



COLLEGE of
CHARLESTON

PHYSICS AND ASTRONOMY
DEPARTMENT

Handbook for Students

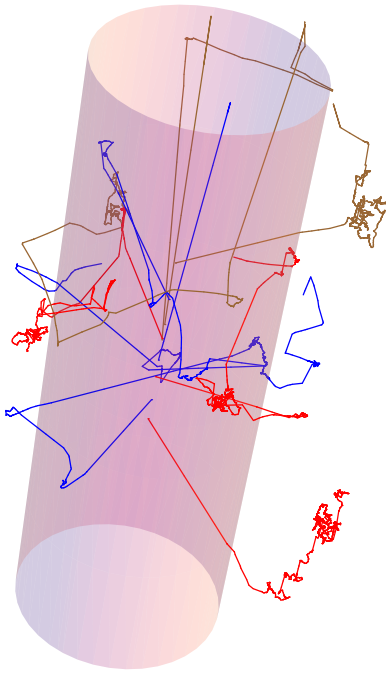
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1 Introduction

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, meteorology, systems engineering, and electrical engineering, as well as concentrations in operational meteorology, atmospheric physics, computational neuroscience, and energy production and minors in physics, astronomy, meteorology, and biomedical physics.

A degree from the programs in our department 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 and unpaid, spanning experimental, theoretical, and computational work) 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 any faculty members that work in areas aligned with your interests.

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 or the advising you receive from your official departmental advisor assigned to you after you declare a major in our department.

2 Our Department – The Big Picture

2.1 Location and Access

The Department is located on the third floor of the Rita Hollings Science Center (RITA), at the corner of George and Coming Streets. The Department office, room 306, is open for business from 8:30–5:00 M-F.

2.2 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, electrodynamics, 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 multivariate calculus, vector analysis, and differential equations. Writing assignments are integral to all labs and to many courses.

3 Our Programs

3.1 Majors

We offer the following degrees:

- B.S. Physics
- B.A. Physics
- B.S. Astrophysics
- B.A. Astronomy
- B.A. Meteorology
- B.S. Systems Engineering
- B.S. Electrical Engineering

122 Credit Hours are required to graduate from any of our programs. Please refer to the college catalog for the official requirements for each program; all programs gradually change over time and this handbook is only accurate up to the date on the cover and focused only on the degree program itself – not the additional general education requirements for all degrees granted by CofC.

Many of the programs that follow include taking a certain number of disciplinary electives off of a list of approved courses.

We have also removed the full list of electives allowed to complete each major/concentration/minor below to present a briefer, more holistic perspective of each of our programs. A complete list of courses that will fulfill the elective requirements of each program can be found in the official undergraduate catalog.

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.

Additionally, for all of our degree programs, HONS 157 and 158 (with associated labs) together with MATH120 and 220 may replace PHYS111 and PHYS112.

3.1.1 B.S. in Physics

We offer a solid, well-established B.S. degree program in Physics for the most technical preparation, for example to enter graduate study in Physics or a related field. Historically, the majority of our students who major in Physics opt for the B.S. degree.

The B.S. 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 any 300- or 400-level physics or astronomy course with a maximum of six credits total from PHYS381, PHYS390 and PHYS399.

Physics Core (28 credits)

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 Electromagnetism I(3)
PHYS419 Research Seminar (1)
PHYS420 Senior Research (3) (or PHYS499 Bachelor's Essay (6))

Plus 15 additional elective credits from 300- or 400-level classes with ASTR or PHYS prefix.

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

PHYS404 Quantum Mechanics II (3)
PHYS405 Thermal Physics (3)
PHYS410 Electromagnetism II (3)

and from other departments:

MATH323 Partial Differential Eqns (3)
CHEM111/112 Princ. of Chem (4+4)
CSCI220 Computer Programming

Note that many of these courses have significant mathematical prerequisites and not all courses are offered every year; it is important to talk to your departmental advisor to ensure you are on track to progress through the program.

3.1.2 B.A. in Physics

The B.A. in Physics is designed for students who may wish to double major in a field outside of the quantitative sciences, or pursue a career that does not require a graduate degree in a physical science. Some students opt for the B.A. degree if their ultimate plans are to go into teaching, medicine, or law.

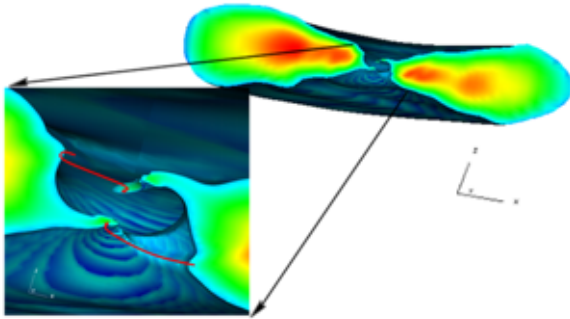
The B.A. in Physics requires 30 hours in physics, 19 required + 11 electives, plus math prerequisites. The department expects the program to be cohesive in design, rather than a haphazard collection of courses.

Physics Core (19 credits)

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) (or PHYS499 Bachelor's Essay (6))

Plus 11 elective hours from a list of approved PHYS and ASTR courses.

The elective courses allowable to complete the B.A. PHYS degree are more expansive than for the B.S. PHYS degree. (For example, there are some 100- and 200-level PHYS and ASTR courses that count towards the B.A. electives). A full list can be found in the CofC undergraduate catalog.



PHYS407 Nuclear Physics (3)
 PHYS410 Electromagnetism II (3)
 PHYS415 Fluid Mechanics (3)

Note that except for the substitution of ASTR377 for PHYS370, this qualifies for the B.S. in Physics. If the student adds PHYS370 to the required courses in the B.S. Astrophysics program, then they have completed the requirements for a double major in Physics and Astrophysics. All Astrophysics students are expected to complete their Senior Research project in an area relevant to Astrophysics.

3.1.3 B.S. in Astrophysics

We offer a comprehensive B.S. degree program in Astrophysics. Like in Physics, many students in this program are preparing for graduate study in Astrophysics or a related field. Historically, the majority of our students who are majoring in an Astronomy-relevant major opt for this degree program. It is also popular for students to double-major in B.S. Physics and B.S. Astronomy; the program is designed to allow you to do this with only one additional course if you are strategic in your elective selection.

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

Astrophysics Core (34 credits)

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 Electromagnetism II (3)
 PHYS419 Research Seminar (1)
 PHYS420 Senior Research (3) (or PHYS499 Bachelor's Essay (6))
 ASTR231 Intro to Astrophysics (3)
 ASTR377 Experimental Astronomy (4)

Plus 9 elective 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)
ASTR413 Astrophysics (3)
PHYS412 Special Topics (in an astronomy-related topic) (3)
 ASTR410, Black Holes (1)
 ASTR/GEOL/PHYS460L, NASA Mission Design Leadership Lab (1)
 PHYS390 Research (in astronomy) (3)
 PHYS394 Digital Signal and Image Processing... (3+1)
 PHYS404 Quantum Mechanics II (3)

3.1.4 B.A. in Astronomy

The B.A. in Astronomy is designed for students who may wish to double major in a field outside of the quantitative sciences, or pursue a career that does not require a graduate degree in a physical science.

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

Astronomy Core (19 credits)

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) (or PHYS499 Bachelor's Essay (6))

Plus 11 elective credits from a list of approved PHYS and ASTR courses.

The elective courses allowable to complete the B.A. Astronomy degree are more expansive than for the B.S. Astrophysics degree. (For example, there are some 100- and 200-level ASTR and PHYS courses that count towards the B.A. electives). A full list can be found in the CoC undergraduate catalog.

All Astronomy students are expected to complete their Senior Research project in an area relevant to Astronomy.

3.1.5 B.A. in Meteorology

Our only Meteorology degree program is the B.A. in Meteorology. However, there are still two different routes through the program depending on a student's ultimate post-graduation goals.

If a student plans to pursue a career as a forecaster, broadcast meteorologist, working for the weather service, or in some other area where graduate study is generally expected, then the student should opt to complete the B.A. in Meteorology *with the Operational Meteorology Concentration* (described in more detail later in this handbook). Alternatively, if a student seeks a career that

does not require graduate study and also does not require a program that meets the minimum federal civil service requirements, then the B.A. in Meteorology without the concentration may be suitable.

The B.A. 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)

PHYS105 Introduction to Meteorology (3)

Or three of the following four classes

GEOL438 Hydrogeology (4)

PHYS405 Thermal Physics (3)

PHYS415 Fluid Mechanics (3)

PHYS459 Cloud and Precipitation Physics (3)

Emphasis Experience (if both courses below are taken, one will count as an elective)

PHYS210 Introduction to Air Pollution (3)

Or

PHYS215 Synoptic Meteorology (3)

and

Additional Required Meteorology Courses (11 credits)

PHYS225 Climate (3)

PHYS370 Experimental Physics (4)

PHYS419 Research Seminar (1)

PHYS420 Senior Research (3) (or PHYS499 Bachelor's Essay (6))

Introductory Physics (8 credits)

PHYS111/112 General Physics I,II (4+4)

or

PHYS101/102 Introductory Physics (4+4) [a minimum grade of C- in each lecture and lab course is required]

Mathematics (8 credits)

MATH120 Introductory Calculus (4)

MATH220 Calculus II(4) or MATH229 Vector Calculus with Chemical Applications(5)

+5 elective hours from a list of approved ASTR, BIOL, CHEM, COMM, CSCI, ENGL, ENVT, GEOL, MATH, and PHYS courses. A full list of courses that meet this requirement can be found in the CofC undergraduate catalog.

All Meteorology students are expected to complete their Senior Research project in an area relevant to atmospheric science.

Regularly meeting with your advisor is particularly important for this program, as many courses have sub-

stantial prerequisites *and* are only offered every other year; it takes a lot of strategic planning to ensure that you can progress all the way through the degree program in the time you desire.

It is possible to additionally take CofC courses that will complete the coursework requirements to obtain a "Certificate in Consulting Meteorology" and/or apply to the "Certified Broadcast Meteorologist Program". These extra credentials are awarded by the American Meteorological Society (AMS) – not by the College of Charleston – and involve additional coursework above and beyond the B.A. in meteorology degree program, as well as an application fee to the AMS and some additional testing. You can learn more about these programs by searching on the American Meteorological Society web page or by talking to a faculty member involved in the Atmospheric Physics/Meteorology programs.

3.1.6 B.S. in Systems Engineering

The B.S. in Systems Engineering is a multidisciplinary major housed within the Physics and Astronomy department, but including courses not just from our department and math but also from Computer Science and Business.

The B.S. in Systems Engineering consists of 92 hours of coursework, plus math prerequisites.

Required courses for the B.S. in Systems engineering are:

Engineering Core (27 credits)

ENGR103 Fund. of Elec. and Systems Engineering(3)

ENGR110 Engineering Graphics(3)

ENGR200 Introduction to Elec. and Mech. Systems(3)

ENGR321 Human Factors Engineering(3)

ENGR386 Systems Eng. Design and Development(3)

ENGR455 Discrete Modelling and Simulation(3)

ENGR470 Capstone Design Project I(3)

ENGR471 Capstone Design Project II(3)

ENGR486 Appl. Systems Design and Ind. Automation(3)

Physics (11 credits)

PHYS111/112 General Physics I, II (4+4)

PHYS272 Methods of Applied Physics (3)

Computer Science (11 credits)

CSCI218 Engineering Programming (3+1)

CSCI221 Computer Programming II(3)

CSCI250 Introduction to Computer Organization and Assembly Language Programming(3+1)

Mathematics (21 credits)

MATH120 Introductory Calculus I(4)

MATH220 Calculus II(4)

MATH207 Discrete Structures I(3)
MATH221 Calculus III(4)
MATH250 Statistical Methods I(3)
MATH452 Operations Research(3)

Business (12 credits)

DSCI304 Production and Operations Management(3)
MGMT301 Management & Organizational Behavior(3)
SCIM366 Lean and Six Sigma(3)
SCIM373 Supply Chain Planning and Analysis(3)

Additional General Science (4 credits)

BIOL111 Intro. to Cell and Molecular Biology(3+1)
OR
CHEM111 Principles of Chemistry(3+1)
OR
HONS151 Honors Biology(3+1)
OR
HONS190 Accelerated General Chemistry(4+1)

Plus 6 credits of disciplinary electives from a list of approved CSCI, ENGR, and PHYS courses. A full list of these approved electives can be found in the CofC undergraduate catalog.

