic careers or to opportunities in the corporate world.

Physics majors have the option of an interdisciplinary minor in neuroscience.

- Core courses: all physics major courses, biol351/psyc351 Principles of Neurobiology, biol352/psyc352 Neurobiology and Behavior, biol447/psyc447 Seminar in Neuroscience, biol448/psyc448 Bachelor's Essay in Neuroscience, and phys/biol396 Biophysical Modeling of Excitable Cells
- Electives: two required (phys203 Physics and Medicine, phys270 Nanomedicine, etc.)





## 5 Advising

First and foremost, **it is your responsibility** to understand the requirements, to plan a program, and to make progress. Advisors merely advise, make suggestions, and give you their perspective on courses and choices. It is important that you maintain contact with your advisor, and other faculty members that can help you make good decisions about your program here. To facilitate this contact, we put a hold on your registration for classes until you speak with your department advisor. Our desire is to aid in your passage towards your goals, but you must be pro-active in the process. We realize that your goals can change. It is important that you let your advisor know as soon as you know, so you can reconfigure your academic plan.

Here are some common issues:

- The single most common problem is a lack of progress in math. Take math every semester to get the necessary courses, and, depending on your goals, take even more, for example Partial Differential Equations would be strongly recommended for graduate school bound students, going into physics or engineering type careers. Take Linear Algebra as early as you can, concurrently with calc II or III. Only students entering the job market with bachelors degree should consider phys272 as their terminal math class. See the note in the course listings for phys272.
- In the second semester of your junior year you should file an application for graduation with the Registrar. See the Senior Information Website at <http://cofc.edu/commencement/>.

- It is very common at universities to have courses listed in catalogs that are seldom offered. There are several reasons for this, but the important thing for you to be aware of is that being in the catalog doesn't mean that you will have an opportunity to take a specific course. The anticipated course offerings page in this handbook, and the course descriptions often give useful information about when courses may be offered.
- Courses that aren't regularly offered can be taught if there is sufficient interest by a group of students. Please talk with the chair if you want to have a course or a special topic course offered. Do it more than a semester beforehand.
- While we don't require a year of chemistry for our majors (many colleges do) we do recommend it, strongly for B.S. students, but also for B.A. students.
- The lower level astr129/130 astronomy classes are designed for non-science majors, so they are not part of the astronomy/astrophysics sequence for majors.
- In every course we teach we make an effort to connect the material to other areas and disciplines. Courses which are particularly broad in their integration and connection include Modern Physics (phys230/331), Atmospheric Physics (phys308), Stellar Astronomy and Astrophysics (astr311), and NASA Mission Design (astr/phys260/260L/460L).
- Engl110 must be taken continuously until you pass.
- Social Science: 6 hours from anthropology, economics, political science, psych or sociology
- Humanities: 12 hours, no more than 6 from any one area.
- General Education Worksheet: <http://registrar.cofc.edu/general-edu/>

### 5.1 Your Plan

Make a plan for your progress towards a degree. Use the worksheets in Appendix B, and go through Degree Works on-line at <http://registrar.cofc.edu/degreeworks/>. Talk with your advisor or any department faculty member about it. The Program of Study Management (POSM) is a valuable on-line aid also. <http://registrar.cofc.edu/posm/>

Appendix D shows anticipated course offerings for the next few regular academic terms. Note that special topics, May and summer offerings are generally not included.

Generally speaking, special topics offerings are only established about a semester in advance, which is why they aren't shown beyond the first semester, if that. None of this is guaranteed either. Be aware that any course can be cancelled due to lack of enrollment, or for other reasons. The introductory astronomy sequence (astr129/130), and General Physics (phys111/112) are generally offered in the summer, in addition to the regular academic year sessions as shown.

There are also courses in the catalog that are not regularly offered. Sufficient student demand, expressed early enough (at least a semester ahead) can result in those courses being offered. Examples are phys302, Classical Mechanics II, phys404, Quantum Mechanics II, and phys410, Electricity and Magnetism II.

Of course, talk with your advisor, but in general, for BS and BA students the single most important piece of advice we can give you is to TAKE MATH EVERY SEMESTER until you have completed the math you will take. Beyond that, take phys301 and 409 earlier rather than later, especially if you are graduate school bound. You need to take these before you take the GRE test in the fall of your senior year. Taking 301 the spring of your junior year and 409 the fall of your senior year is a good plan. If you plan on a biomedical-related path, take biol111/111L and biol112/112L as early as possible. They are prerequisites for core courses both for the interdisciplinary minor in neuroscience and the biomedical physics minor.

We often also recommend csci220, chem111/112, math245 and 423. Carefully select the physics and other courses that meet your needs. Make sure your senior research is consistent with your goals.

## 5.2 Career Goal Advice

In addition to a traditional graduate programs in physics or astronomy it is common to enter programs in engineering, medicine, meteorology, atmospheric physics, oceanography, optics, applied physics, engineering physics, business, and education. Particularly strong fields in recent years include environmental science (the College has a masters degree program in this area), meteorology/atmospheric physics, and medical/health physics. Graduate school in physics or related fields such as physical oceanography, meteorology, electrical engineering, nuclear engineering, and computer science are common tracks to take.

If you are one of the many graduate school bound seniors you need to seriously consider a regimented preparation program for the Graduate Record Examination (GRE) and the MCAT or similar tests. The Center for Student Learning (CSL), 3-5635, has the Post-Grad Test Prep Program. They run weekly workshops to prepare students for the general GRE (other workshops too for

MCAT, LSAT, etc.). Additionally the CSL offers printed materials that will help. Our club maintains test materials for the GRE.

The bachelor of science degree requires at least one revisit to all major subject areas at an advanced level. The degree programs allow some flexibility so that you can pursue electives that strengthen your program, and allow you to pursue your interests.

It usually isn't necessary to know exactly what you want to do. Even graduating seniors about to enter graduate school or the work force seldom know what they will end up doing. You will be exposed to a lot of things here and elsewhere in your education. Don't commit to something earlier than is necessary. Our students are well prepared to compete in programs beyond the bachelor's level and in the work force. No one expects you to know it all yet. Please see our web pages, <http://physics.cofc.edu/student-ops/job.php>, for links to many career related sites.

We are pleased to help our students market themselves, whether to graduate schools, professional schools, or in the job market. In addition to further education in physics, medicine, or engineering, the job market for those with a bachelor's degree includes technical sales, technical field representative, education, technical writing, laboratory technician, medical equipment maintenance, repair or operation, computer programming, and many engineering-type positions. We can help you prepare resumés and perhaps inform you about the scientific aspects of a job you are interested in.

Since all of the department faculty have been to graduate school, we have a good perspective on the process. Our web pages at <http://physics.cofc.edu/student-ops/more-school.php> are an excellent reference to the process, and we are pleased to talk with you about it, both formally, in phys419 and informally at other times. Talk with several faculty if you are contemplating graduate or professional school in any field.

### 5.2.1 Jobs with a BS in physics

It is common to sell yourself as a versatile engineering-type. Elective classes you select should reflect your desire to enter the job market in technical fields. Especially helpful courses include: Photonics, (phys340), Electronics (phys320), Solid State (phys408), Technical Writing (engl334), and Chemistry (chem111/112), and computer proficiency, via csci220 or other experience. Make your senior research project one of an applied nature. Cultivate skills that are marketable: proficiency with specialized computer programs such as Mathematica™, MATLAB™, L<sup>A</sup>T<sub>E</sub>X, and a variety of computer skills, including unix operating systems. Summer jobs and internships in industry are a very valuable experience. A wide

range of markets employ physicists. Don't search only for jobs with physics in the job title, there are many more with "engineer" or "scientist" in the title.

The biomedical field is a fast growing and challenging interdisciplinary endeavor that requires knowledge integration across physics, biology, and other disciplines. It offers rewarding jobs from medical imaging to medical data mining. Especially helpful courses include: Digital Image and Signal Processing with Biomedical Applications (phys394) and Biophysical Modeling of Excitable Cells (biol396/phys396).

We provide advice and assistance for graduates entering the job market. Please refer to our web pages at <http://physics.cofc.edu/student-ops/job.php> for a good starting point. The American Institute for Physics (AIP) is an excellent resource for career related information—careers, salaries, and employment trends. <http://www.aip.org/statistics/>

Resumés are a critical communications mechanism for anyone looking to change their position, either to move into other educational opportunities (such as grad school) or in the job market. Resumés are used to simplify the process of evaluating student candidates for research positions, both within the department and externally. In phys230 and 419 you will have the opportunity to prepare a resumé that will serve as a template for future resumés. Please refer to our web pages on resumé and cover letter preparation at <http://physics.cofc.edu/student-ops/resume.php>. Department faculty are always willing to edit your resumé and cover letters. Never send out important application documents without competent editing by someone else.

### 5.2.2 Grad School Bound Physicists

There are many sub-fields in physics—solid state physics (often used synonymously with condensed matter physics), nuclear physics, laser physics, surface physics, fractals, chaos, atmospheric, plasma, relativity, vacuum, fluids... They all have complementary experimental, theoretical and computational disciplines and are often closely allied with studies in other scientific disciplines. Some sense of your field of interest is useful, but not vital, when searching for graduate school opportunities. Take phys481, Physics Problem Solving, to help you on the GRE test. Dr. Wragg is a valuable resource for guidance on graduate school admission, as are other faculty members.

### 5.2.3 Astronomers

Astronomy historically has dealt with the positions and apparent motions of stars, while astrophysics was applied to the study of the nature of stars, primarily using spectroscopy. In current usage the terms are inter-

changeable. A BS degree in Astrophysics gives you a structured program preparing you for graduate or professional placement in the field.

### 5.2.4 Medical School

Statistics show that a physics degree is a very good preparation for medical school. The acceptance rate to medical school for students with physics degrees is high. We can easily structure a program that allows you to take the important chemistry and biology courses as part of your program of study for the BA or BS degree in physics. It is also likely that we can make your research experience relevant to medicine and medical research.

Dr. Linda Jones is the primary departmental resource for students interested in this field. Ms. Karen Eippert is the College's Director of Pre-professional Health Advising, so if you are interested in becoming a physician, you need to be in contact with her. She is the expert on qualifications, applications and entrance exam details. Her office is room 132 SSMB, and she is on the web at <http://healthprof.cofc.edu/>.

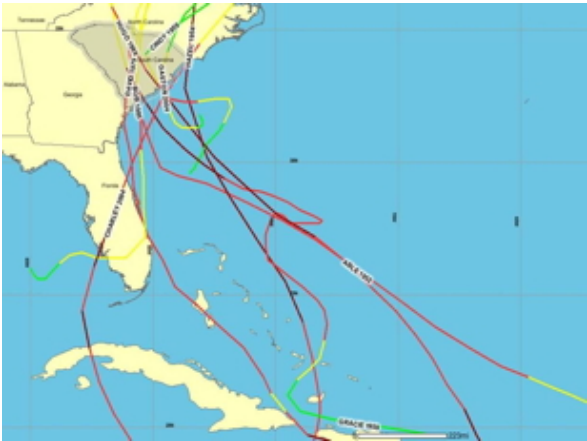
### 5.2.5 Meteorologists

We have a program to prepare you for work or graduate education in meteorology or atmospheric physics. If you are heading into a graduate program you should take classes in Fluid Mechanics, Thermodynamics, Atmospheric Physics and other meteorology electives. Other strongly recommended things include the GIS class in the Geology Department, IDL graphics and programming, and learn the Unix/Linux computer operating system that is used in many research environments. Consult with Drs. Lindner, Larsen, or Williams for more information.

### 5.2.6 Physics Teachers

The Physics and Astronomy Department is affiliated with the School of Education in providing a BA/BS in Physics with certification to teach physics in South Carolina schools. Our students have done research projects in science education as their senior research projects. Dr. Ana Oprisan, JC Long room 229, phone 953-7582, is the person to talk with in the Department of Physics and Astronomy about the physical sciences requirements and/or preparing a capstone project. Several other Department faculty members have significant involvement with pre-college education, from running science workshops for teachers, to visiting schools to present science programs. Teachers with strong physics and math credentials have excellent employment opportunities. Dr. Meta Van Sickle, room 213, 86 Wentworth, phone 953-6357, is the person to talk with in the School of Edu-

cation about preparing yourself for teaching certification in physics. This program is lengthy, involving extensive education and physics coursework, so early entry is desirable. See the Teacher Education Program Worksheet which are available from <http://ehhp.cofc.edu/student-resources/pos.php> for important details. The rewards and job opportunities are many for those who complete the certification process.



### 5.3 Sample Programs of Study

Please note that these programs are representative only, and are subject to individual needs, interests, and backgrounds, as well as to course offering schedules. Problems progressing in the major are most often related to progress in mathematics classes that prepare you for the physics and astronomy classes. It is vital to attack the mathematics you need as early as you possibly can.

#### 5.3.1 BS in Physics

<p><b>Freshman Fall</b>            math120, Calc I (4)            phys111, General Physics I (4)            engl110, Freshman Comp (4)            FYSM (3)            (total = 15)</p>	<p><b>Freshman Spring</b>            math220, Calc II (4)            phys112, General Physics II (4)            Elective (3)            hist101/103 (3)            Elective (3)            (total = 17)</p>
<p><b>Sophomore Fall</b>            phys230, Modern Physics I (3)            math221, Calc III (4)            math203, Linear Algebra (3)            Language I (3)            hist102/104 (3)            (total = 16)</p>	<p><b>Sophomore Spring</b>            phys370, Experimental Physics (4)            math323, Differential Eqns (3)            Physics elective (3)            Language II (3)            Humanity/Soc. Sci. (3)            (total = 16)</p>
<p><b>Junior Fall</b>            phys409, E&amp;M (3)            Physics Elective (3)            Humanity/Soc. Sci. (3)            Elective (3)            Language III (3)            (total = 15)</p>	<p><b>Junior Spring</b>            phys301 Classical Mechanics (3)            Physics Elective (3)            Language IV (3)            Elective (3)            Humanity/Soc. Sci. (3)            (total = 15)</p>
<p><b>Senior Fall</b>            phys419 Research Seminar (1)            phys403, Quantum Mechanics I (3)            Physics Elective (3)            Humanity/Soc. Sci. (3)            Elective (3)            Elective (3)            (total = 16)</p>	<p><b>Senior Spring</b>            phys420, Senior Research (3)            Physics Elective (3)            Humanity/Soc. Sci. (3)            Elective (3)            Elective (3)            (total = 15)</p>

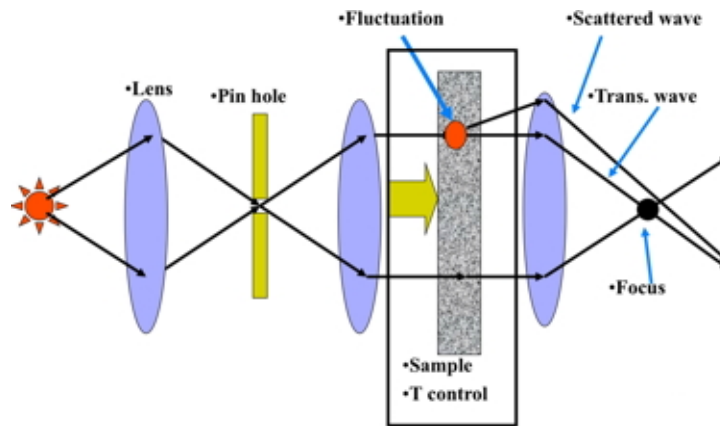
Carefully consider your goals and talk with your advisor for recommendations of the courses to fill out your studies. Remember, it isn't your goal to graduate just having met the minimum requirements. Your success in educational programs beyond the BS and in the workplace is closely tied to the breadth and depth of your undergraduate program.

Graduate schools would normally expect that you have taken Thermal Physics (phys405) and the second semester of Quantum Mechanics (phys404). Your preparation would also be considerably enhanced by taking Partial Differential Equations (math423).

### 5.3.2 BA in Physics

<p><b>Freshman Fall</b>            math120, Calc I (4)            phys111, General Physics I (4)            engl110, Freshman Comp (4)</p> <p>Humanity/Soc. Sci. (3)            (total = 14)</p>	<p><b>Freshman Spring</b>            math220, Calc II (4)            phys112, General Physics II (4)            Elective (3)            Elective (3)            hist101/103 (3)            (total = 17)</p>
<p><b>Sophomore Fall</b>            phys230, Modern Physics I (3)            math221, Calc III (4)            Humanity/Soc. Sci. (3)            Language I (3)            hist102/104 (3)            (total = 16)</p>	<p><b>Sophomore Spring</b>            math203, Linear Algebra (3)            Elective (3)            Physics elective (3)            Language II (3)            Humanity/Soc. Sci. (3)            (total = 16)</p>
<p><b>Junior Fall</b>            Elective (3)            Physics Elective (3)            math323, Differential Eqns (3)            Elective (3)            Language III (3)            (total = 15)</p>	<p><b>Junior Spring</b>            phys370 Experimental Physics (4)            Elective (3)            Language IV (3)            Elective (3)            Humanity/Soc. Sci. (3)            (total = 16)</p>
<p><b>Senior Fall</b>            phys419 Research Seminar (1)            Physics Elective (3)            Humanity/Soc. Sci. (3)            Elective (3)            Elective (3)            Elective (3)            (total = 16)</p>	<p><b>Senior Spring</b>            phys420, Senior Research (3)            Physics Elective (3)            Humanity/Soc. Sci. (3)            Elective (3)            Elective (3)            (total = 15)</p>

Physics electives are at least 11 additional hours with department approval from any 200-, 300-, or 400-level physics courses. Often the BA is for students with specific goals, such as medical school or education, and these goals dictate courses not illustrated in the above program.