Computer Science(8 credits)

CSCI218 Engineering Programming(3+1)
CSCI250 Intro to Comp. Org. and Assembly(3)
CSCI250L Microcontroller and Assembly Lab(1)

Mathematics (18 credits)

MATH120 Introductory Calculus I(4)
MATH207 Discrete Structures I(3)
MATH220 Calculus II(4)
MATH221 Calculus III(4)
MATH250 Statistical Methods(3)

Additional General Science (4 credits) BIOL111 Intro to Cell and Molecular Biology(3+1)

OR
CHEM111 Principles of Chemistry(3+1)

Plus 6 credits of disciplinary electives from a list of approved ENGR and PHYS courses. A full list of these approved electives can be found in the CofC undergraduate catalog.

3.1.7 B.S. in Electrical Engineering

The B.S. in Electrical Engineering is a unique program focused on students interested in the electrical, wiring, networking, and programming of Internet of Things (IoT) devices. The program is also unique in that – based on input from local industry leaders – there is required course work in the area of autonomous electrical vehicle design.

The B.S. in Electrical Engineering consists of 92 hours of coursework, plus math prerequisites.

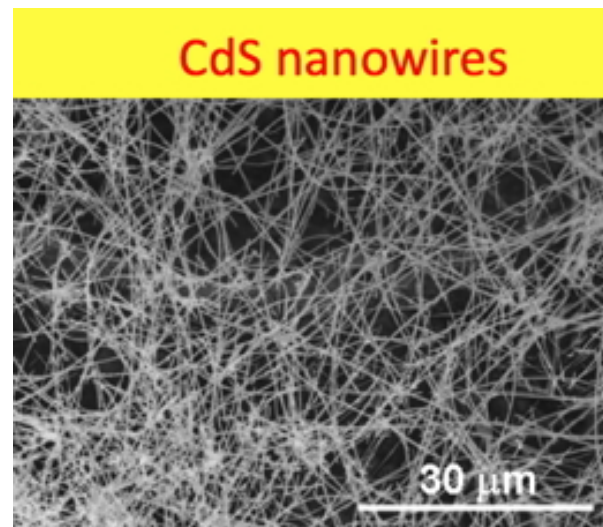
Required courses for the B.S. in Electrical engineering are:

Engineering Core (37 credits)

ENGR103 Fund of Elec. and Systems Engineering(3)
ENGR110 Engineering Graphics(3)
ENGR210/310 Circuit Analysis I, II (4+4)
ENGR341 Electromech. Energy Conv. and Elec. Power(3)
ENGR380 Vehicle Electrical and Electronic Design(3)
ENGR400 Digital Design(3)
ENGR401 Comm. and Autonomous Navigation(3+1)
ENGR410 Control Systems(3+1)
ENGR470/471 Capstone Design Project I, II (3+3)

Physics(19 credits)

PHYS111/112 General Physics I, II(4+4)
PHYS272 Methods of Applied Physics(3)
PHYS320 Intro to Electronics(3+1)
PHYS394 Digital Signal and Image Processing...(3+1)



3.2 Concentrations

A concentration is a focused area of study within your major. We offer concentrations in operational meteorology (within the meteorology B.A.), atmospheric physics (within the physics B.S.), computational neuroscience (within either the Physics B.A. or Physics B.S.), and energy production (within either the Physics B.A. or Physics B.S.)

3.2.1 Operational Meteorology

The Operational Meteorology Concentration within the Meteorology B.A. is necessary for any student who wants to meet the minimum job requirements to obtain a job in forecasting, broadcast meteorology, work for the national weather service, and/or to pursue graduate study within meteorology. It is substantially more intense than the B.A. without the concentration.

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*.

Additional Physics and Meteorology Core Courses (18 credits)

PHYS215 Synoptic Meteorology (3)
PHYS230 Introduction to Modern Physics (3)
PHYS405 Thermal Physics (3)
PHYS415 Fluid Mechanics (3)
PHYS425 Mesoscale Meteorology (3)
PHYS459 Cloud and Precipitation Physics (3)

Additional Mathematics Cognate Core (7 credits)

MATH221 Calculus III (4)
MATH323 Differential Equations (3)
OR
PHYS272 Methods of Applied Physics (3)

Additional Electives (6 Credits from the following)

BIOL342 Oceanography (4)
CHEM111 Principles of Chemistry (4)
CSCI220 Computer Programming (4)
GEOL438 Hydrogeology (4)
MATH250 Statistical Methods I (3)
PHYS340 Photonics (4)
PHYS409 Electromagnetism I (3)

The amount of additional coursework necessary beyond what is taken to complete the B.A. requirements can be minimized by working carefully with your advisor to choose strategic options within the Meteorology B.A. that fulfill both the B.A. degree requirements AND the concentration requirements.

If you wish to get a job with NOAA, in Broadcasting,

or as a forecaster this may dictate which electives you need to choose off of the above list. Make sure to work closely with your advisor to ensure you are taking the courses not only to get the degree but also to ensure you have the qualifications necessary for the job you seek.

Also keep in mind that the Certificate in Consulting Meteorology and/or the Certified Broadcast Meteorologist Programs also have additional course requirements above and beyond the listed Concentration and major requirements.

3.2.2 Atmospheric Physics

Whereas the Operational Meteorology Concentration in the Meteorology B.A. is designed for people who have a primary interest in Meteorology but seek a more quantitatively intense program to prepare them for a professional career in Meteorology, the Atmospheric Physics Concentration in the Physics B.S. is designed for those who may be more focused on a broad Physics education but plan to pursue graduate study within the domains of Atmospheric Science, Planetary Science, Atmospheric Physics, or related fields.

The Atmospheric Physics Concentration within the Physics B.S. degree will consist of 18 hours (9 core credits and 9 elective credits), in addition to the requirements for the Physics B.S.

Additional Core Courses (9 credits)

PHYS405 Thermal Physics (3)
PHYS415 Fluid Mechanics (3)
PHYS459 Cloud and Precipitation Physics (3)

Plus 9 credits of disciplinary electives from a list of approved ASTR, ENVT, GEOL, and PHYS courses.

A full list of these approved electives can be found in the CofC undergraduate catalog.

Note that in this and other concentrations, “core courses” in the concentration are typically also allowable as “electives” within the degree program housing them, so a strategic selection of courses can minimize the additional courses taken to complete the concentration requirements.

3.2.3 Computational Neuroscience

The CNS concentration targets majors in Physics (B.S. or B.A.) 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+1)
BIOL396/PHYS396 Biophysical Modeling of Excitable Cells (3)
PHYS394 Digital Signal and Image Processing with Biomedical Applications (3+1)

Additional Electives (7 credits)

Group 1 – Selected from an approved list of BIOL and PSYC courses
Group 2 – Selected from an approved list of CSCI and MATH courses
Group 3 – Selected from an approved list of PHYS courses

Each elective must be in a different group. A list of electives in each group is available in the undergraduate catalog.

3.2.4 Energy Production

The Energy Production Concentration within the Physics B.A. or B.S. is an option for students interested in documenting an emphasis in coursework related to the applied area of consumer energy.

The 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.

Additional Core Courses (8 credits)

CHEM111 General Chemistry I (3+1)
PHYS350 Energy Production (3+1)

Additional Electives (10 credits)

Group I-

PHYS320 Intro to Electronics (4)
PHYS340 Photonics (4)
PHYS405 Thermal Physics (3)
PHYS407 Nuclear Physics (3)
PHYS408 Solid State Physics (3)

Group II – Selected from an approved list of CHEM, GEOL, and PHYS Courses

At least 6 credits must be from Group I, and a full list of electives in Group II is available in the undergraduate catalog.

3.3 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, Meteorology, and Biomedical Physics. 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.

3.3.1 Minor in Physics

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

Core Courses (8 credits)

PHYS111/112 General Physics I,II (4+4)
OR
PHYS101/102 Introductory Physics (4+4) [a minimum grade of B in each lecture and lab course is required]

Plus 10 credits of approved PHYS electives.

A list of approved courses to fulfill the elective requirement is listed in the undergraduate catalog.

3.3.2 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.

Astronomy Core (3+ credits)

ASTR 129/130 Astronomy I,II (4+4)
OR
HONS 159/160 Honors Astronomy I,II (4+4)
OR
ASTR 231 Introduction to Astrophysics (3)

Plus additional credits of approved ASTR, GEOL, HIST, HONS, PHIL, and PHYS electives sufficient to total 18 credit hours in the minor.

A list of approved courses to fulfill the elective requirement is listed in the undergraduate catalog.

3.3.3 Minor in Meteorology

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

Core course (3 credits)

PHYS105 Introduction to Meteorology(3)

Meteorology Electives (2 courses selected off of a list of approved courses)

Plus additional credits of approved ASTR, BIOL, CHEM, CSCI, ENGL, ENVT, GEOL, PHYS, and HONS electives sufficient to total 18 credit hours in the minor.

A list of approved courses to fulfill the Meteorology Electives and the additional elective requirement is listed in the undergraduate catalog.

3.3.4 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.

Introductory Physics (4 credits)

PHYS 102 Introductory Physics II (4)

OR

PHYS 112 General Physics II (4)

OR

HONS 158 Honors Physics II (4)

Introductory Biology (4 credits)

BIOL 112 Form and Function of Organisms (4)

OR

HONS152 Honors Biology II(4)

Biomedical Courses (6 credits)

PHYS203 Physics and Medicine(3)

PHYS 396/BIOL396 Biophysical Modeling of Excitable Cells(3)

Plus additional credits of approved BIOL, CHEM, and PHYS electives sufficient to total 18 credit hours in the minor.

3.4 Anticipated Course Offerings

Note: Although these are our *plans*, do not consider any of these listings to be a guarantee. Enrollment, demand swings, and other factors may result in cancellation or addition of courses in any semester. Special topics courses may be offered on short notice. Also, although not listed there are individual enrollment courses like PHYS381, PHYS390, PHYS397, PHYS399, and PHYS420 that are offered every semester as needed.

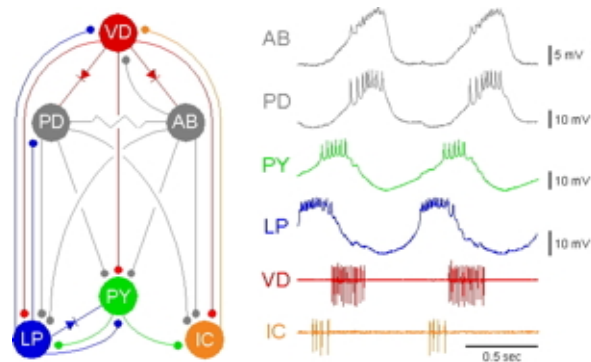
(I also sometimes make mistakes, despite every effort to keep this list up-to-date and accurate).

3.4.1 Spring 2022

ASTR129/129L	Astronomy I
ASTR130/130L	Astronomy II
ASTR205	Intelligent Life in the Universe
ASTR231	Introduction to Astrophysics
ASTR260/260L	NASA Space Mission Design
ASTR312	Galactic and Extragalactic Astronomy
ASTR460L	NASA Space Mission Design Leadership Lab
ENGR103	Fundamentals of Electrical and Systems Engineering
ENGR110	Engineering Graphics
HONS158/158L	Honors Physics II
HONS160/160L	Honors Astronomy II
PHYS101/101L	Introductory Physics I
PHYS102/102L	Introductory Physics II
PHYS111/111L	General Physics I
PHYS112/112L	General Physics II
PHYS215	Synoptic Meteorology
PHYS230	Modern Physics I
PHYS260/260L	NASA Space Mission Design
PHYS270	Nanotechnology in Medicine
PHYS272	Methods of Applied Physics
PHYS301	Classical Mechanics I
PHYS370	Experimental Physics
PHYS394/394L	Digital Signal and Image Processing with Biomedical Applications
PHYS404	Intro Quantum Mechanics II
PHYS405	Thermal Physics
PHYS412	General Relativity
PHYS419	Research Seminar
PHYS457	Satellite Meteorology
PHYS460L	NASA Space Mission Design Leadership Lab

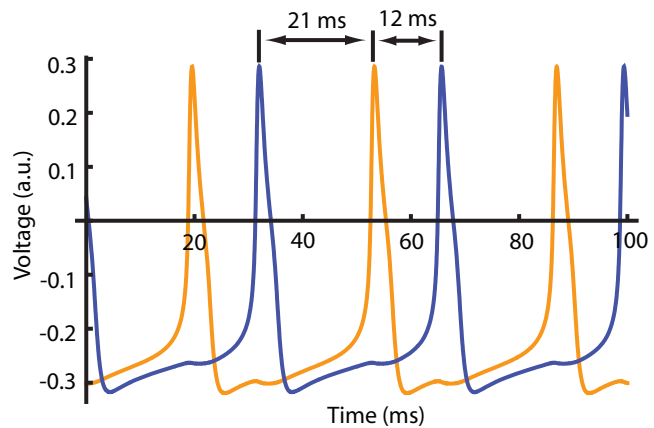
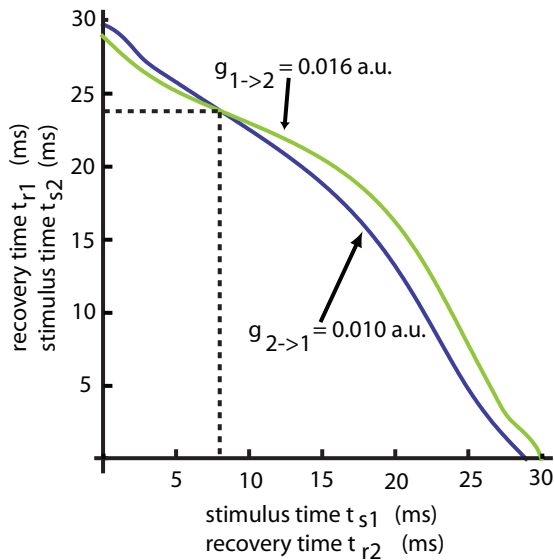
3.4.2 Fall 2022