### 5.3.3 BS in Astrophysics

Immediate entry into the calculus sequence is vital to the progress of the program.

<p><b>Freshman Fall</b>            math120, Calc I (4)            phys111, General Physics I (4)            engl110, Freshman Comp (4)            Language I (3)            Elective (1)            (total = 15)</p>	<p><b>Freshman Spring</b>            math220, Calc II (4)            phys112, General Physics II (4)             Elective (3)            Language II (3)            (total = 14)</p>
<p><b>Sophomore Fall</b>            phys230, Modern Physics I (3)            math221, Calc III (4)            math203, Linear Algebra (3)            Language III (3)            Elective (3)            (total = 16)</p>	<p><b>Sophomore Spring</b>            astr231 Intro to Astrophysics (3)            math323, Differential Eqns (3)            Humanity (3)            Language IV (3)            hist101/103 (3)            (total = 15)</p>
<p><b>Junior Fall</b>            phys409, E&amp;M (3)            astr377, Experimental Astro (4)            Humanity (3)            Social Science (3)            hist102/104 (3)            (total = 17)</p>	<p><b>Junior Spring</b>            phys405, Thermal Physics (3)            Astro elective (3)            phys301, Classical Mechanics (3)            Social Science (3)            Astro elective (3)            (total = 15)</p>
<p><b>Senior Fall</b>            phys419 Research Seminar (1)            phys403, Quantum Mechanics I (3)            Humanity (3)            Astro elective (3)            Elective (3)            (total = 13)</p>	<p><b>Senior Spring</b>            phys420, Senior Research (3)            math245, Numerical Methods (3)            Humanity (3)             Elective (6)            (total = 15)</p>

A total of 43 credits in the major, with department approval, is required for graduation. Note that not every course is offered every year, so you must plan ahead.

Carefully consider your goals and talk with your advisor for recommendations of the courses to fill out your studies. If your advisor is not an astronomer, you should probably change to one who is. Other astronomy faculty are also happy to share their recommendations with you at any time.

Remember, it isn't your goal to graduate just having met the minimum requirements. Your success in educational programs beyond the BS and in the workplace is closely tied to the breadth and depth of your undergraduate program.

Graduate schools would normally expect that you have computer programming skills. You would also be expected to have some observational astronomy experience, and experience with acquisition of data and data reduction using common astronomical tools and techniques. These skills can be obtained in special topics classes, experimental astronomy (astr377), and in research experiences. It would be a good idea for the prospective astronomer to be a teaching assistant (TA) in astr129/130, the introductory astronomy sequence, which is primarily taken by non-science majors. The TA experience will enhance your knowledge of the sky, and some of the basic skills in astronomy, and make you a more attractive candidate for many graduate programs due to your classroom experience.

### 5.3.4 BA in Astronomy

<b>Freshman Fall</b> math120, Calc I (4) phys111, General Physics I (4) engl110, Freshman Comp (4) Language I (3) Elective (3) (total = 16)	<b>Freshman Spring</b> math220, Calc II (4) phys112, General Physics II (4) Elective (3) Elective (3) Language II (3) (total = 17)
<b>Sophomore Fall</b> elective elective Astro elective (3) Language III (3) Astro elective (3) (total = 16)	<b>Sophomore Spring</b> astr231 Intro to Astrophysics (3) Elective (3) Elective (3) Language IV (3) hist101/103 (3) (total = 15)
<b>Junior Fall</b> Elective (3) astr377, Exp. Astro (4) Humanity (3) Social Science (3) hist102/104 (3) (total = 17)	<b>Junior Spring</b> Elective (3) Astro elective (3) Humanity (3) Social Science (3) Elective (3) (total = 15)
<b>Senior Fall</b> phys419 Research Seminar (1) Elective (3) Humanity (3) Astro elective (3) Elective (3) (total = 13)	<b>Senior Spring</b> phys420, Senior Research (3) Elective (3) Humanity (3) Elective (3) Elective (3) (total = 15)

A total of 30 credits in the major, with department approval, is required for graduation. Note that not every course is offered every year, so you must plan ahead.

Carefully consider your goals and talk with your advisor for recommendations of the courses to fill out your studies. If your advisor is not an astronomer, you should probably change to one who is. Other astronomy faculty are also happy to share their recommendations with you at any time.

It would be a good idea for the prospective astronomer to be a teaching assistant (TA) in astr129/130, the introductory astronomy sequence, which is primarily taken by non-science majors. The TA experience will enhance your knowledge of the sky, and some of the basic skills in astronomy, and make you a more attractive candidate for many teaching positions due to your classroom experience.



# Appendices

## A Department Faculty and Staff

**Narayanan “NK” Kuthirummal**, Associate Professor and Chair, office: 215 JCL, phone: 3-7457, email: kuthirummaln@cofc.edu. B. Sc. Calicut Univ., India, M. Sc. Cochin Univ. , India, Ph.D. Banaras Hindu Univ., India. Interests: spectroscopy, optical and thermal properties.

**Joseph Carson**, Associate Professor, office: 212 JCL, phone: 3-3643, email: carsonjc@cofc.edu. B.A. Pomona College, M.S. and Ph.D., Cornell University. Interests: Exo-planets, planet and star formation, and adaptive optics.

**George Chartas**, Associate Professor, office: 206 JCL, phone: 3-3609, email: chartasg@cofc.edu. B.S. Univ. of Patras, Ph.D. Univ. of Wisconsin-Madison. Interests: Accretion and outflows in active galactic nuclei, imaging the environments of supermassive black holes, quasar evolution, gravitational lensing, X-ray astronomy and instrumentation.

**Dina Drozdov**, Visiting Assistant Professor, office: 302 HWWE, phone: 3-8072, email: drozdovd@cofc.edu. B.S. The Ohio State University, M.S. Clemson University, Ph.D. Clemson University. Interests: Observational astronomy, Type Ia supernovae, Interstellar and Circumstellar Dust, STEM outreach events.

**Robert J. Dukes, Jr.**, Professor Emeritus, email: dukesr@cofc.edu. B.S. Univ. of Arizona, M.S. U. of Texas at El Paso, Ph.D. Univ. of Arizona. Interests: Observational astronomy, automated telescopes, variable stars.

**P. Chris Fragile**, Professor, office: 207 JCL phone: 3-3181, email: fragilec@cofc.edu. B.S. Duke. Ph.D. Notre Dame. Interests: Computational astrophysics, particularly numerical simulations of novel hydrodynamic and magnetohydrodynamic (MHD) effects in astrophysics.

**Jon Hakkila**, Professor and Associate Dean of the Graduate School, office: 214 JCL, phone: 3-6387, email: hakkilaj@cofc.edu. B.A., Univ. of California-San Diego, M.S., Ph.D. New Mexico State University. Interests: Gamma-ray bursts, data mining.

**Linda Jones**, Professor, office: 107 HWWE, phone: 3-0779, email: jonesl@cofc.edu. B.S. College of Charleston. Ph.D. Illinois Institute of Technology. Interests: medical physics, lasers in medicine.

**Philip A. Ladd**, Physics Lab Manager, office: 303 HWWE, phone: 3-5864, email: laddpa@cofc.edu. B.S. Wofford College. Interests: Computation, Physics Education.

**Michael L. Larsen**, Associate Professor, office: 217 JCL, phone: 3-2128, email: larsenml@cofc.edu. B.S. and Ph.D. Michigan Technological University. Interests: atmospheric microphysics and physical meteorology.

**B. Lee Lindner**, Associate Professor, office: 225 JCL, phone: 3-8288, email: lindnerb@cofc.edu. B.S. University of Washington, Ph.D. University of Colorado. Interests: Atmospheric physics, terrestrial and Martian atmospheres.

**Gardner Marshall**, Instructor, office: 222 JCL, phone: 3-1015, email: marshallgr@cofc.edu. Ph.D. William & Mary. Interests: Theoretical particle physics, which includes topics such as Higgs bosons, supersymmetry, and models of dark matter.

**Alfair Meredith**, Office Manager, email: mereditha@cofc.edu. office: 216b JCL, phone: 3-5593

**Laney R. Mills**, Professor Emeritus, email: millsl@cofc.edu. B.S., B.A. Southwestern at Memphis, M.S., Ph.D. Louisiana State University. Interests: Chaos, nonlinear systems, climate modeling.

**Ana Oprisan**, Associate Professor, office: 229 JCL, phone: 3-7582, email: oprisana@cofc.edu. B.S. in Physics from Alexandru Ioan Cuza University of Iasi, Romania. M.S. and Ph.D. in Engineering and Applied Science (Physics) from the University of New Orleans. Interests: Theory and experiment of fluids near the critical point, investigation of nanocolloids using light scattering experiments, and image processing.