ASTR129/129L	Astronomy I
ASTR130/130L	Astronomy II
ASTR260/260L	NASA Space Mission Design
ASTR377	Experimental Astronomy
ASTR460L	NASA Space Mission Design Leadership Lab
ENGR103	Fundamentals of Electrical and Systems Engineering
ENGR200	Introduction to Electrical and Mechanical Systems
ENGR210/201L	Circuit Analysis I
ENGR321	Human Factors Engineering
ENGR386	Systems Engineering: Design and Development
HONS157/157L	Honors Physics I
HONS159/159L	Honors Astronomy I
HONS280	The Physics of Sound and Music
PHYS101/101L	Introductory Physics I
PHYS102/102L	Introductory Physics II
PHYS111/111L	General Physics I
PHYS112/112L	General Physics II
PHYS225	Climate
PHYS230	Modern Physics I
PHYS260/260L	NASA Space Mission Design
PHYS340/340L	Photonics
PHYS370	Experimental Physics
PHYS396	Biophysical Modeling of Excitable Cells
PHYS403	Intro Quantum Mechanics I
PHYS409	Electromagnetism I
PHYS419	Research Seminar
PHYS425	Mesoscale Meteorology
PHYS460L	NASA Space Mission Design Leadership Lab
PHYS481	Physics Problem Solving



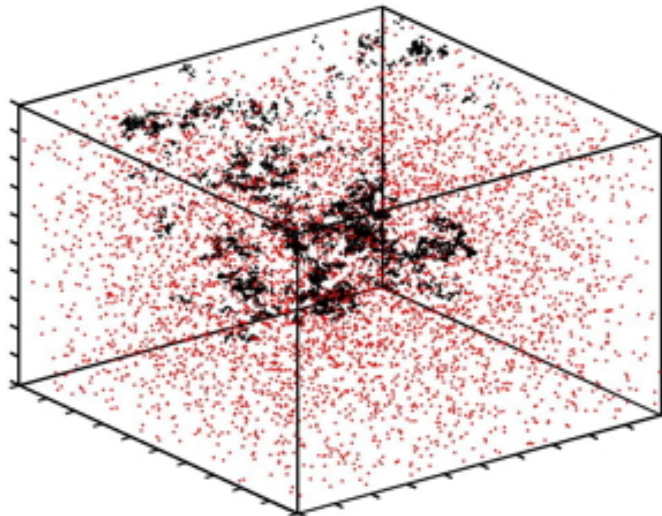
3.4.3 Spring 2023

ASTR129/129L	Astronomy I
ASTR130/130L	Astronomy II
ASTR210	Black Holes in the Universe
ASTR231	Introduction to Astrophysics
ASTR260/260L	NASA Space Mission Design
ASTR306	Planetary Astronomy
ASTR410	Black Holes
ASTR460L	NASA Space Mission Design Leadership Lab
ENGR103	Fundamentals of Electrical and Systems Engineering
ENGR110	Engineering Graphics
ENGR310/310L	Circuit Analysis II
ENGR486	Applied Systems Design and Industrial Automation
HONS158/158L	Honors Physics II
HONS160/160L	Honors Astronomy II
PHYS101/101L	Introductory Physics I
PHYS102/102L	Introductory Physics II
PHYS111/111L	General Physics I
PHYS112/112L	General Physics II
PHYS203	Physics and Medicine
PHYS210	Intro to Air Pollution
PHYS230	Modern Physics I
PHYS260/260L	NASA Space Mission Design
PHYS272	Methods of Applied Physics
PHYS301	Classical Mechanics I
PHYS305	The Nexus of Business and Meteorology
PHYS350/350L	Energy Production
PHYS370	Experimental Physics
PHYS405	Thermal Physics
PHYS415	Fluid Mechanics
PHYS419	Research Seminar
PHYS460L	NASA Space Mission Design Leadership Lab



3.4.4 Fall 2023

ASTR129/129L	Astronomy I
ASTR130/130L	Astronomy II
ASTR260/260L	NASA Space Mission Design
ASTR311	Stellar Astronomy and Astrophysics
ASTR377	Experimental Astronomy
ASTR460L	NASA Space Mission Design Leadership Lab
HONS157/157L	Honors Physics I
HONS159/159L	Honors Astronomy I
ENGR103	Fundamentals of Electrical and Systems Engineering
ENGR200	Introduction to Electrical and Mechanical Systems
ENGR210/210L	Circuit Analysis I
ENGR321	Human Factors Engineering
ENGR341	Electromechanical Energy Conversion and Electric Power
ENGR380	Vehicle Electrical and Electronic Design
ENGR386	Systems Engineering: Design and Development
ENGR470	Capstone Design Project I
PHYS101/101L	Introductory Physics I
PHYS102/102L	Introductory Physics II
PHYS105	Introduction to Meteorology
PHYS111/111L	General Physics I
PHYS112/112L	General Physics II
PHYS230	Modern Physics I
PHYS260/260L	NASA Space Mission Design
PHYS320/320L	Intro to Electronics
PHYS370	Experimental Physics
PHYS396	Biophysical Modeling of Excitable Cells
PHYS403	Intro Quantum Mechanics I
PHYS409	Electromagnetism I
PHYS419	Research Seminar
PHYS459	Cloud and Precipitation Physics
PHYS460L	NASA Space Mission Design Leadership Lab
PHYS481	Physics Problem Solving



3.5 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. Sample programs are listed for our B.S. programs and the Operational Meteorology Concentration attached to the Meteorology B.A. only; the B.A. programs in Physics and Astronomy generally have a lot more flexibility and thus aren't outlined here.

3.5.1 BS in Physics

Freshman Fall MATH120, Calc I (4) PHYS111, General Physics I (4) ENGL110, Freshman Comp (4) FYE (3) (total = 15)	Freshman Spring MATH220, Calc II (4) PHYS112, General Physics II (4) HIST103 (3) Humanity I (3) Social Science I (3) (total = 17)
Sophomore Fall PHYS230, Modern Physics I (3) MATH221, Calc III (4) MATH203, Linear Algebra (3) Foreign Language I (3) HIST104 (3) (total = 16)	Sophomore Spring PHYS370, Experimental Physics (4) MATH323, Differential Eqns (3) Humanity II (3) Foreign Language II (3) Social Science II (3) (total = 16)
Junior Fall PHYS409, Electromagnetism I (3) Physics Elective I (3) Elective (3) Humanity III (3) Foreign Language III (3) (total = 15)	Junior Spring PHYS301 Classical Mechanics (3) Physics Elective II (3) Elective (3) Humanity IV (3) Foreign Language IV (3) (total = 15)
Senior Fall PHYS419 Research Seminar (1) PHYS403, Quantum Mechanics I (3) Physics Elective III (3) Physics Elective IV (3) Elective (3) Elective (3) (total = 16)	Senior Spring PHYS420, Senior Research (3) Elective (3) Physics Elective V (3) Elective (3) Elective (3) (total = 15)

The above sample schedule intentionally moves most of the free electives as far back in the schedule as possible to keep maximum flexibility in place in case the Physics electives that you want/need don't line up optimally with your schedule. Your optimal path is likely to deviate from this plan.

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 semesters of Quantum Mechanics (PHYS404) and Electromagnetism (PHYS410). Those interested in going into a laboratory based career should seriously consider Electronics (PHYS 320) and/or Photonics (PHYS340) as electives. Your preparation would also be considerably enhanced by taking Partial Differential Equations (MATH423) and/or Mathematical Statistics (MATH430). Many students also benefit from fitting PHYS 272 (Methods of Applied Physics) into their schedules in the first available semester after completing Calc III to help ensure the full mathematical foundation necessary for the upper-level courses is solid.

3.5.2 BS in Astrophysics

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

<p>Freshman Fall MATH120, Calc I (4) PHYS111, General Physics I (4) ENGL110, Freshman Comp (4) Foreign Language I (3) (total = 15)</p>	<p>Freshman Spring MATH220, Calc II (4) PHYS112, General Physics II (4) FYE (3) Foreign Language II (3) (total=14)</p>
<p>Sophomore Fall PHYS230, Modern Physics I (3) MATH221, Calc III (4) MATH203, Linear Algebra (3) Foreign Language III (3) HIST103 (3) (total = 16)</p>	<p>Sophomore Spring ASTR231 Intro to Astrophysics (3) MATH323, Differential Eqns (3) Humanity I (3) Foreign Language IV (3) HIST104 (3) (total = 15)</p>
<p>Junior Fall PHYS409, Electromagnetism I (3) ASTR377, Experimental Astro (4) Humanity II (3) Humanity III (3) Social Science I (3) (total = 16)</p>	<p>Junior Spring PHYS301, Classical Mechanics (3) PHYS405, Thermal Physics (3) Astro Elective I (3) Humanity IV (3) Social Science II (3) (total = 15)</p>
<p>Senior Fall PHYS419 Research Seminar (1) PHYS403, Quantum Mechanics I (3) Astro Elective II (3) Elective (3) Elective (3) Elective (3) (total = 16)</p>	<p>Senior Spring PHYS420, Senior Research (3) Astro Elective III (3) Elective (3) Elective (3) Elective (3) (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.

3.5.3 BA in Meteorology with Operational Meteorology Concentration (Fall even year start)

Because this is a very sequenced major (lots of courses have to be taken in a particular order) AND because a lot of our courses in this program are only offered every other year, we offer two schedules for this program. This is one for students starting in fall of even years (e.g Fall 2022, Fall 2024, etc.) Beginning in Calc I as a first semester Freshman is critical for completing the program in four years.

Freshman Fall MATH120, Calc I (4) PHYS111, General Physics I (4) ENGL110, Freshman Comp (4) Foreign Language I (3) (total = 15)	Freshman Spring MATH220, Calc II (4) PHYS112, General Physics II (4) FYE (3) Foreign Language II (3) (total = 14)
Sophomore Fall PHYS230, Modern Physics I (3) MATH221, Calc III (4) MATH203, Linear Algebra (3) Foreign Language III (3) HIST103 (3) (total = 16)	Sophomore Spring PHYS215, Synoptic Meteorology (3) MATH323, Differential Equations (3) Humanity I (3) Foreign Language IV (3) HIST104 (3) (total = 15)
Junior Fall PHYS225, Climate (3) PHYS370, Experimental Physics (4) Humanity II (3) Humanity III (3) Social Science I (3) (total = 16)	Junior Spring PHYS415, Fluid Mechanics (3) PHYS425, Mesoscale Meteorology (3) Meteorology Elective (3) Humanity IV (3) Social Science II (3) (total = 15)
Senior Fall PHYS419, Research Seminar (1) PHYS459, Cloud and Precip (3) Elective (3) Elective (3) Elective (3) Elective (3) (total = 16)	Senior Spring PHYS420, Senior Research (3) PHYS405, Thermal Physics (3) Elective (3) Elective (3) Elective (3) (total = 15)

Note that although the plan above completes the requirements for the major with the concentration, if you want to obtain a job relevant to forecasting or broadcast meteorology there are other courses that are generally expected to be in your portfolio (e.g. MATH250, CSCI220, and others depending on what you are looking to do). It may make sense to take some of these additional courses earlier in your CofC career by moving some HIST, Humanity, and/or Social Science back to the second half of your undergraduate career. Although the 7 electives listed may seem like a lot, there are very specific things you should spend that time on if you seek to get a job in the very competitive world of Meteorology.

Carefully consider your goals and talk to your advisor for recommendations of the courses to fill out your schedule. If your advisor is not a meteorologist, you should probably change to one who is. Other atmospherically inclined faculty will be happy to share their recommendations with you at any time.

Note that if you have to withdraw from a MATH or MET class, it can cause you to need to delay your graduation by a year or more, depending on the course in question. Make sure to talk to your advisor before assuming you can just make up a course the following semester; often you have to wait quite a while until it comes around again.