**Sorinel Adrian Oprisan**, Professor, office: 228 JCL, phone: 3-0780, email: oprisans@cofc.edu. BS and Ph.D. in physics from Alexandru Ioan Cuza University of Iasi, Romania. M.S. in Computer Science from the Univ. of New Orleans. Interests: computational physics/neuroscience, biophysics, nonlinear dynamics and chaos.

**Laura Penny**, Professor, office: 208 JCL, phone: 3-8290, email: pennyl@cofc.edu. B.S. Trinity University, M.S., Ph.D. Georgia State University. Interests: Stellar astronomy, binary star evolution.

**Norris Preyer**, Associate Professor Emeritus, email: preyern@cofc.edu. B.S., Ph.D. MIT. Interests: Computational physics, bio-optics.

**Terry Richardson**, Senior Instructor, office: 211 JCL, phone: 3-8071, email: richardson@cofc.edu. B.S. Univ. of South Carolina, M.S. Vanderbilt, Ed.S. George Peabody College. Interests: Scientific photography and digital imaging.

**Greg Smith**, Visiting Assistant Professor, office: 227 JC Long, phone: 3-0730, email: gmsmith@cofc.edu. B.S. College of Charleston, Ph.D. Wake Forest. Interests: Organic electronics, specifically materials and devices including light-emitting diodes (OLEDs), photovoltaics (OPVs), field-effect transistors (OFETs), and thermoelectrics.

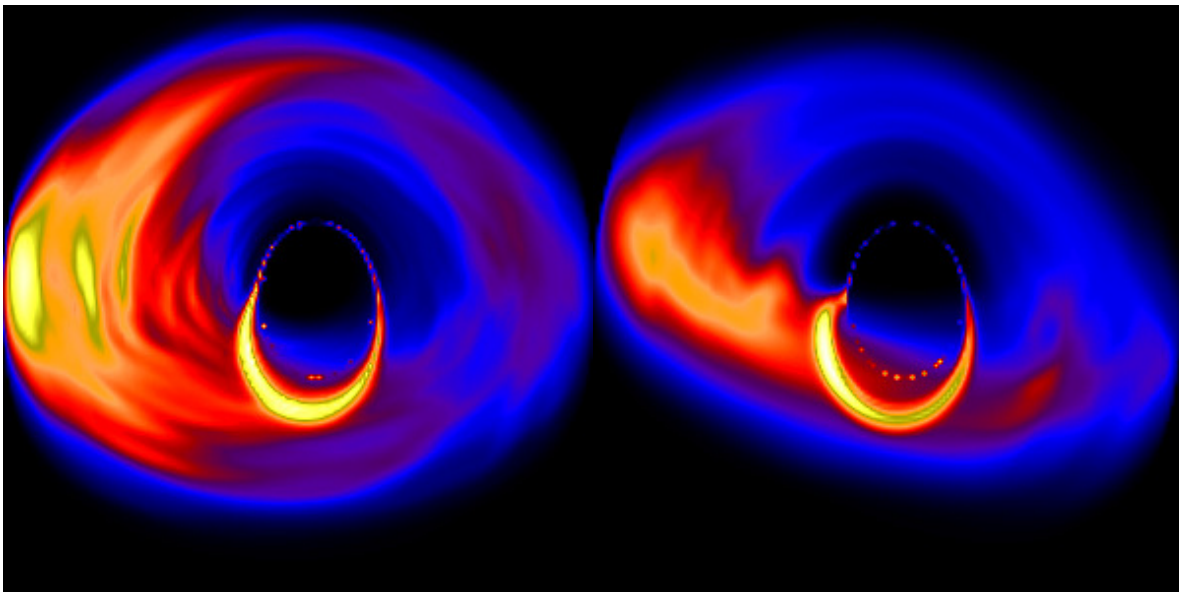
**Alem Teklu**, Associate Professor, office: 210 JCL, phone: 3-7187, email: teklu@cofc.edu. B.S. Asmara Univ, M.Sc. Addis Ababa Univ. M.S. Louisiana State Univ. Ph.D. LSU. Interests: Experimental solid state physics.

**Chris True**, Astronomy Lab Manager, office: 203b Bell, phone: 3-2031, email: truec@cofc.edu. B.S, M.S. Appalachian State University. Interests: Astronomy and optical systems.

**Ana Uribe**, Visiting Assistant Professor, office: 302 HWWE, phone: 3-8072, email: uribeal@cofc.edu. B.S. and M.S. in Physics, Universidad de los Andes, Bogota, Colombia. Ph.D. in Astronomy, Ruprecht-Karls-Universität Heidelberg (at Max-Planck-Institute for Astronomy), Germany. Interests: planet formation, protoplanetary disks, planet-disk interactions, numerical simulations, magneto-hydrodynamics, accretion processes, hot-Jupiter atmospheres.

**Gabriel Williams**, Assistant Professor, office: 223 JCL, phone: 3-0278, email: williamsgj@cofc.edu. B.S. Morehouse College, M.S. University of Texas at Brownsville, Ph.D. Colorado State University. Research interests: Dynamics and structural variability of tropical cyclones with broader interests in geophysical fluid dynamics.

**Jeff Wragg**, Senior Instructor, office: 209 JCL, phone: 3-5781, email: wraggj@cofc.edu. B.S. Boise State Univ., M.S. Univ. of Maine, Ph.D. Univ. of Missouri. Interests: Experimental physics, scanning probe and electron microscopy.







### B.3 BA Astronomy Checklist

**General College Requirements**

	Taken	Will Take
English 110	_____	_____
History 101&102 (or 103&104)	_____	_____
Foreign Language (0-12 credits)	_____	_____
FYE	_____	_____
Social Science (6 credits)	_____	_____
Humanities (12 credits)	_____	_____
(Max of 6 from any one area)	_____	_____

**BA Required courses (18 credits)**

phys111 (4) General Physics I	_____	_____
phys112 (4) General Physics II	_____	_____
astr231 (3) Intro to Astrophysics	_____	_____
astr377 (4) Experimental Astro	_____	_____
phys419 (1) Research Seminar	_____	_____
phys420 (3) Senior Research	_____	_____

**Plus 11 hours from the following**

(at least 6 from courses in **bold**)

Max 3 credits in phys390	_____	_____
<b>astr205 (3) Intelligent Life</b>	_____	_____
<b>astr306 (3) Planetary Astro</b>	_____	_____
<b>astr311 (3) Stellar Astro</b>	_____	_____
<b>astr312(3) Galactic Astro</b>	_____	_____
<b>phys390 (3) Research (in astro)</b>	_____	_____
<b>phys412(3) Special Topics (in astro)</b>	_____	_____
<b>astr413 (3) Astrophysics</b>	_____	_____
astr210 (3) Black Holes	_____	_____
astr260 (2) astr/geol/phys210 NASA Mission Design	_____	_____
astr460 (1) astr/geol/phys210 NASA Leadership Lab	_____	_____
geol206 (3) Planetary Geology	_____	_____
geol412 (3) Crustal Geophysics	_____	_____
phys230 (3) Modern Physics I	_____	_____
phys301 (3) Classical Mechanics	_____	_____
phys340 (4) Photonics	_____	_____
phys394 (3+1) Digital Signal and Image Processing...	_____	_____
phys403 (3) Quantum Mechanics	_____	_____
phys404 (3) Quantum Mechanics II	_____	_____
phys405(3) Thermal Physics	_____	_____
phys407 (3) Nuclear Physics	_____	_____
phys409 (3) Electricity & Magnetism	_____	_____
phys410(3) Electricity & Magnetism II	_____	_____
phys415(3) Fluid Mechanics	_____	_____

**Math courses**

math120 (4) Calculus I	_____	_____
math220 (4) Calculus II	_____	_____

Note that other math may be required as pre-reqs to some courses above

## B.4 BS Astrophysics Checklist

<b>General College Requirements</b>	<b>Taken</b>	<b>Will Take</b>
English 110	_____	_____
History 101&102 (or 103&104)	_____	_____
Foreign Language (0-12 credits)	_____	_____
FYE	_____	_____
Social Science (6 credits)	_____	_____
Humanities (12 credits)	_____	_____
(Max of 6 from any one area)	_____	_____
<b>BS required courses</b>		
<b>Physics</b> 27 credits		
phys 111/112 (4+4) General Physics I-II	_____	_____
phys 230 (3) Modern Physics I	_____	_____
phys 301 (3) Classical Mechanics I	_____	_____
phys 403 (3) Quantum Mechanics	_____	_____
phys 405 (3) Thermal Physics	_____	_____
phys 409 (3) Electricity & Magnetism I	_____	_____
phys 419 (1) Research Seminar	_____	_____
phys 420 (3) Senior Research	_____	_____
<b>Astronomy</b>		
astr231 (3) Intro to Astrophysics	_____	_____
astr377 (4) Experimental Astronomy	_____	_____
Plus at least 9 credits from the following, with at least 6 from the <b>bold</b> .		
<b>astr306 (3) Planetary Astronomy</b>	_____	_____
<b>astr311 (3) Stellar Astronomy</b>	_____	_____
<b>astr312 (3) Galactic Astronomy</b>	_____	_____
<b>phys412 (3) Special Topics (in astro)</b>	_____	_____
<b>astr413 (3) Astrophysics</b>	_____	_____
phys390 (3) Research (in astro)	_____	_____
phys394 (3+1) Digital Signal and Image Processing...	_____	_____
phys404 (3) QM II	_____	_____
phys407 (3) Nuclear Physics	_____	_____
phys410 (3) E&M II	_____	_____
phys415 (3) Fluid Mechanics	_____	_____
astr410 (1) Black Holes	_____	_____
astr260 (2) astr/geol/phys210 NASA Mission Design	_____	_____
astr460 (1) astr/geol/phys210 NASA Leadership Lab	_____	_____
<b>Math courses</b>		
math 120 (4) Calculus I	_____	_____
math 220 (4) Calculus II	_____	_____
math 221 (4) Calculus III	_____	_____
math 203 (3) Linear Algebra	_____	_____
math 323 (3) Differential Equations	_____	_____

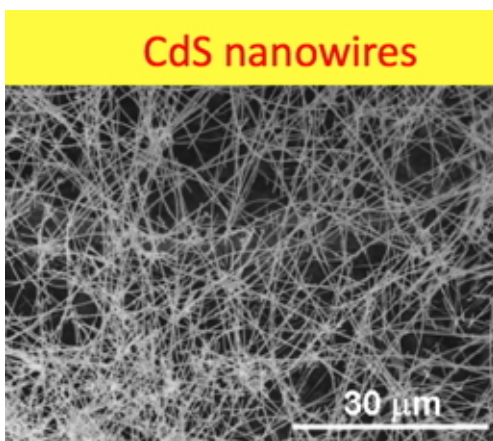
Plus other electives to get a total of 122 credits. You must also demonstrate skill in analytical computer programming via a suitable course or experience.

## C 420/499 Proposals

### C.1 Purchasing Procedures

Note also that your advisor and the phys419 instructor do not approve budgets, but rather evaluate them as reasonable. They have no spending authority and no authority to obligate funds. The department chair does.

1. Create a list of the items you wish to procure. Include the cost and vendor of these items.
2. On this page, obtain a signature of approval from your project advisor.
3. Obtain signature of approval from the department chair.
4. After approval by the department chair, requests should be brought to the lab manager for their assistance with the purchase.
  - (a) If the vendors are local, with lab manager approval the student may make the necessary purchases and return all receipts to the lab manager for reimbursement.
  - (b) If the vendor is not local, the lab manager will be responsible for procurement of the items.



## C.2 420/499 Expectations

Your research project is expected to be the culmination of your undergraduate education. It is guided by a faculty member, but is independently executed by you. The burden of responsibility is yours, not your advisor's. You must demonstrate a mature approach to this responsibility. You must conduct your project in a timely fashion, maintaining close contact with your advisor. The presented products (the Poster Session, regional or national meeting presentation, and final written report) should be polished, professional products.

Your advisor may base your grade on these and/or other factors–

Timeliness	Oral Presentation
Diligence	Poster Session Presentation
Scientific rigor	Final written report
Record keeping	Attendance at Department seminars and colloquia

### and, if in final term

300 word contemplative essay (not graded, but must be submitted to Chair)	Exit interview with the Chair
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### Due Dates (Adapted and completed by Advisor)

Final report is due by \_\_\_\_\_. (Timely drafts before then)

Poster Session Entries are due \_\_\_\_\_, The Poster Session is on \_\_\_\_\_.

Oral presentation is \_\_\_\_\_. Abstracts are due by \_\_\_\_\_.

### Record Keeping

Record keeping in research is vital. Your advisor will likely mandate some formal mechanism for this. A standard model is a research notebook, which is an up to date diary of your project. It should contain dates, names, times, equipment lists, diagrams, raw data, musings, ideas, sketches, casual observations.... It should be decipherable by your colleagues, but is intended to be a working document, not a finished product. It is also increasingly common to have some sort of shared, on-line record keeping space. Whatever record keeping your advisor requires, expect it to be examined from time to time, and to play a role in your grade.

\_\_\_\_\_  
(signature of student)

\_\_\_\_\_  
(date)



## D Anticipated Course Offerings

Note: This isn't a guarantee. Enrollment, demand swings, and other factors may result in cancellation or addition of courses. Special topics courses may be offered on short notice.

### Fall 2017

astr/phys260/260L/460L NASA Mission  
astr311 Stellar Astronomy  
astr377 Experimental Astronomy  
phys230 Modern Physics I  
phys272 Meth. of Applied Physics  
phys308 Atmospheric Physics  
phys320 Electronics  
phys370 Experimental Physics  
phys396 Biophysical Modeling  
phys403 Quantum Mechanics I  
phys409 Electricity and Magnetism I  
phys419 Research Seminar  
phys481 Problem Solving

### Fall 2018

phys105 Intro Meteorology  
astr/phys260/260L/460L NASA Mission  
astr377 Experimental Astronomy  
phys230 Modern Physics I  
phys272 Meth. of Applied Physics  
phys308 Atmospheric Physics  
phys340 Photonics  
phys370 Experimental Physics  
phys396 Biophysical modeling  
phys403 Quantum Mechanics I  
phys409 Electricity and Magnetism I  
phys419 Research Seminar  
phys481 Problem Solving

### Spring 2017

astr210/410 Black Holes  
astr231 Intro to Astrophysics  
astr/phys260/260L/460L NASA Mission  
astr306 Planetary Astro  
phys105 Intro to Meteorology  
phys203 Physics and Medicine  
phys225 Climate  
phys230 Modern Physics I  
phys301 Classical Mechanics  
phys350 Energy Production  
phys370 Experimental Physics  
phys405 Thermal Physics  
phys415 Fluid Mechanics  
phys419 Research Seminar

### Spring 2018

astr205 Intelligent Life  
astr231 Intro to Astrophysics  
astr/phys260/260L/460L NASA Mission  
astr312 Galactic/Extragalactic  
phys230 Modern Physics I  
phys270 Nanotech in Medicine  
phys301 Classical Mechanics  
phys370 Experimental Physics  
phys394 Digital processing - biomedical appls  
phys404 QM II  
phys405 Thermal Physics  
phys407 Nuclear Physics  
phys408 Solid State Physics  
phys419 Research Seminar

### Spring 2019

astr210/410 Black Holes  
astr231 Intro to Astrophysics  
astr/phys260/260L/460L NASA Mission  
astr306 Planetary Astro  
phys203 Physics and Medicine  
phys230 Modern Physics I  
phys301 Classical Mechanics  
phys350 Energy Production  
phys370 Experimental Physics  
phys405 Thermal Physics  
phys415 Fluid Mechanics  
phys419 Research Seminar

## E Courses

Credit hours for each are in parentheses. The usual terms the courses are offered are indicated after the course title. This information is not a guarantee that a course will be offered, but is a guide to planning your program.

Legend: F= every fall, S=every spring, oF=odd-year fall, eF=even-year fall, S1=summer session 1, S2=summer session 2, M=maymester or May evening

### E.1 Astronomy

**astr129 Astronomy I** (3) Offered: F, S, S1

An introduction to astronomy. Prerequisites and Corequisites: astr129L. A working knowledge of high school algebra is assumed. Note: No credit for astr129 if you have passed hors390(I), honors astronomy, first semester.

**astr129L Astronomy I Laboratory** (1) Offered: F, S, S1  
Prerequisite or Corequisite: astr129.

**astr130 Astronomy II** (3) Offered: F, S, S2

A continuation of astr129. Prerequisites or Corequisites: astr130L. Prerequisites: astr129. A working knowledge of high school algebra is assumed. Note: No credit for astr130 if you have passed hors390(II), honors astronomy, second semester

**astr130L Astronomy II Lab** (1) Offered: F, S, S2  
Prerequisite or Corequisite: astr130. Prerequisite: astr129L.

**astr205 Intelligent Life in the Universe** (3) Offered: eS  
A general survey of the topic, stressing the interrelations between the fields of astronomy, physics, chemistry, biology, geology, and philosophy.

**astr210 Black Holes in the Universe** (3) Offered: oS  
Properties of black holes and observations of objects that might harbor them. Topics include Einstein's special and general relativity, stellar evolution, black hole detection, accretion and outflows, gravitational waves, the Hawking effect, singularities and the possibility of creating mini black holes in the laboratory. (For non-science majors.)