3.5.4 BA in Meteorology with Operational Meteorology Concentration (Fall odd year start)

Because this is a very sequenced major (lots of courses have to be taken in a particular order) AND because a lot of our courses in this program are only offered every other year, we offer two schedules for this program. This is one for students starting in fall of odd years (e.g Fall 2021, Fall 2023, etc.) Beginning in Calc I as a first semester Freshman is critical for completing the program in four years.

<p>Freshman Fall MATH120, Calc I (4) PHYS111, General Physics I (4) ENGL110, Freshman Comp (4) Foreign Language I (3) (total = 15)</p>	<p>Freshman Spring MATH220, Calc II (4) PHYS112, General Physics II (4) FYE (3) Foreign Language II (3) (total = 14)</p>
<p>Sophomore Fall PHYS225, Climate (3) PHYS230, Modern Physics I (3) MATH221, Calc III (4) MATH203, Linear Algebra (3) Foreign Language III (3) (total = 16)</p>	<p>Sophomore Spring MATH 323, Differential Equations (3) PHYS370, Experimental Physics (4) Social Science I (3) Humanity I (3) Foreign Language IV (3) (total = 16)</p>
<p>Junior Fall PHYS459, Cloud and Precip (3) Social Science II (3) HIST103 (3) Humanity II (3) Humanity III (3) (total = 16)</p>	<p>Junior Spring PHYS215, Synoptic Meteorology (3) PHYS405, Thermal Physics (3) HIST104 (3) Humanity IV (3) Elective (3) (total = 15)</p>
<p>Senior Fall PHYS419, Research Seminar (1) Meteorology Elective (3) Elective (3) Elective (3) Elective (3) Elective (3) (total = 16)</p>	<p>Senior Spring PHYS420, Senior Research (3) PHYS415, Fluid Mechanics (3) PHYS 425, Mesoscale Meteorology (3) Elective (3) Elective (3) (total = 15)</p>

Note that although the plan above completes the requirements for the major with the concentration, if you want to obtain a job relevant to forecasting or broadcast meteorology there are other courses that are generally expected to be in your portfolio (e.g. MATH250, CSCI220, and others depending on what you are looking to do). It may make sense to take some of these additional courses earlier in your CofC career by moving some HIST, Humanity, and/or Social Science back to the second half of your undergraduate career. Although the 7 electives listed may seem like a lot, there are very specific things you should spend that time on if you seek to get a job in the very competitive world of Meteorology.

Carefully consider your goals and talk to your advisor for recommendations of the courses to fill out your schedule. If your advisor is not a meteorologist, you should probably change to one who is. Other atmospherically inclined faculty will be happy to share their recommendations with you at any time.

Note that if you have to withdraw from a MATH or MET class, it can cause you to need to delay your graduation by a year or more, depending on the course in question. Make sure to talk to your advisor before assuming you can just make up a course the following semester; often you have to wait quite a while until it comes around again.

3.5.5 BS in Systems Engineering

This particular schedule is a little more preliminary and subject to change than the other sample programs of study, since we are in the process of offering these courses for the very first time and it is hard for us to predict how often some of the courses in this program will be offered. This program also has specifically required courses from other departments that control their own offering schedule, so we cannot promise the courses you need will be offered in the semester you need to take them.

Completing this degree program if you fall behind in Math, ENGR, or PHYS courses will take additional time. Please consult with your advisor to get you through this program!

<p>Freshman Fall MATH120, Calc I (4) PHYS111, General Physics I (4) ENGR103, Fundamentals of Engineering (3) ENGL110, Freshman Comp (4) FYE (3) (total = 18)</p>	<p>Freshman Spring MATH220, Calc II (4) PHYS112, General Physics II (4) ENGR110, Engineering Graphics (3) MATH 207, Discrete Structures I (3) HIST103 (3) (total = 17)</p>
<p>Sophomore Fall MATH 221, Calc III (4) MATH 250, Statistical Methods (3) ENGR 200, Intro to Elec. and Mech. Systems (3) CSCI 218, Engineering Programming (4) ECON 200, Microeconomics (3) (total = 17)</p>	<p>Sophomore Spring PHYS 272, Methods of Applied Physics (3) CSCI 221, Computer Programming II (3) CSCI 250, Intro. to Comp. Org. and Assembly Prog. (4) HIST 104 (3) ECON 201, Macroeconomics (3) (total = 16)</p>
<p>Junior Fall ENGR 321, Human Factors Engineering (3) ENGR 386, Systems Eng. Design and Develop. (3) Engineering Elective I (3) MGMT 301, Management & Org. Behavior (3) Foreign Language I (3) Humanity I (3) (total = 18)</p>	<p>Junior Spring MATH 452, Operations Research (3) ENGR 486, Appl. System Design and Ind. Automation (3) Engineering Elective II (3) DSCI 304, Production and Operations Management (3) Foreign Language II (3) Humanity II (3) (total = 18)</p>
<p>Senior Fall ENGR 470, Capstone Design I (3) SCIM 373, Supply Chain Planning and Logistics (3) Additional Science (4) Foreign Language III (3) Humanity III (3) (total = 16)</p>	<p>Senior Spring ENGR 471, Capstone Design II (3) ENGR 455, Discrete Modelling and Simulation (3) SCIM 366, Lean and Six Sigma (3) Foreign Language IV (3) Humanity IV (3) (total = 15)</p>

Note that there are NO free electives in this program (the engineering elective and additional science are selected from a list of approved classes); dropping a class or falling behind will likely add time to graduation.

3.5.6 BS in Electrical Engineering

This particular schedule – just like the systems engineering program – is a little more preliminary and subject to change than the other sample programs of study, since we are in the process of offering these courses for the very first time and it is hard for us to predict how often some of the courses in this program will be offered. This program also has specifically required courses from other departments that control their own offering schedule, so we cannot promise the courses you need will be offered in the semester you need to take them.

Completing this degree program if you fall behind in Math, ENGR, or PHYS courses will take additional time. Please consult with your advisor to get you through this program!

<p>Freshman Fall MATH120, Calc I (4) PHYS111, General Physics I (4) ENGR103, Fundamentals of Engineering (3) ENGL110, Freshman Comp (4) Humanity I (Fulfilling FYE) (3) (total = 18)</p>	<p>Freshman Spring MATH220, Calc II (4) PHYS112, General Physics II (4) ENGR110, Engineering Graphics (3) MATH 207, Discrete Structures I (3) Humanity II (3) (total = 17)</p>
<p>Sophomore Fall MATH 221, Calc III (4) ENGR210, Circuit Analysis I (4) CSCI218, Engineering Programming (4) Foreign Language I (3) (total = 15)</p>	<p>Sophomore Spring PHYS 272, Methods of Applied Physics (3) PHYS394, Signal/Image Proc. (4) ENGR310, Circuit Analysis II (4) CSCI250 (Comp Org/Assembly) (4) Foreign Language II (3) (total = 18)</p>
<p>Junior Fall MATH250, Statistical Methods (3) PHYS320, Intro to Electronics (4) ENGR341, Elecmech. Energy Conversion/Power (3) ENGR380, Vehicle Electrical Design (3) Foreign Language III (3) (total = 16)</p>	<p>Junior Spring ENGR400, Digital Design (3) ENGR401, Comm. and Auto. Nav. (4) Social Science I (sugg ECON200) (3) Humanity III (3) Foreign Language IV (3) (total = 16)</p>
<p>Senior Fall ENGR410, Control Systems (4) ENGR470, Capstone Design I (3) Engineering Elective I (3) Social Science II (Sugg ECON201) (3) HIST103 (3) (total = 16)</p>	<p>Senior Spring Engineering Elective II (3) ENGR 471, Capstone Design II (3) Additional Science (4) HIST104 (3) Humanity IV (3) (total = 16)</p>

Note that there are NO free electives in this program (the engineering electives and additional science are selected from a list of approved classes); dropping a class or falling behind will likely add time to graduation.

3.6.3 B.S. Astrophysics Checklist

General College Requirements

First Year Experience (3)
 English 110 (4)
 History (3) (Pre-Modern, e.g. HIST103)
 History (3) (Modern, e.g. HIST104)
 Foreign Language (0-12) (Through 202 Level)

Taken

Will Take

Humanities (12)
 (Max of 6 cr. from any one area)

Social Science (6)

B.S. Req'd. Courses in PHYS/ASTR

PHYS111 (4) General Physics I
 PHYS112 (4) General Physics II
 PHYS230 (3) Modern Physics I
 PHYS301 (3) Classical Mechanics I
 PHYS403 (3) Intro Quantum Mechanics I
 PHYS405 (3) Thermal Physics
 PHYS409 (3) Electromagnetism I
 PHYS419 (1) Research Seminar
 PHYS420 (3) Senior Research [or 499 (6)]
 ASTR231 (3) Intro to Astrophysics
 ASTR377 (4) Experimental Astronomy

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

ASTR306 (3) Planetary Astronomy
ASTR311 (3) Stellar Astronomy
ASTR312 (3) Galactic Astronomy
ASTR413 (3) Astrophysics
PHYS412 (3) Special Topics (in astro)

ASTR410 (1) Black Holes
 ASTR460L (1) ASTR/PHYS/GEOL NASA Leadership Lab
 PHYS390 (3) Research (in astro)
 PHYS394 (3+1) Digital Signal and Image Processing...
 PHYS404 (3) Intro Quantum Mechanics II
 PHYS407 (3) Introduction to Nuclear Physics
 PHYS410 (3) Electromagnetism II
 PHYS415 (3) Fluid Mechanics

Math courses

MATH120 (4) Calculus I
 MATH220 (4) Calculus II
 MATH221 (4) Calculus III
 MATH203 (3) Linear Algebra
 MATH323 (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.

Math courses

MATH120 (4) Calculus I

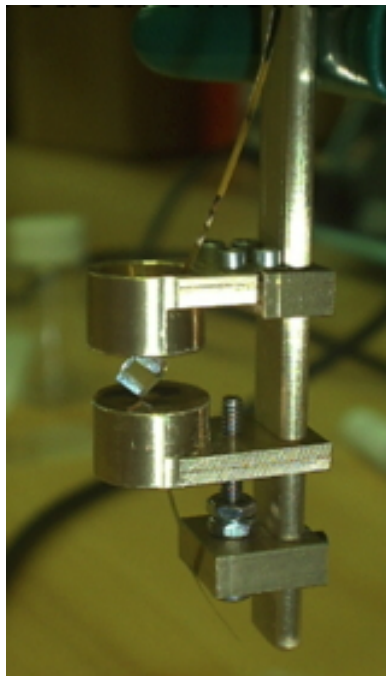
MATH220 (4) Calculus II

Note that other math may be required as pre-reqs to some courses in previous sections.

Taken

Will Take

Other Electives



3.6.5 B.A. Meteorology Checklist (Without Concentration)

General College Requirements	Taken	Will Take
First Year Experience (3)	_____	_____
English 110 (4)	_____	_____
History (3) (Pre-Modern, e.g. HIST103)	_____	_____
History (3) (Modern, e.g. HIST104)	_____	_____
Foreign Language (0-12) (Through 202 Level)	_____	_____
	_____	_____
	_____	_____
Humanities (12) (Max of 6 cr. from any one area)	_____	_____
	_____	_____
	_____	_____
Social Science (6)	_____	_____
	_____	_____
B.A. Base Experience Option 1 (3 credits)		
PHYS105 (3) Introduction to Meteorology	_____	_____
B.A. Base Experience Option 2 (9 credits) (take 3 of 4 courses below)		
GEOL438 (4) Hydrogeology	_____	_____
PHYS405 (3) Thermal Physics	_____	_____
PHYS415 (3) Fluid Mechanics	_____	_____
PHYS459 (3) Cloud and Precipitation Physics	_____	_____
B.A. Emphasis Experience Option 1 (3 credits)		
PHYS210 (3) Introduction to Air Pollution	_____	_____
B.A. Emphasis Experience Option 2 (3 credits)		
PHYS215 (3) Synoptic Meteorology	_____	_____
B.A. Required courses (11 credits)		
PHYS225 (3) Climate	_____	_____
PHYS370 (4) Experimental Physics	_____	_____
PHYS419 (1) Research Seminar	_____	_____
PHYS420 (3) Senior Research [or 499(6)]	_____	_____
Introductory Physics Option 1 (8 credits)		
PHYS111 (4) General Physics I	_____	_____
PHYS112 (4) General Physics II	_____	_____
Introductory Physics Option 2 (8 credits)		
PHYS101 (4) General Physics I	_____	_____
PHYS102 (4) General Physics II	_____	_____
Mathematics Option 1 (8 credits)		
MATH120 (4) Calculus I	_____	_____
MATH220 (4) Calculus II	_____	_____
Mathematics Option 2 (9 credits)		
MATH120 (4) Calculus I	_____	_____
MATH229 (5) Vector Calculus with Chemical Applications	_____	_____