**astr231 Introduction to Astrophysics** (3) Offered: S  
A general survey of fundamental astronomy. The course covers fundamental astronomy concepts, conventions, and terminology. It briefly reviews certain physical concepts, such as gravity and radiative processes, and applies them in an astrophysical context. It then introduces the basic principles required for more advanced courses: planetary, stellar, and galactic/extragalactic astrophysics. Prerequisites: phys112 or hors158

**astr260 NASA Space Mission Design** (2) Offered: F, S  
Students work on teams with engineering students at another university to design unmanned NASA satellite missions. Student teams interactively participate through presentations, assigned readings, on-line discussions,

classroom exercises and dynamic activities, and compete for best mission with final projects being evaluated by a panel of NASA experts. Prerequisites: astr130 or astr206 or hors160 or geol206 or phys102 or phys112 or hors158 or permission of instructor. Corequisites: astr260L or astr460L

**astr260L NASA Space Mission Design Lab** (1) Offered: F, S

Lab students work on teams with engineering students at another university to design unmanned NASA satellite missions. Student teams interactively participate through presentations, assigned readings, on-line discussions, classroom exercises and dynamic activities, and compete for best mission with final projects being evaluated by a panel of NASA experts. Corequisites: astr260

**astr306 Planetary Astronomy** (3) Offered: oS  
The nature and origin, evolution, and current state of the solar system and extrasolar systems are reviewed. Celestial mechanics, planetary interiors, atmospheres and solar system debris are covered in depth. Prerequisite: astr231

**astr311 Stellar Astronomy and Astrophysics** (3) Offered: oF

The basic concepts of stars and stellar systems are explored. Topics covered include: stellar interiors, stellar atmospheres, stellar spectra, star formation, stellar evolution, stellar remnants, variable stars, and binary stars. Lectures three hours per week. Prerequisites: astr231 and math221

**astr312 Galactic and Extragalactic Astronomy** (3) Offered: eS

Structure, kinematics, and dynamics of galaxies including the Milky Way. Galactic evolution, active galaxies and quasars, accretion disks, and cosmology. Prerequisites: astr231 and math221.

**astr377 Experimental Astronomy** (4) Offered: F  
A course designed to emphasize the concepts, principles, and experimental techniques of modern observational astronomy and astrophysics. Topics include astrometry, multi-wavelength instrumentation and imaging, and data analysis techniques. Hands-on projects plus lecture. Observatory work will be required. Scientific report writing will also be required. Prerequisite: astr231

**astr410 Black Holes** (1) Offered: oS  
An augmentation of astr210 requiring calculus and computation. Research topics include using relativity (to explain quasar gravitational lensing, effects of general relativity on GPS satellites, and frame dragging with Gravity Probe B), calculating accretion disk emission spectra, and constraining environments and properties of black holes inhabiting active galactic nuclei. Prerequisite: phys112 or permission of instructor. Corequisite: astr210

**astr413 Astrophysics** (3)  
Covers the application of physics to problems in stel-

lar atmospheres and interiors, the interstellar medium and galactic dynamics. Lectures, three hours per week. Prerequisites: phys301, math323, or permission of the instructor.

**astr460L: NASA Space Mission Design Leadership Lab**(1) Offered: F, S

Lab students lead local teams and work with engineering students at another university to design unmanned NASA satellite missions. Student teams interactively participate through presentations, assigned readings, on-line discussions, classroom exercises and dynamic activities, and compete for best mission with final projects being evaluated by a panel of NASA experts. Prerequisites: Permission of instructors. Corequisites: astr260

## E.2 Physics

**phys101 Introductory Physics** (3) Offered: F, S, S1

A general physics course intended for those students who plan to take only one physics sequence. Subjects covered are: mechanics (vectors, linear and rotational motion, equilibrium, and gravitational fields); heat (mechanical and thermal; properties of solids, liquids, and gases); and wave motion. Upon completion of 101 with a grade of B or better and successful completion of math120 a student may transfer to phys112. Lectures, three hours per week. Prerequisites and Corequisites: Physics 101L is a corequisite or prerequisite. Note: A working knowledge of algebra and simple trigonometry is assumed. phys101 is not open to students who have passed phys111 or hons157.

**phys101L Introductory Physics Laboratory** (1) Offered: F, S, S1

Prerequisite and Corequisite: Physics 101 is a corequisite or prerequisite for Physics 101L.

**phys102 Introductory Physics** (3) Offered: F, S, S2

A continuation of phys101. Subjects covered are: electricity (electric fields, AC and DC circuits); magnetism; optics (geometric and physical); and modern physics. Prerequisite or Corequisite: Physics 102L is a corequisite or prerequisite for Physics 102. Phys101 or phys111 or hons157 is a prerequisite. Note: phys102 is not open to students who have passed phys112 or hons158.

**phys102L Introductory Physics Laboratory** (1) Offered: F, S, S2

Prerequisites and Corequisites: Physics 102 is a corequisite or prerequisite for Physics 102L. Physics 101L is a prerequisite or corequisite for Physics 102L.

**phys105 Introduction to Meteorology** (3) Offered: oF  
Survey of the most important topics in meteorology. Sample topics include cloud formation, violent storms, thunder and lightning, rainbows, rain and snow, climate and forecasting. Prerequisite: A working knowledge of high school algebra is assumed.

**phys106L Exercises in Weather and Climate** (2) Offered: Maymester-online

Exercises for important topics in meteorology, including clouds, forecasting, thunderstorms, tornadoes, hurricanes and climate change. Concepts will be learned primarily in group-based exercises, supplemented with recorded lecture to provide needed background. Course is intended to be taught in an online format. Prerequisites: None

**phys110 Conceptual Physics** (3)

(Not expected to be offered in the near future)

**phys111 General Physics I** (3) Offered: F, S, S1

Introduction to principles of physics primarily for scientists and engineers. Subjects covered are mechanics (vectors, linear and rotational motion, equilibrium and gravitational fields); heat (mechanical and thermal properties of solids, liquids and gases); and wave motion. Lecture three hours per week; laboratory three hours per week. Prerequisite or corequisite: Mathematics 120 or equivalent or permission of instructor.

**phys111L General Physics Laboratory** (1) Offered: F, S, S1

Corequisite: Phys111 or permission of instructor.

**phys112 General Physics II** (3) Offered: F, S, S2

A continuation of phys111. Subjects covered are: electricity (electric fields, AC and DC circuits); magnetism; light (geometric and physical optics, spectra); and modern physics (relativity and nuclear physics). Lectures three hours per week; laboratory three hours per week. Prerequisite: Physics 111 or hons 157. Prerequisite or corequisite: math220 or equivalent or permission of instructor. Note: upon completion of phys101 with a grade of B or better and successful completion of math120 a student may transfer to phys112

**phys112L General Physics Laboratory** (1) Offered: F, S, S1

Corequisite: Physics 112 or permission of instructor.

**phys150 Physics of Sound and Music** (3)

An investigation of mechanical and electronic generation of sound; propagation of sound; perception of sound and music; the acoustics of vocal and instrumental music; musical elements such as pitch, loudness, and timbre; and musical constructs such as scales, temperament and harmony. Lectures three hours per week. A working knowledge of high school algebra is assumed.

**phys203 Physics and Medicine** (3) Offered: oS

The application of physics to a variety of medical issues. Useful for students who intend to become medical professionals and students interested in the applications of physics to medicine. Prerequisites: phys102 or phys112 or Hons158.

**phys210 Intro to Air Pollution** (3) Offered:

Sources of air pollution, and the influence of anthropogenic and natural processes on air quality. Topics in-

clude the atmosphere's chemical composition, atmospheric chemical reactions, greenhouse gases, global warming and the roles of government in air pollution control.

Prerequisites: phys105, or phys106L with C- grade or higher, or with permission from the instructor

**phys215 Synoptic Meteorology** (3) Offered:

Application of physical principles to synoptic-scale weather analysis and forecasting. Topics include weather observing techniques and weather map analysis; analysis of cyclones, fronts, and jets; temperature and precipitation forecasting techniques; and analysis of soundings and thermodynamic diagrams.

Prerequisites: math120 and (phys101 (with a grade of C- or better), phys105, phys111, or hons157), or permission of the instructor

**phys225 Climate** (3) Offered:

This course serves as an introduction to the study of Earth's climate. Topics may include global energy balance, atmospheric radiative transfer, the hydrologic cycle, environmental energy transport, climate sensitivity, and feedback mechanisms. Lecture three hours per week.

Prerequisites: phys112 or hons158 or (phys102 (with a grade of C- or better) and [math220 or math229]) or Permission of Instructor

**phys230 Intro to Modern Physics I** (3) Offered: F, S

Introduction to relativity, atomic theory, x-rays, wave-particle duality, and elements of quantum mechanics. Prerequisite: Physics 112 or hons158. Prerequisite or corequisite: math 221, or permission of the instructor.

**phys260, NASA Space Mission Design** (2)

See astr260.

**phys260L, NASA Space Mission Design Lab** (1)

See astr260L. Co-requisite: phys260.

**phys270 Nanotechnology in Medicine** (3) Offered: eS

An introductory level interdisciplinary course covering nanotechnology and its use in medicine. Students will learn the basic physics behind smart nanobiomaterials, nanobiosensors, and DNA motifs. They will also learn nanotechnology in cancer treatment and drug delivery, medical imaging using quantum dots, nanofabrication, characterization tools used in nanotechnology, and nanotoxicology. Prerequisites or Corequisites: phys102 or phys112 or hons158 or permission of the instructor.

**phys272 Methods of Applied Physics** (3) Offered: F

This course is designed to develop skills in applying mathematical tools and concepts developed formally in the mathematics curriculum for use in the undergraduate physics curriculum. The focus will be on the practical problem solving process rather than the abstract or theoretical nature of techniques. Prerequisite: math221 and (phys112 or hons158).

**Note:** Even though this course satisfies the prerequisite requirement of math323 for upper-level physics

classes (but not math classes), students bound for graduate school in physics would be wise to take the formal Linear Algebra (math203) and Differential Equations (math323) classes offered by the math department. In fact, taking Partial Differential Equations (math423) would be fairly common for strong students who are physics or engineering graduate school bound. Students well served by taking phys272 and not the math203+math323 classes are those who plan to enter the job market at the BS degree level.

**phys298 Special Topics** (1-3)

An examination of an area of physics in which a regular course is not offered. Prerequisite: Permission of the instructor and chair.

**phys301 Classical Mechanics I** (3) Offered: S

Newtonian dynamics of particles and rigid bodies, relativistic mechanics, Lagrangian and Hamiltonian mechanics, and waves. Lectures, three hours per week. Prerequisites: (phys112 or hons158), and math 323, or permission of the instructor.

**phys302 Classical Mechanics II**(3)

Prerequisite: Physics 301.

**phys308 Atmospheric Physics** (3) Offered: eF

(Note: being phased out after F16) An introduction to the study of the Earth's atmosphere. Topics covered include atmospheric thermodynamics, synoptic meteorology, violent storms, radiative transfer, basic modeling, ozone depletion, acid rain, and global warming. Lectures, three hours per week. Prerequisites: Physics 112 or hons158 or permission of the instructor.

**phys320 Introductory Electronics** (4) Offered: oF

Lectures, three hours per week; laboratory, three hours per week. Prerequisite: (phys102 and math120) or phys112 or phys158 or permission of the instructor.

**phys331 Intro to Modern Physics II** (3) Offered: eS

Prerequisite: Physics 230 or permission

**phys340 Photonics** (4) Offered: eF

An intermediate lecture and lab-based course in modern optics. Topics covered include: the wave equation, interference, diffraction, polarization, holography, spectroscopy, lasers, second harmonic and terahertz generation, optical communication, optical materials, and biophotonics. Lectures three hours per week; laboratory three hours per week. Prerequisite: phys 112 or hons158 or permission of the instructor.

**phys350 Energy Production** (4) Offered: oS

The science and technology of solar, nuclear, fuel cell, geothermal, wind, hybrid, and other energy systems. A study of the nature of energy and scientific issues relating to its production, storage, distribution, and use from a physics perspective. Lectures three hours per week. Laboratory three hours per week. Prerequisite: chem111 + (phys112 or hons158 or(phys102+math120))

**phys370 Experimental Physics** (4) Offered: F, S

An opportunity for students to develop experimental, analytical, and research techniques through lecture and extensive laboratory experiences. Scientific writing and associated skills, such as professional illustrations, graphics, statistical analysis, and use of computational tools are heavily stressed. Student professional goals play a significant role in experiment selection. Prerequisite: phys230, or phys225, or permission of the instructor.

**phys381 Internship** (1-3)

A student will gain professional experience as an intern at a private firm or government agency. A written proposal must be approved through the Department Internship Coordinator prior to enrolling in the course. At least 40 hours of work is required for each 1 credit awarded for the course. Prerequisites: Physics or meteorology majors, and phys370 or permission of the coordinator.

**phys390 Research** (1-3)

Literature and/or laboratory investigations of specific problems in physics or astronomy. The topic of the investigations will be determined by the interests of the student in consultation with the department faculty. Open to exceptional students and particularly suited to those intending to continue toward a graduate degree. Prerequisite: Permission.

**phys394 Digital Signal and Image Processing with Biomedical Applications** (3) Offered: eS

A systematic presentation of mathematical aspects and the corresponding computational techniques and tools currently used in digital signal and image processing. The topics include signal sampling, temporal and frequency domain representations, filtering, denoising, enhancing, and visualization of signals with emphasis on biomedical data. Prerequisites: phys112 and phys112L or hons158 and hons158L Corequisite: phys394L

**phys394L Digital Signal and Image Processing with Biomedical Applications Laboratory** (1) Lab to accompany phys394. Corequisite: phys394

**phys396 Biophysical Modeling of Excitable Cells** (3) Offered: F

An introduction to the concepts and methods of computer modeling of excitable cells. Topics include basic electrophysiology of excitable cells, biophysics of ion conduction, mathematical modeling of activation/inactivation mechanisms using experimental data, and computer simulations. Prerequisites: (biol112 or hons152 and phys112 or hons158) or (biol211 and biol305 and phys102), or permission of the instructor.

**phys397 Zero Credit Research** (0)

A student works under faculty supervision to learn a research method, to explore possible research topics or to continue an ongoing study. The faculty member helps the student to determine the course goals and objectives and supervises the execution of project. The student will provide a written report to the faculty at the end of the

semester. Student will receive a "P" (pass) or "NP" (Not Pass) grade for the course. Prerequisite: Permission of the instructor

**phys399 Tutorial** (3)

Individual instruction given by a tutor in regularly scheduled meetings (usually once a week). Prerequisite: Junior standing, plus permission of the tutor and the department chair.

**phys403 Intro Quantum Mechanics I** (3) Offered: F Wave-particle duality; the wave function; general principles of quantum mechanics; systems in one, two and three dimensions; electron spin; perturbation theory; electro-magnetic radiation; systems containing identical particles; and applications. Lectures, three hours per week. Prerequisite: phys230 and math323 or permission of the instructor.

**phys404 Intro Quantum Mechanics II** (3) Offered: Prerequisite: phys403.

**phys405 Thermal Physics** (3) Offered: S An introduction to quantum statistical mechanics, thermodynamic functions, and the laws of thermodynamics. There is an emphasis on the application of the fundamental concepts to astrophysics, atmospheric physics, low-temperature physics, and solid-state physics. Prerequisite: phys230. Corequisite (math323 or phys272), or permission of the instructor.

**phys407 Nuclear Physics** (3) Offered: eS An introduction to the theory of the nucleus, including constituents of the nucleus; nuclear forces and structure; natural and induced radioactivity; properties of alpha, beta and gamma radiation; particle accelerators; and fission, fusion and nuclear reactors. Lectures three hours per week. Prerequisite: phys230 or permission of the instructor.

**phys408 Solid State Physics** (3) Offered: eS A survey of the fundamental principles determining the macroscopic properties of solids. The lattice system and the electron system are investigated as a basis for understanding dielectric, magnetic, optical, semiconductive and superconductive behavior in solids. Lectures three hours per week. Prerequisite or corequisite: Physics 230 and (math323 or phys272) or permission of the instructor.

**phys409 Electricity and Magnetism I**(3) Offered: F An intermediate course in electricity and magnetism. Subjects to be covered will include electric fields, magnetic fields, electric current, Maxwell's equations, conductors, dielectrics and magnetic materials. Lectures three hours per week. Prerequisites: phys112 or hons158, and math323 or permission of the instructor.

**phys410 Electricity and Magnetism II** (3) Prerequisite: Physics 409.

**phys412 Special Topics** (1-3) An examination of an area in physics in which a regular

course is not offered. Prerequisite: Permission of the instructor.

**phys415 Fluid Mechanics** (3) Offered: oS

An introduction to fluid mechanics that develops physical concepts and formulates basic conservation laws. Topics include fluid statics, kinematics, stresses in fluids, flow of real (viscous) fluids and compressible flow. Lectures three hours per week. Prerequisites: math323 or phys272 or permission of the instructor.

**phys419 Research Seminar** (1) Offered: F, S

This course is intended to prepare the student for Phys 420. Prerequisite or corequisite: phys370 or astr377 or permission of the instructor.

**phys420 Senior Research** (3)

Conducting, writing and presenting the results of the research project proposed in Phys 419. The presentation must be at a scientific forum approved by the research advisor. Prerequisites: phys419 or permission. No credit for both phys420 and phys499.

**phys425 Mesoscale Meteorology** (3)

Applications of dynamics and forecasting techniques in diagnosing the organization of mesoscale and convective phenomena. Topics include mesoscale instabilities; boundary layer dynamics; air mass boundaries; convective initiation; convective storms; mesoscale convective systems; tornadoes; flash flooding; and various orographic mesoscale phenomena.