3.6.6 B.A. Meteorology Checklist (With Operational Meteorology Concentration)

General College Requirements	Taken	Will Take
First Year Experience (3)	_____	_____
English 110 (4)	_____	_____
History (3) (Pre-Modern, e.g. HIST103)	_____	_____
History (3) (Modern, e.g. HIST104)	_____	_____
Foreign Language (0-12) (Through 202 Level)	_____	_____
	_____	_____
	_____	_____
	_____	_____
Humanities (12) (Max of 6 cr. from any one area)	_____	_____
	_____	_____
	_____	_____
Social Science (6)	_____	_____
	_____	_____
Physics and Meteorology Core Courses (43 credits)		
PHYS111 (4) General Physics I	_____	_____
PHYS112 (4) General Physics II	_____	_____
PHYS215 (3) Synoptic Meteorology	_____	_____
PHYS225 (3) Climate	_____	_____
PHYS230 (3) Introduction to Modern Physics	_____	_____
PHYS370 (4) Experimental Physics	_____	_____
PHYS405 (3) Thermal Physics	_____	_____
PHYS415 (3) Fluid Mechanics	_____	_____
PHYS419 (1) Research Seminar	_____	_____
PHYS420 (3) Senior Research [or 499(6)]	_____	_____
PHYS425 (3) Mesoscale Meteorology	_____	_____
PHYS459 (3) Cloud and Precipitation Physics	_____	_____
Plus at least 6 credits from the following:		
BIOL342 (4) Oceanography	_____	_____
CHEM111 (3+1) Principles of Chemistry	_____	_____
CSCI220 (3+1) Computer Programming	_____	_____
GEOL438 (4) Hydrogeology	_____	_____
MATH250 (3) Statistical Methods 1	_____	_____
PHYS340 (4) Photonics	_____	_____
PHYS409 (3) Electromagnetism I	_____	_____
Mathematics Core Courses (15 credits)		
Must include at least one of the two bolded courses		
MATH120 (4) Calculus I	_____	_____
MATH220 (4) Calculus II	_____	_____
MATH221 (4) Calculus III	_____	_____
MATH323 (3) Differential Equations	_____	_____
PHYS272 (3) Methods of Applied Physics	_____	_____
(Cont'd. on next page)		

Additional Science (4-5 credits)

(Choose One of the Following)

BIOL111 (4) Introduction to Cell and Molecular Biology

CHEM111 (4) Principles of Chemistry

HONS151 (4) Honors Biology

HONS190 (5) Accelerated General Chemistry

Taken

Will Take

_____	_____
_____	_____
_____	_____
_____	_____

Additional Disciplinary Electives (6 credits)

(Selected from list of approved courses)

_____	_____
_____	_____
_____	_____

Other Electives

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____



4 Courses taught by the Department

Credit hours for each are in parentheses. The usual terms the courses are offered (if known) are indicated after the course title. This information is not a guarantee that a course will be offered, but hopefully can help you while planning your program.

Legend: F= every fall, S=every spring, oF=odd-year fall, eF=even-year fall, oS=odd-year spring, eS=even-year spring.

4.1 Astronomy

ASTR129 Astronomy I (3) (F,S)

An introduction to astronomy. Corequisite: ASTR129L. A working knowledge of high school algebra is assumed. Note: No credit for ASTR129 if you have passed HONS159, Honors Astronomy I.

ASTR129L Astronomy I Laboratory (1) (F,S)

Corequisite: ASTR129.

ASTR130 Astronomy II (3) (F,S)

A continuation of ASTR129. Corequisite: ASTR130L. Prerequisites: ASTR129. A working knowledge of high school algebra is assumed. Note: No credit for ASTR130 if you have passed HONS160, Honors Astronomy II.

ASTR130L Astronomy II Lab (1) (F,S)

Corequisite: ASTR130. Prerequisite: ASTR129L.

ASTR205 Intelligent Life in the Universe (3) (eS)

A general survey of the topic, stressing the interrelations between the fields of astronomy, physics, chemistry, biology, geology, and philosophy. Topics include the physical setting for origin and evolution of life, existence of such conditions elsewhere, possible number of extraterrestrial civilizations, possibility of contact, and implications of an encounter.

ASTR210 Black Holes in the Universe (3) (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) (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 HONS158

ASTR260 NASA Space Mission Design (2) (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 ASTR306 or HONS160 or GEOL206 or PHYS102 or PHYS112 or HONS158 or permission of instructor. Corequisites: ASTR260L/GEOL260L/PHYS260L or ASTR 460L/GEOL460L/PHYS460L

ASTR260L NASA Space Mission Design Lab (1) (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) (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) (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. Prerequisites: ASTR231 and MATH221

ASTR312 Galactic and Extragalactic Astronomy (3) (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) (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, Advanced Topics (1) (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) (offered sporadically when sufficient student demand)

Covers the application of physics to problems in stellar atmospheres and interiors, the interstellar medium and galactic dynamics. Prerequisites: PHYS301 and MATH323 or permission of the instructor.

ASTR460L: NASA Space Mission Design Leadership Lab (1) (FS)

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 instructor. Corequisites: ASTR260/GEOL260/PHYS260

4.2 Engineering

ENGR103 Fundamentals of Electrical and Systems Engineering (3) (F)

Introduction to a broad range of engineering topics and fields, such as mechanical design, engineering materials, machining, electricity and magnetism, computers and programming, data analyzing and graphing, robotics and process control, systems engineering concepts, and communications. Discussions include the roles, duties, and responsibilities, fundamental skills, engineering ethics, professionalism, and social responsibility in various engineering careers. Students are also guided to the appropriate academic resources and support services at the College of Charleston.

ENGR110 Engineering Graphics (3) (S)

A broad introduction to engineering design using Computer-Aided Design (CAD) tools and freehand sketching fundamentals. Emphasis is placed on a thorough understanding of multi-view projection principles and the visualization of exact space conditions relevant to 3D modeling. The concept of 3D problem solving techniques using CAD is stressed. Prerequisite or Corequisite: MATH 120 or HONS 115

ENGR200 Introduction to Electrical and Mechanical Systems (3) (F)

The fundamentals of AC/DC currents and voltages will be covered, such as voltage, current, sources and Ohm's law, followed by general and powerful procedures (nodal and mesh analyses) used in analyzing electric circuits. The course will also cover transducers, sensors, pneumatic and hydraulic systems, materials, actuation systems, and fundamentals of robotics. Prerequisites PHYS112/PHYS112L, MATH220 or HONS215, each with a grade of C- or better

ENGR210 Circuit Analysis I (3) (F)

The fundamentals of AC/DC currents and voltages and of circuit analysis are first covered, such as voltage, current, sources and Ohm's law followed by general and powerful procedures (nodal and mesh analyses) used in analyzing electric circuits. These methods are first applied to resistive circuits and later to circuits with more complex elements such as capacitors and inductors using homogeneous and nonhomogeneous differential equations. Circuits with DC sources as well as those with sinusoidal sources are analyzed using Thevenin's and Norton's theorems. The subjects of steady-state power and three-phase balanced systems are also covered. Prerequisites PHYS112/PHYS112L, MATH220 or HONS215 each with a grade of C- or better. Corequisite ENGR210L

ENGR210L Circuit Analysis I Lab (3) (F)

This course is designed to apply the concepts being covered in ENGR210. Hands-on lab exercises will be assigned each week within a structured setting. Students will also work in a team to develop a semester-long project. Corequisite ENGR210

ENGR310 Circuit Analysis II (3) (S)

Continuation of ENGR210. The course deals with the analysis of electrical circuits containing both active and passive components under steady state and time varying conditions with emphasis on circuit enabled applications of convolution, Fourier series, and Laplace and Fourier transforms. Prerequisites ENGR210/ENGR210L. Corequisite ENGR310L. Prerequisite or Corequisite PHYS272

ENGR310 Circuit Analysis II Lab (1) (S)

This course is designed to apply the concepts being covered in ENGR310. Hands-on lab exercises will be assigned each week within a structured setting. Students will also work in a team to develop a semester-long project. Corequisite ENGR310

ENGR321 Human Factors Engineering (3) (F)

Human factors design principles and the nature of human interaction with their physical work environment are covered, including topics in cognitive engineering, ergonomics, system design, and the nature of human performance in the workplace. Prerequisite MATH250 with a grade of C- or better

ENGR341 Electromechanical Energy Conversion and Electric Power (3) (oF)

The course deals with electromechanical energy conversion principles and electric power. Topics covered include electromechanical energy conversion principles, power transformers, power transmission and distribution systems, power analysis, and motors. Prerequisites ENGR310/ENGR310L

ENGR360 Electrical Instrumentation and Measurement (3) (TBD)

The course describes electronic measurement and instrumentation. It introduces concepts related to the use of sensing modalities and associated sensor technologies, and the interface electronics required for the collection and processing of data from them in relation to non-destructive testing (NDT) of materials. This course also provides hands-on experience for students in the use of sensor technologies such as ultrasound, eddy current sensing, and imaging, and data processing using standard commercial software tools. Prerequisites CSCI218/CSCI218L and ENGR310/ENGR310L

ENGR380 Vehicle Electrical and Electronic Design (3) (oF)

The course describes electrical and electronics designs used in state-of-the-art fuel ground, air and underwater vehicles. Vehicles covered will include those used for personal, commercial or military applications. Systems covered include automobiles, drones, and submarines. The course will cover concepts related to onboard monitoring electronics, cruise control concepts, and DC power distribution. The course will conclude with a discussion on automotive regenerative braking, sonar, and sensing and control technologies used for autonomous navigation. Prerequisites ENGR310/ENGR310L

ENGR381 Internship (1-3) (F,S)

A student will gain professional experience as an intern at a private firm or government agency. A written proposal must be approved through the director of the engineering programs prior to enrolling into the course. At least 40 hours of work is required for each credit awarded for the course. Prerequisite: permission of the instructor and program director

ENGR386 Systems Engineering: Design and Development (3) (F)

This course provides students with an introduction to quantitative techniques that are relevant to systems engineering. Focuses on the use of quantitative techniques to model and evaluate design options. Scope includes: Analysis methods of system engineering design and management, system analysis, system command control, Analytical Problem Solving and Solution Development Synthesis, system development, System Verification and Validation (V&V) Strategy, etc. Prerequisites ENGR200, CSCI218/CSCI218L, and MATH250 each with a grade of C- or better

ENGR387 Systems Engineering: Advanced Design and Development (3) (TBD)

This course provides students with advanced techniques that are relevant to systems engineering. Major topics covered include System development process models, System documentation strategy, technical review strategy, specification analysis, user-centered system design, system interface definition, analysis, design, and control. Prerequisite ENGR386

ENGR390 Research (1-3) (F,S)

Research investigations of specific problems in an appropriate engineering field. The topic of the investigations will be determined by the interests of the student in consultation with the department and faculty. Open to exceptional students and particularly suited to those intending to continue toward a graduate degree. Prerequisite: instructor and program director permission

ENGR399 Tutorial (1-3) (F,S)

Individual instruction given by a tutor in regularly scheduled meetings (usually once a week). Prerequisite: instructor and program director permission

ENGR400 Digital Design (3) (TBD)

This course introduces the modern design methodologies for digital logic and automatic synthesis of digital systems. Students are provided with access to the VHDL/Verilog and CAD tools to use hardware description language to model, analyze, and design various digital circuits/systems. It is expected that the students will acquire a clear understanding of the main techniques, design strategies, and the optimizations that are involved in modern digital circuit modeling, design, and synthesis. VLSI design automation and testing. Prerequisites PHYS320, CSCI250/CSCI250L

ENGR401 Communications and Autonomous Navigation (3) (TBD)

The course describes short- and long-range communication technologies used for autonomous navigation of vehicles, and coordination movement of ground, air, and underwater vehicles. Short range discussions will cover data protocols, error correction, bandwidth, and latencies used in Bluetooth, Zigbee, and WiFi communication. Long range communications will primarily focus on 4G and 5G technologies. Vehicle formations will consider structured and ad-hoc communication network topologies and algorithms. Prerequisites CSCI250/CSCI250L and PHYS 320. Corequisite ENGR401L

ENGR401L Communications and Autonomous Navigation Lab (1) (TBD)

This course is designed to apply the concepts being covered in ENGR401. Hands-on lab exercises will be assigned each week within a structured setting. Students will also work in a team to develop a semester-long project. Corequisite ENGR401

ENGR410 Control Systems (3) (TBD)

Analysis and design of linear feedback systems; control components; time, frequency, and transform domain representations and design techniques; systems specifications, performance indices, evaluation and testing; controller and compensator design; complex frequency and state-variable techniques. Introduction to sampled-data systems. Computer-aided design and simulation. Prerequisites CSCI250/CSCI250L, PHYS272, PHYS394/PHYS394L. Corequisite ENGR410L