Prerequisites: math221 and phys215, or permission of the instructor

**phys457 Satellite Meteorology** (3)

Satellite meteorology is the measurement of the weather by sensors aboard satellites Prerequisite: (One of the following: [phys459; phys425; phys230; phys225; phys215; phys210; phys106 (with a grade of C- or better); phys105] and one of the following: [phys102 (with a grade of C- or better); phys112; hons158] and one of the following: [math220; math229]; or permission of the instructor)

**phys459 Cloud and Precipitation Physics** (3)

Essential elements of the physics associated with the study of clouds and precipitation. Lectures three hours per week. Prerequisites: (phys112 or hone158). Corequisites or Prerequisites: (math323 or phys272), or permission of the instructor

**phys460L: NASA Space Mission Design Leadership Lab**(1)

See astr460L.

**phys481 Physics Problem Solving** (1) Offered: F

Physicists are problem solvers. Often, a full solution to a system is unnecessary to grasp the central elements of a problem. This course utilizes the basic tools of symmetry, limiting cases, scaling, and dimensional analysis to engage in problem solving exercises where speed is more important than a closed form solution. Pre- or Corequisites: phys370; or astr377.

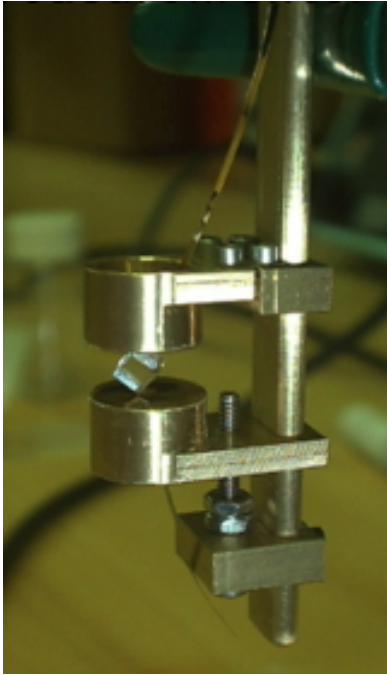
**phys499 Bachelor's Essay** (6)

Normally taken by students in the Honors Program instead of phys420. A project proposal must be submitted in writing and approved by the department prior to registration for the course. Prerequisites: phys419 or permission of the chair. No credit for both phys420 and phys499.

## F Letters of Recommendation

At some time you will need letters of recommendation (LoR), to apply for graduate or professional schools, jobs, research positions, or scholarships. Here are some recommendations relating to these letters.

Find recommenders who can make your best case. Ask yourself what is your relationship with the recommender, how long, how relevant to the purpose of this LoR, how positively can they speak on your behalf? Contact them *well before* you need the recommendation. Then give them supporting materials to make their job of writing the LoR easy. Some will even ask you to provide them with a draft LoR, so be prepared to write your own.



Generic checklist for LoRs–

1. Identify prospective recommenders.
2. Talk or email with a prospective recommender.
3. In a timely manner present them with:
  - (a) A list of schools with deadlines
  - (b) An unofficial transcript.
  - (c) Supporting material about you
    - i. What are your goals?
    - ii. Courses you had with recommender
    - iii. GRE scores
    - iv. Relevant skills
    - v. Research experience, Special projects, REU, teaching experience ...
4. Follow-up until the recommender has submitted the recommendation, but don't pester.
5. Follow-up with the recipient. Your application package can be held up because a component gets lost or misfiled at the receiving end. Verify that your application package is complete far enough ahead of the deadline to address any problems.

## **G Internships**

The Department is pleased to offer you the opportunity to pursue an internship in which you will gain professional experience as an intern at a private firm or government agency. The primary motivation is to offer a career-relevant experience for students entering the job market with a bachelor's degree.

The student is the primary motivator of the internship, and the required paperwork. In consultation with the department Internship Coordinator (Dr. NK), and the on-site supervisor, the student shall draft a mutually agreeable Learning Contract (LC). An internship is a professional position. It is not menial work, nor is it a fill-in or temporary position at the workplace.

### **G.1 Student Responsibilities**

1. Obtain approval from department Internship Coordinator to pursue
2. Complete Learning Contract (suggestions below)
3. Perform to the best of your ability those tasks assigned by your supervisor which are related to your learning objectives and to the responsibilities of the position
4. Follow all the rules, regulations, and normal requirements of the organization
5. Complete the academic requirements of the LC under the guidance of the Internship Coordinator
6. Notify the department Internship Coordinator of any changes needed to the agreement or of any problem during the on-the-job experience

### **G.2 Faculty Internship Coordinator Responsibilities**

1. Work with the student to formulate goals and learning objectives
2. Keep in contact with the student
3. Assess the intern's learning based upon the site supervisor's evaluation and the departmental requirements: maintain hours on the job, submission of LC, journal, meeting with advisor, final paper or other visible product, and public oral presentation
4. Site visit at least once (for local internships), to discuss the intern's performance and the applicability of theory to the field experience
5. Get a mid-term evaluation from the supervisor.

### **G.3 Paid vs. Unpaid**

The US Department of Labor specifies that an internship can legally be unpaid ONLY if:

1. The intern is provided training similar to that which would be provided at a vocational school (the student is under continued and direct supervision);
2. The training is for the benefit of the student, not to meet the labor needs of the business;
3. The student does not displace a regular employee and an employee has not been relieved of assigned duties;
4. The employer provides the training and derives no immediate advantage from the intern's activities, and on occasion his/her operations may actually be impeded;
5. The student is not necessarily entitled to a job at the conclusion of the internship; and
6. The employer and student agree and understand that no wages will be paid to the student.

### **G.4 Site Supervisor Responsibilities**

1. Discuss the responsibilities and scope of the internship with the student
2. Work with the student to develop goals and learning objectives
3. Provide ongoing supervision and feedback to the student
4. Be available to talk with and meet the Faculty Internship Advisor during a site visit
5. Complete a candid evaluation of the intern's performance for the Faculty Advisor

### **G.5 The Learning Contract**

Things to address in the learning contract:

- Employer
- Company
- Address
- Site Supervisor Name and Contact information
- Internship compensation: hourly or stipend total
- Work days/hours



- **Position Description:** This is a description in as much detail as possible, of the intern's role and responsibilities. List duties, meetings, activities, project deadlines, etc.
- **Supervision and Resources:** Describe the supervision (and time frame) to be provided to the intern by the site supervisor. For example, an on-site supervisor may have daily meetings with the intern to discuss the progress and challenges. Also indicate what resources will be available to assist the intern in accomplishing their duties. (desk, computer, workspace...)
- **Assessment and Evaluation:** In addition to informal and regular assessment and evaluation provided by the on-site supervisor, the supervisor will complete a mid-term and final evaluation. The evaluations should be based on the goals and tasks indicated in the job description and learning objectives. These evaluations will be shared with the intern, the Department Internship Advisor, and College Internship staff.
- **Goals in the Agreement:** Professional, Academic, and Personal goals should all be specific, measurable, attainable (within the internship timeframe), and have a timeline.

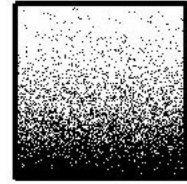
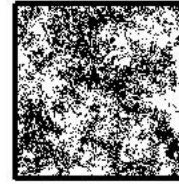
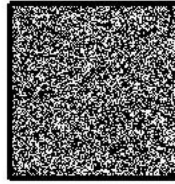
The Learning Contract should be structured so that it is clear what each objective is, how it will be accomplished and evaluated, and what closing activities are required. Below are some ideas that may be useful in constructing a Learning Contract. Goals may be in any or all of the following areas: academic learning, career exploration, and skill development.

### **Learning Objectives**

1. Are you looking to improve or develop skills, expand knowledge of a specific field, apply or test a particular body of knowledge?
2. Are you interested in testing a career interest and your own suitability for that career?
3. Are you interested in learning how a particular company, organization, or industry works?

### **Learning Tasks and Strategies**

1. Describe the specific process for achieving your goals. You can list more than one strategy to meet each objective
2. Will you undergo training? How many hours?
3. Will you be working on a specific project?



4. Will you prepare by reading or preliminary problem solving, or learning skills?
5. Will you attend any related conferences or meetings?
6. Will people at work observe you and give you feedback?

### **Evaluation and Closing Activities**

1. Describe how your progress will be measured
2. How will you know, and show others, that you have achieved your learning objectives?
3. Will you keep a journal?
4. Will you compile records of your activities? (e.g. reports, notes, staff meeting records...)
5. Describe your final project/activity and components for a final grade.
6. Will you summarize your experience into a final reflective paper?
7. Will you make a formal oral presentation to the department?
8. Will you organize data into a research project/paper?