ENGR410L Control Systems Lab (1) (TBD)

This course is designed to apply the concepts being covered in ENGR410. Hands-on lab exercises will be assigned each week within a structured setting. Students will also work in a team to develop a semester-long project. Corequisite ENGR410

ENGR417 Intelligent Systems (3) (TBD)

The course is an advanced course that combines control systems, data analysis, and machine learning. The control part of the course will study state-of-the-art algorithms used for creating and sustaining vehicle formations, and adding a vehicle to or removing a vehicle from a formation. The course will also explore how to analyze vehicle data for the determination of its condition, and for understanding the impact of human driving actions on vehicle performance. And finally, the course will assess the capabilities of machine learning algorithms that can learn how to adapt formations to vehicle inputs from humans. The objective of the course is to educate the students on emerging technologies related to autonomous and (mixed) human-machine navigation of ground, air, and underwater vehicles. Prerequisites ENGR401/ENGR401L and ENGR410/ENGR410L

ENGR455 Discrete Modelling and Simulation (3) (TBD)

Fundamentals and techniques for designing and using simulation, modeling, and optimization algorithms with applications in system performance modeling, business infrastructure modeling, and distributed and parallel computing. An introduction to advanced complex systems models. Prerequisite PHYS272

ENGR470 Capstone Design Project I (3) (F)

This course is the first part of the Capstone Design Project. Students work on a challenging design and implementation project which includes the demonstration of engineering knowledge and problem solving skills acquired in earlier coursework, project planning, oral presentations, report-writing, ethical behavior, and teamwork skills. All team projects are subject to Instructor/Program Director approval. Prerequisite: senior standing in Electrical or Systems Engineering

ENGR471 Capstone Design Project II (3) (S)

This course is the second part of the Capstone Design Project. Students will continue to work on a challenging design and implementation project which includes the demonstration of engineering knowledge, problem solving, project planning, oral presentations, report-writing, ethical behavior, and teamwork skills. All team projects are subject to instructor and program director approval. Prerequisite ENGR470

ENGR486 Applied Systems Design and Industrial Automation (3) (oS)

Students learn to design and integrate mechanical systems, electrical systems, and control systems. The course focuses on systems engineering design and integration process, development of functional, physical, and operational architectures in the context of mechatronic systems. The course emphasizes engineering, functional modeling for design, and formulation and analysis of physical design alternatives followed by actual design and implementation of a mechatronic system that is multidisciplinary in nature, requiring the student teams to learn about various real world systems such as internet communications, navigation, robotics, creating a GUI, and transmitting and receiving data from sensors. Prerequisites ENGR386 and PHYS272

ENGR490 Special Topics in Engineering (1-3) (E,S)

An examination of an area in engineering in which a regular course is not offered. Prerequisite PHYS272 or permission of the instructor with program director approval

ENGR499 Bachelor's Essay (6) (E,S)

Normally taken by students in the Honors Program, and consisting of a two-semester sequence (ENGR499A and ENGR499B). This is an intensive research and writing course for accomplished and motivated upper-level students under the close supervision of a faculty member in the department or program. Students must take the initiative in seeking a faculty member to help in the design and supervision of the project. This is an individual enrollment course, and registration is carried out through consultation with the faculty mentor. Prerequisite: permission of the instructor and department/program director and senior standing

4.3 Honors

HONS157 Honors Physics I (3) (F)

This course is a calculus-based introduction to physics. Topics include mechanics, wave motion, fluids, and heat. Lectures emphasize the application of these topics in interdisciplinary areas. Examples of interdisciplinary applications are forces and torque to biomechanics, fluid dynamics to medicine, and heat and thermodynamics to chemistry. This is the Honors course version of PHYS111; students may not receive credit for both. Prerequisite or Corequisite MATH120 or equivalent or permission of instructor. Corequisite HONS157L

HONS157L Honors Physics I Lab (1) (F)

A project-based laboratory program to accompany the Honors Physics I lecture. In addition to running standard labs, students will design and complete an experiment on one of the course topics. This is the Honors course version of PHYS111L. Students may not receive credit for both. Corequisite HONS157

HONS158 Honors Physics II (3) (S)

A continuation of Honors Physics I. Topics covered are Electricity, Magnetism, Light, Relativity, Atomic Physics, Quantum Physics, and Nuclear Physics. Lectures emphasize the application of these topics in interdisciplinary areas. Examples of interdisciplinary applications are electric potentials in biology and medicine, magnetic field in medicine, or optics and the biology of human vision and possibly visual arts. This is the Honors course version of PHYS112. Students may not receive credit for both. Prerequisites HONS157/HONS157L or PHYS111/PHYS111L, MATH120, or permission of the instructor. Corequisite HONS158L

HONS158L Honors Physics II Lab (3) (S)

A project-based laboratory program to accompany Honors Physics II. In addition to running standard labs, students will design and complete an experiment on one of the course topics. This is the Honors course version of PHYS112L. Students may not receive credit for both. Prerequisites HONS157/HONS157L or PHYS111/PHYS111L, MATH120, or permission of the instructor. Corequisite HONS158

HONS159 Honors Astronomy I (3) (F)

An introduction to astronomy. Topics considered include a brief history of astronomy, coordinates, time, the earth's structure and motion, astronomical instrumentation, the moon, eclipses, comets, meteors, interplanetary medium, stars, star clusters, interstellar matter, galaxies, and cosmology. This is the Honors course version of ASTR129. Students may not receive credit for both. Prerequisite: the course assumes a working knowledge of algebra and trigonometry. Corequisite HONS159L

HONS159L Honors Astronomy I Lab (1) (F)

A laboratory program to accompany Honors Astronomy I. This is the Honors course version of ASTR129L. Students may not receive credit for both. Prerequisite: the course assumes a working knowledge of algebra and trigonometry. Corequisite HONS159

HONS160 Honors Astronomy II (3) (S)

A continuation of HONS159 Honors Astronomy I. This is the Honors course version of ASTR130. Students may not receive credit for both. Prerequisite: HONS159/HONS159L. This course assumes a working knowledge of algebra and trigonometry. Corequisite HONS160L

HONS160L Honors Astronomy II Lab (1) (S)

A laboratory program to accompany Honors Astronomy II. This is the Honors course version of ASTR130L. Students may not receive credit for both. Prerequisites HONS159/159L. This course assumes a working knowledge of algebra and trigonometry. Corequisite HONS160

HONS280 The Physics of Sound and Music (3) (eF)

A multidisciplinary introduction to the science of sound (acoustics) including content from physics and music theory with a few selected topics from biology and psychology. Topics will include mechanical and electronic generation and propagation of sound; perception of sound; the acoustics of vocal and instrumental music; musical elements such as pitch, loudness, and timbre; and musical constructs such as scales, temperament, and harmony.

4.4 Physics

PHYS101 Introductory Physics (3) (F,S)

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. Prerequisites or Corequisite: PHYS101L; 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) (F,S)

A laboratory program to accompany PHYS101. Prerequisite or Corequisite: PHYS101

PHYS102 Introductory Physics (3) (F,S)

A continuation of PHYS101. Subjects covered are: electricity (electric fields, AC and DC circuits); magnetism; optics (geometric and physical); and modern physics. Prerequisite: PHYS101 or PHYS111 or HONS157. Prerequisite or Corequisite: PHYS102L

PHYS102L Introductory Physics Laboratory (1) (F,S)

A laboratory program to accompany PHYS102. Prerequisite or Corequisite PHYS102.

PHYS105 Introduction to Meteorology (3) (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) (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.

PHYS111 General Physics I (3) (F,S)

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. Prerequisite or Corequisite: MATH120 or equivalent or permission of instructor. Students may not receive credit for both PHYS111 and HONS157

PHYS111L General Physics Lab (1) (F,S)

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. Corequisite: PHYS111 or permission of instructor. Students may not receive credit for both PHYS111L and HONS157L

PHYS112 General Physics II (3) (F,S)

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). Prerequisite: PHYS111 or HONS157. Prerequisite or corequisite: MATH220 or equivalent or permission of instructor. Corequisite PHYS112L. Note that 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) (F,S)

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). Corequisite: PHYS112 or permission of instructor. Students may not receive credit for both PHYS112L and HONS158L

PHYS150 Physics of Sound and Music (3) (offered sporadically when sufficient student demand)

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. A working knowledge of high school algebra is assumed.

PHYS203 Physics and Medicine (3) (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 Introduction to Air Pollution (3) (oS)

Sources of air pollution, and the influence of anthropogenic and natural processes on air quality. Topics include 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 permission from the instructor

PHYS215 Synoptic Meteorology (3) (eS)

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) (eF)

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. 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 (3) (F,S)

An introduction to atomic and nuclear physics. Topics include: relativity, atomic theory, x-rays, wave particle duality, and elements of quantum mechanics. Prerequisite: PHYS112 or HONS158. Prerequisite or corequisite: MATH221 or permission of the instructor

PHYS260 NASA Space Mission Design (2) (F,S)

See ASTR260. Corequisite: PHYS260L or PHYS460L.

PHYS260L NASA Space Mission Design Lab (1) (F,S)

See ASTR260L. Corequisite: PHYS260.

PHYS270 Nanotechnology in Medicine (3) (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) (S)

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 offers an avenue for satisfying the prerequisite requirement for several upper-level physics 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. Although there is some double-coverage of topics, we do find that students who take PHYS272 in addition to MATH323 tend to do better in our upper-level courses.

PHYS298 Special Topics (1-3) (offered sporadically)

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 (3) (S)

Newtonian dynamics of particles and rigid bodies, relativistic mechanics, Lagrangian and Hamiltonian mechanics, and waves. Prerequisites: (PHYS112 or HONS158), and (MATH323 or PHYS272) or permission of the instructor

PHYS302 Classical Mechanics II (3) (offered sporadically when sufficient student demand)

A continuation of PHYS301. Prerequisite PHYS301

PHYS305 The Nexus of Business and Meteorology (3) (oS)

Course examines how business in weather-dependent sectors (Insurance, Utilities, Oil/Gas, Agribusiness, Environmental, Shipping, Aviation, Tourism, Construction, Stock Options, Weather Derivatives, Law, Weather Modification/Mitigation, National Defense, Event Planning, etc.) utilize climatological and forecast data to manage risk, people, and logistics. Consumer-driven businesses (retail, restaurants, theaters, etc.) must manage behavior response to weather conditions. Businesses dedicated to weather (forecasting, broadcasting, mitigation, etc.) combine knowledge of business practices and meteorology. Managing climate change will also be addressed. Students learn how to obtain climate/forecast data, assess meteorological impacts to various businesses, and understand the rapid decisions required to manage changing weather. Prerequisites: One of the electives from the METR section of the Business Applications of Weather and Climate minor, One of the electives from the Business section of the Business Applications of Weather and Climate minor, and [MATH120 or MATH250 or (MATH104 and MATH105)] or permission of the instructor.

PHYS320 Intro to Electronics (4) (oF)

Basic principles of electronics and their application to instrumentation for students preparing for research in applied mathematics, medicine, biology, physics, and chemistry. Prerequisite (PHYS102 and MATH120) or PHYS112 or HONS158 or permission of the instructor. Corequisite PHYS320L

PHYS320L Intro to Electronics Laboratory (0) (oF)

Laboratory section to accompany PHYS320. Corequisite PHYS320

PHYS331 Intro to Modern Physics II (3) (offered sporadically when sufficient student demand)

A continuation of PHYS230. Topics include: statistical mechanics, solid state physics, and nuclear physics. Prerequisite PHYS230 or permission of instructor

PHYS340 Photonics (4) (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. Prerequisite PHYS112 or HONS158 or permission of the instructor. Corequisite PHYS340L

PHYS340L Photonics Laboratory (0) (eF)

Laboratory section to accompany PHYS340. Corequisite PHYS340

PHYS350 Energy Production (4) (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. Prerequisites: CHEM111 and (PHYS112 or HONS158 or (PHYS102 and MATH120)) Corequisite PHYS350L

PHYS350L Energy Production Laboratory (0) (oS)

Laboratory to accompany PHYS350. Corequisite PHYS350

PHYS370 Experimental Physics (4) (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 PHYS 225 or permission of the instructor

PHYS381 Internship (1-3) (F,S)

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) (F,S)

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 of the instructor and department chair

PHYS394 Digital Signal and Image Processing with Biomedical Applications (3) (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/PHYS112L or HONS158/HONS158L. Corequisite: PHYS394L

PHYS394L Digital Signal and Image Processing with Biomedical Applications Laboratory (1) 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/PHYS112L or HONS158/HONS158L. Corequisite: PHYS394

PHYS396 Biophysical Modeling of Excitable Cells (3) (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: BIOL111 and (PHYS112 or HONS158) or permission of the instructor

PHYS397 Research Experience Physics/Astronomy (0) (F,S)

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 grade of "S" (satisfactory) or "U" (unsatisfactory) for the course. Prerequisite: Only majors may take a zero credit research course. Permission of the instructor and approval of the department chair.

PHYS399 Tutorial (3) (F,S)

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 Introductory Quantum Mechanics I (3) (F)

An introduction to the principles of quantum mechanics in one, two, and three dimensions. Topics may include the wave function, Schrödinger equation, operators, the hydrogen atom, bra-ket notation, spin, and identical particles. Prerequisites: PHYS230 and (MATH323 or PHYS272) or permission of the instructor

PHYS404 Introductory Quantum Mechanics II (3) (offered sporadically when sufficient student demand)

Further development and applications of the principles of quantum mechanics. Topics may include a more mathematical formulation of quantum theory, perturbation theory, the variational method, electromagnetic radiation, scattering theory, the path integral formulation, and the EPR paradox. Prerequisites: PHYS403 or permission of the instructor

PHYS405 Thermal Physics (3) (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. Prerequisites: PHYS230 and (MATH323 or PHYS272) or permission of the instructor

PHYS407 Introduction to Nuclear Physics (3) (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. Prerequisite: PHYS230 or permission of the instructor

PHYS408 Introduction to Solid State Physics (3) (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. Prerequisites: PHYS230 and (MATH323 or PHYS272) or permission of the instructor

PHYS409 Electromagnetism I (3) (F)

This is an intermediate course in electromagnetism with particular emphasis to electrostatics and magnetostatics. The major topics covered in this course are: electrostatic fields; magnetostatic fields; electric current and Lorentz force law; conductors, capacitors, and dielectric materials; magnetic materials; and electromagnetic induction. Prerequisites: (PHYS112 or HONS158) and (MATH323 or PHYS272) or permission of the instructor.

PHYS410 Electromagnetism II (3) (offered sporadically when sufficient student demand)

This course is a continuation of PHYS409 with particular emphasis given to applications of electrodynamics. The major topics covered in this course are: conservation laws in electrodynamics; electromagnetic waves in vacuum and in matter; retarded potentials and electromagnetic radiation; and relativistic electrodynamics. Prerequisite: PHYS409

PHYS412 Special Topics (1-3) (offered sporadically when sufficient student demand)

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

PHYS415 Fluid Mechanics (3) (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. Prerequisites: MATH323 or PHYS272 or permission of the instructor

PHYS419 Research Seminar (1) (F,S)

This course will normally be conducted in the penultimate semester of the student's time at CofC and consists of successfully preparing and presenting a research proposal. The course is intended to prepare the student for PHYS420. Prerequisite or corequisite: PHYS370 or ASTR377 or permission of the instructor

PHYS420 Senior Research (3) (F,S)

Conducting, writing and presenting the results of the research project proposed in PHYS419. The presentation must be at a scientific forum approved by the research advisor. This course will normally be taken during the student's final semester at CofC. Prerequisites: PHYS419 and permission of the instructor and chair. No credit for both PHYS420 and PHYS499.

PHYS425 Mesoscale Meteorology (3) (eF)

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

PHYS430 General Relativity (3) (eS)

An introduction to Einstein's theory of General Relativity, with a particular emphasis on modern applications and tests. The course begins with a deeper dive into Special Relativity before moving on to learning about curved spacetimes and the applications of General Relativity in modern physics and astrophysics. Prerequisite: PHYS409 and Prerequisite or Corequisite: PHYS301

PHYS457 Satellite Meteorology (3) (eF)

Satellite meteorology is the measurement of the weather by sensors aboard Earth-observing satellites. Topics include satellite orbits and navigation; electromagnetic radiation; instrumentation; image interpretation; atmospheric temperature, winds, clouds, precipitation, and radiation. Prerequisites: (At least one of the following: [PHYS459; PHYS425; PHYS230; PHYS225; PHYS215; PHYS210; PHYS106L (with a grade of C- or better); PHYS105] and at least one of the following: [PHYS102 (with a grade of C- or better); PHYS112; HONS158] and at least one of the following: [MATH220; MATH229]; or permission of the instructor)

PHYS459 Cloud and Precipitation Physics (3) (oF)

Essential elements of the physics associated with the study of clouds and precipitation. Prerequisites: (PHYS112 or HONS158). Prerequisites or corequisites: (MATH323 or PHYS272) or permission of the instructor

PHYS460L NASA Space Mission Design Leadership Lab (1) (E,S)

See ASTR460L. Corequisite PHYS260

PHYS481 Physics Problem Solving (1) (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. Prerequisite PHYS370 or ASTR377

PHYS499 Bachelor's Essay (6)

Normally taken by students in the Honors Program, and consisting of a two-semester sequence (PHYS499A and PHYS499B). This is an intensive research and writing course for accomplished and motivated upper-level students under the close supervision of a faculty member in the department or program. Students must take the initiative in seeking a faculty member to help in the design and supervision of the project. This is an individual enrollment course, and registration is carried out through consultation with the faculty mentor. Prerequisite: PHYS419 or permission of the department chair

5 Our Department – Additional Information

5.1 Department Faculty and Staff

Narayanan “NK” Kuthirummal, Professor and **Chair**, office: RITA 303, phone: 3-7457, email: kuthirum-maln@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: RITA 305, 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: RITA 307, 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.

D.J. Connor, Instructor, office: RITA 316, phone: TBD, email: connordm1@cofc.edu. B.S. University of Wisconsin-Platteville, Ph.D. North Carolina State University. Interests: medical imaging, x-ray optics, and physics education.

P. Chris Fragile, Professor, office: RITA 309, 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.

Yu Gong, Assistant Professor, office: 335 RITA, phone: 3-5781, email: gongy@cofc.edu. B.S. Lanzhou Univ, Ph.D. City University of New York. Interests: Ultrafast science, electron, phonon, and spin dynamics.

Linda Jones, Professor, office: RITA 313, 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: RITA 342, phone: 3-5864, email: laddpa@cofc.edu. B.S. Wofford College. Interests: Computation, Physics Education.

Michael L. Larsen, Associate Professor, office: RITA 317, phone: 3-2128, email: LarsenML@cofc.edu. B.S. and Ph.D. Michigan Technological University. Interests: Microphysics of aerosol particles, clouds, and precipitation.

B. Lee Lindner, Professor, office: RITA 319, phone: 3-8288, email: lindnerb@cofc.edu. B.S. University of Washington, Ph.D. University of Colorado. Interests: Sea breeze, hurricane surge, sea fog, rain chemistry, coastal flooding, synoptic climatology, and hurricane climatology.

Gardner Marshall, Senior Instructor, office: RITA 321, 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: RITA 306, phone: 3-5593

Olufunke Oladimeji, Instructor, office: RITA 312, phone: 3-0730, email: oladimeji00@cofc.edu. B.Eng. Covenant University, M.S. Manchester Metropolitan University. M.S. and Ph.D. Texas Tech University. Interests: Organizational Performance Measurement, System Dynamics, Systematic Literature Reviews, Systems Engineering, Engineering Management, Data Science

Ana Oprisan, Professor, office: RITA 323, 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: RITA 325, phone: 3-0780, email: oprisans@cofc.edu. B.S. 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.

Ashley Pagnotta, Assistant Professor, office: RITA 329, phone: 3-0731, email: pagnotta@cofc.edu. B.A. Texas A&M, M.S., Ph.D. Louisiana State University. Interests: Observational astrophysics of novae, supernovae, and other variable stars.

Laura Penny, Professor, office: 327 RITA, phone: 3-8290, email: pennyl@cofc.edu. B.S. Trinity University, M.S., Ph.D. Georgia State University. Interests: Stellar astronomy, binary star evolution.

Alem Teklu, Professor, office: RITA 331, phone: 3-7187, email: teklua@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: RITA 374, phone: 3-2031, email: truec@cofc.edu. B.S, M.S. Appalachian State University. Interests: Astronomy and optical systems.

Ana Uribe, Instructor, office: RITA 314, phone: 3-8071, 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, Associate Professor, office: RITA 333, 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.

Emeritus Faculty

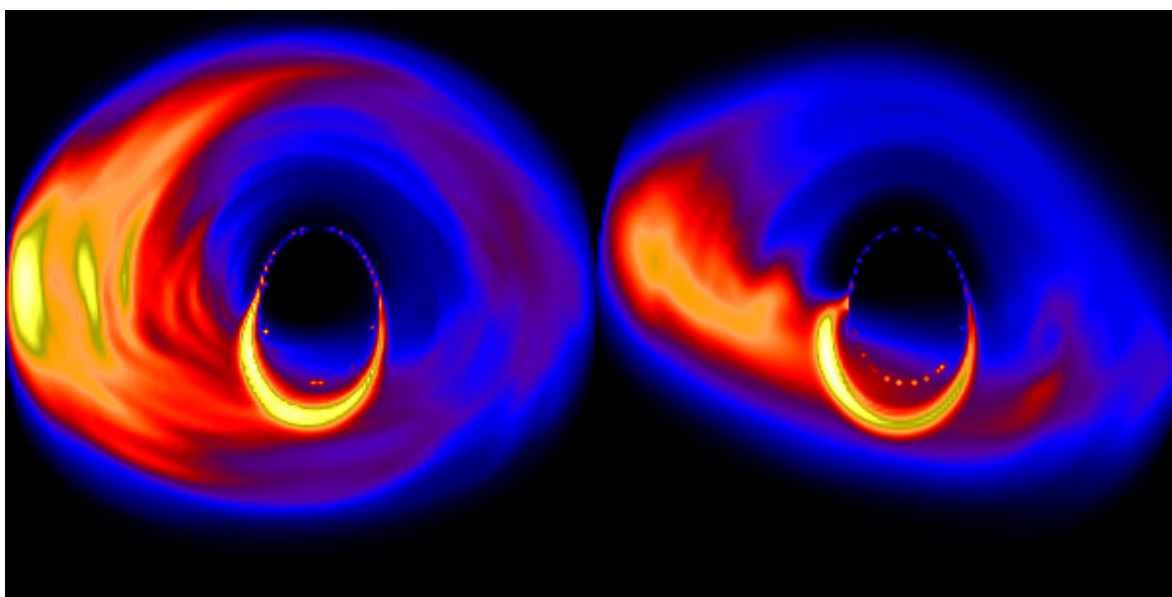
Robert J. Dukes, Jr., Professor Emeritus, email: dukesr@cofc.edu. B.S. Univ. of Arizona, M.S. U. of Texas at El Paso, Ph.D. Univ. of Arizona. Interests: Observational astronomy, automated telescopes, variable stars.

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.

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

Terry Richardson, Senior Instructor Emeritus, email: richardsont@cofc.edu. B.S. Univ. of South Carolina, M.S. Vanderbilt, Ed.S. George Peabody College. Interests: Scientific photography and digital imaging.

Jeff Wragg, Senior Instructor Emeritus, 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.



5.2 Computing Facilities

The Department maintains a computer lab in RITA 326 and a more advanced lab in RITA 369.

The 326 lab is for general student use, including non-majors who are taking physics classes. Some of our computational courses and labs are scheduled in this room. The software on these computers 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.

The 369 lab is primarily used for student computational research. It is built off of the same image as the computers in the 326 lab (and thus has the same base software packages), but these machines have a bit more advanced hardware.

Another lab with hardware and software specifically designed to investigate meteorological phenomena is under development and should be open for student use soon.

The computer labs are primarily under the supervision of Mr. Ladd. Most faculty have their own research spaces, with dedicated computers and other hardware. Speak with individual research faculty for access to those computers.

Other research labs have substantial dedicated computational resources. The College maintains a research-grade parallel Linux computer cluster used heavily by some of the astrophysics faculty. There are also customized systems specifically designed to assist with research tasks in the soft condensed matter lab, the biophysical modeling lab, and the atmospheric microphysics lab just to name a few. You may gain access to these systems if/when you work in a research group that utilizes them.

5.3 Faculty Research Areas

Students and faculty in this department have an extremely broad set of interests. At some point, you'll be looking to link up with a faculty mentor to start doing research for your capstone research experience and/or senior design project. In order to try to find out what individual faculty members specialize in, you may want to check out individual faculty webpages (<https://physics.cofc.edu/faculty-and-staff-listing/index.php>), or just send individual faculty a quick email asking what they're working on these days.

To get you started, here's a rough breakdown of current faculty interests by topic area and investigation modality (though some faculty are willing to venture outside of their comfort zone to work with a student).

- Astrophysics
 - Computational
 - * P. Chris Fragile
 - * Ana Uribe
 - Observational
 - * Joseph Carson
 - * George Chartas
 - * Ashley Pagnotta
 - * Laura Penny
 - * Ana Uribe
- Physics
 - Computational
 - * Joseph Carson
 - * D.J. Connor
 - * P. Chris Fragile
 - * Michael Larsen
 - * Ana Oprisan
 - * Sorinel Oprisan
 - * Gabriel Williams
 - Experimental
 - * Joseph Carson
 - * D.J. Connor
 - * Yu Gong
 - * Linda Jones
 - * NK Kuthirummal
 - * Michael Larsen
 - * Ana Oprisan
 - * Sorinel Oprisan
 - * Alem Teklu
 - Theoretical
 - * Gardner Marshall
- Meteorology/Atmospheric Physics
 - Computational & Operational
 - * B. Lee Lindner
 - * Gabriel Williams
 - Experimental (Lab and Fieldwork)
 - * Michael Larsen
- Systems Engineering
 - * Olufunke Oladimeji

6 Additional Information for Students

6.1 Advising

The programs in our department are complicated and, to help you navigate through the process of getting your degree, you will be assigned an academic advisor from among the department faculty when you declare a major in our department.

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 we find with students going through our programs.

- 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.
- 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 for a few semesters in advance are shown elsewhere 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), 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/>

6.1.1 Developing a Customized Plan to achieve your Goals

Make a plan for your progress towards a degree. Use the worksheets elsewhere in this handbook, 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/>

Earlier in the handbook are listings for expected course offerings for the next several semesters. 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. 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 Introductory Physics (PHYS101/102) 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 (Electromagnetism II). These courses are often part of the standard preparation for grad-school bound Physics and Astrophysics students at other undergraduate institutions, so *if you are planning on heading to graduate school and want to help plug holes in your grad school application portfolios, you should work with your classmates to approach the department chair to get these courses offered!*

One of the best things about our program is that we have a greater diversity of courses you are unlikely to see at other universities – it is pretty rare to have an undergraduate course in Fluid Mechanics, Nuclear Physics, Solid State Physics, or Digital and Signal Processing. However, your professors can only teach so many courses and offering these unusual electives can come at the expense of offering what are normal core courses at other universities. In particular, most grad-school bound Physics students have two semesters of Electrodynamics and Quantum Mechanics. We can offer these courses if sufficient demand is there, but you need to band together to request this at least a semester in advance!

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 PHYS409 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 PHYS301 the spring of your junior year and PHYS409 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 MATH423. Carefully select the physics and other courses that meet your needs. Make sure your senior research is consistent with your goals.

6.1.2 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. There is also a course offered every fall (PHYS481) which is largely devoted to helping you prepare for the Physics GRE. Dr. Larsen has continued to stay informed about the nuances of both the General and Physics GRE and can give you a lot more information about these exams.

It usually isn't necessary to know exactly what you want to do as you enter your final years at CofC. 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.

6.1.3 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^AT_EX, 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).

6.1.4 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 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 is the person to talk with in the School of Education 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.

6.1.5 Jobs with a BA in meteorology

Many of our meteorology students come in with the idea of going into a career in forecasting and then find that the mathematics or other courses are a bit more daunting than they anticipated. The good news is that there are other avenues to a career related to atmospheric science or meteorology that don't have the stringent course expectations necessary to get a job as a forecaster. A comprehensive listing of career paths relevant to meteorology majors can be found at <http://williamsgj.people.cofc.edu/Meteorology/careerguides.pdf>.

6.1.6 General advice for applying for jobs straight out of College

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 PHYS419 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.

6.1.7 Grad School Bound Physicists

There are many sub-fields in physics—solid state physics (often used synonymously with condensed matter physics), atomic physics, molecular physics, optical 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. Larsen is a valuable resource for guidance on graduate school admission, as are other faculty members.

6.1.8 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 interchangeable. A BS degree in Astrophysics gives you a struc-

tured program preparing you for graduate or professional placement in the field.

One piece of good news is that there is a recent trend that fewer graduate programs in Astrophysics require you to take the Physics GRE to get admitted to their programs; some still do, however, so you want to start paying attention to the admission requirements for your preferred graduate programs early enough (prior to the start of your senior year) to know if you need to study and sign up for the Physics GRE.

6.1.9 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/>.

6.1.10 Grad School Bound Atmospheric Scientists

We have programs to prepare you for graduate education in meteorology or atmospheric physics. If you are opting for graduate work in Atmospheric Science or Meteorology, you probably should opt for the B.A. in Meteorology with the Operational Meteorology Concentration, maybe with a little extra coursework depending on what particular topic you plan to pursue in grad school. If you are headed towards Atmospheric Physics in grad school, then the B.S. in Physics with the concentration in Atmospheric Physics is built for you. Either way, apart from our required courses in our programs, you may want to consider courses like 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.

6.2 Departmental 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 the equivalent of 12 semester hours of exceptionally fine work (as evaluated by the faculty mentor(s)) 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.

6.2.1 Monetary Awards

Recently, the College of Charleston adopted an online scholarship awarding system dubbed the "Cougar Scholarship Award System" (CSAS). This platform allows interested students to apply for all privately funded scholarships through a single interface and a single application (that has a single due-date of February 1st). To submit an application for all scholarships that you are eligible for, you need to log into <https://cofc.academicworks.com/>.

Here are some basic details about the scholarships associated with our department that you can apply for through CSAS.

- 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.
- The **J. Fred Watts Scholarship** (\$1000) may be awarded annually to a major who is pursuing teaching certification in physics or astronomy. 8
- 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.
- 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.
- **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.
- **Quattrochi Merit Scholarships** were created by Peter Lawrence Quattrochi and Jane Elizabeth Quattrochi '93, for students at the College of Charleston.

6.3 Doing research in the department

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 are limited 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, PHYS397, and PHYS420, as paid or unpaid research assistants to department faculty, or by participating in external research programs. Research experiences may be available in the summer, during the 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.

There are multiple ways to get paid to participate in CofC summer research experiences; the college has a program called the Summer Undergraduate Research with Faculty (SURF) program (<http://tinyurl.com/cofcsurf>). Additionally, the School of Science and Mathematics has its own summer research award program (<https://ssm.cofc.edu/undergraduate-research/index.php>). A third avenue to obtain funding for summer research is that the Physics and Astronomy department often is able to support one or more students (information about these opportunities will be provided if/when funds are available). Finally, many faculty in the department are funded through external grants that have specific funds earmarked for summer student financial support.

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. 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 CV/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.

6.4 Information about 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 is expected to manage 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.

6.4.1 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

6.4.2 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.

6.4.3 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

6.4.4 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 (if appropriate)
- 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?

6.4.5 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.

6.5 Studying Abroad

Although the College of Charleston takes great pride in its study abroad programs (see <https://international.cofc.edu/>), making this work in the highly technical, structured, and sequenced majors within our department is pretty tricky. In general, you should expect that studying abroad for even a semester is likely to add time to your undergraduate career; courses in other countries seldom line up sufficiently well with our departmental offerings to satisfy our degree requirements. That being said, the advantages to studying abroad

for a semester may be personally and professionally substantial and well worth the additional time added to your undergraduate degree.

In general, if you plan to study abroad while majoring in one of our programs, you should start a dialogue with your departmental advisor at least a semester (better a year) in advance of when you would like to go, and be ready to do a lot of extra leg-work to try to determine in advance if the courses you could take at the international institution could transfer back to CofC. The center for international education can work with you on this front, but you have to be pro-active and flexible to make it work.

6.6 PHYS 419/420/499 Protocols and Expectations

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 and Astronomy 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.

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 (typically discussed in an introduction section), and how will it be investigated (typically discussed in a "methods" section)? 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. Expected Outcome: What will the research produce? Expected minimums include a formal written report, oral presentation (somewhere), and poster presentation (at least in the SSM Poster Session). How will your mentor evaluate your project?
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. If you re-

quire resources not currently at hand, how will they be acquired?

5. Timeline: A list of expected interim tasks and their approximate dates of accomplishment.

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, except in the case of your advisor having their own grant funds, 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/undergraduate-research/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.

Your advisor may base your grade on these and/or other factors—timeliness, diligence, scientific rigor, record keeping, oral presentation, Poster Session presentation, final written report, and attendance at seminars and colloquia.

6.6.1 Proposal Writing 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, captioned, sufficient and well done?
- Approach: Is the approach to the research clear and sufficiently articulated?
- 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?
- Outcomes: A final written report, an oral presentation somewhere, and a poster presentation at least at the SSM Poster Session
- 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?

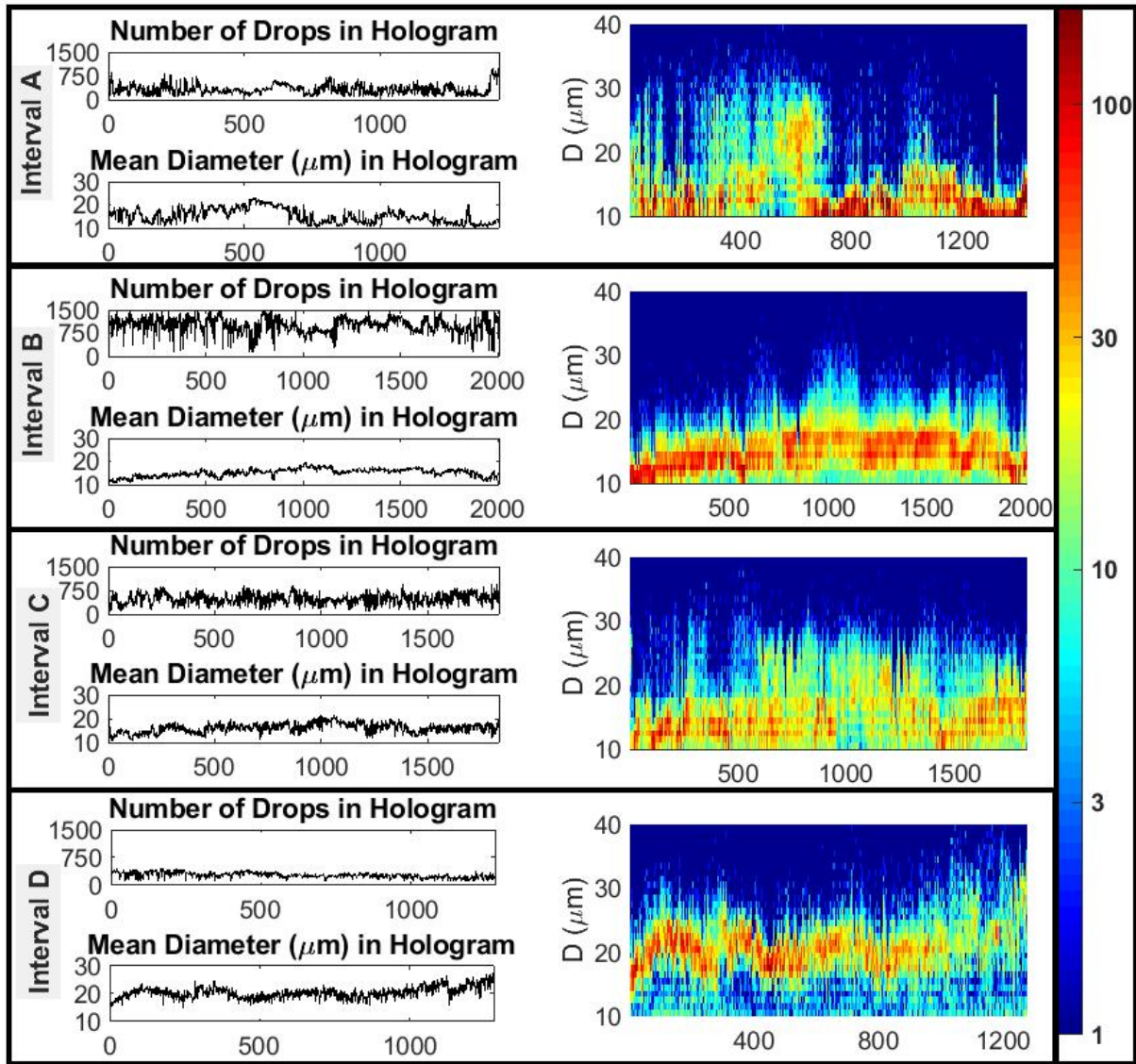
Your capstone research project is expected to be the culmination of your undergraduate education. It is guided by a faculty member, but is independently executed by you. The burden of responsibility is yours, not your advisor's. You must demonstrate a mature approach to this responsibility. You must 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.

6.6.2 Jobs in the Department

The Department has job opportunities for students as teaching assistants, research assistants, and tutors. 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) for TA positions and the department chair (kuthirumaln@cofc.edu) if you may be interested in serving as a departmental tutor for introductory classes. 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.



HOLOGRAM NUMBER