PHYSICS

Faculty: Woolard, Chair; Dominguez, McLeskey, Reisenweaver, and Rodruck. (Department of Physics, Engineering, and Astrophysics)

The mission of the Physics Major at Randolph-Macon College is to provide students with a rigorous education in physics that fosters conceptual understanding, problem-solving ability, communication, and investigative skills. Through coursework, labs, and research, students gain breadth and depth in core areas of physics while also developing computational proficiency essential to modern science. The program emphasizes physics as a mode of inquiry, encouraging students to design experiments, analyze data, and engage with contemporary methods. Students learn to articulate ideas clearly to specialists and the broader community. By cultivating critical thinking, independence, and curiosity, the major prepares students for graduate study, STEM professions, and diverse careers. Ultimately, it nurtures innovative problem solvers, lifelong learners, and engaged citizens who recognize the enduring value of physics as both a foundational science and a liberal art.

The department highly encourages each student to participate in research opportunities outside of their normal course work. PHYS 271-PHYS 274, the College's Schapiro Undergraduate Research Fellowship Program (SURF) and the NSF Research Experience for Undergraduates (REU) are some examples of programs which provide students unique research experiences. Students who successfully complete SURF, REU or other research internship programs may request research proficiency for PHYS 400 and substitute another elective course on the physics major. Review of the student's work and permission of the department is required.

- Physics Major (https://catalog.rmc.edu/programs/physics/physics-major/)
- Physics Minor (https://catalog.rmc.edu/programs/physics/physics-minor/)

PHYS 105 - A Hitchhiker's Guide to Physics (With Apologies to Douglas Adams) (4 Hours)
This course is a one-semester exploration of the physical world, built around the theme of understanding objects and processes that surround us. Topics to be explored may include sound, light, conservation of energy, electricity and magnetism, the relativity of time and space, and the ethics involved in scientific studies. Students will explore these and other ideas, with student interest driving the specific topics covered. Experiment, direct observation, and data analysis will reinforce the conceptual understanding of topics and allow the students to further discover the limits of their application to specific phenomena and devices. Through the preparation of written and oral reports, students will develop skills in the communication of technical themes. Six contact hours each week.
Curriculum: NS,SP

PHYS 110 - Physics of Light (4 Hours)
This course is a one-semester introduction to the physics of light, from a conceptual and historical perspective. The focus of the course is the development of various models of light, including the ray model, the wave model, and the quantum mechanical model. Specific topics include light and shadow, pigments and colors, mirrors, and lenses, optical devices such as telescopes and cameras, and wave-particle duality. This course is highly experiential, and centers on laboratory investigations of light as well as travel to historical locations connected to the development of the theory of light.
Curriculum: EL,NS,SP

PHYS 115 - Navigation (3 Hours)
Throughout history, scientists and explorers set out to learn more about their world, moved by the promise of wealth and curiosity. They ventured into new and exotic regions as advances in navigation permitted more extensive expeditions. This course will explore the science that underpins various navigation techniques - the compass, the stars, GPS.
Curriculum: OC

PHYS 130 - Atmospheres and Weather (3 Hours)
An introduction to planetary atmospheres and weather phenomena, with special emphasis on the Earth. More than just a meteorology study, the course will use atmospheric phenomena elsewhere in the solar system as a way of understanding similar occurrences on the Earth. Climate and weather topics include general circulation, cloud formation processes, the solar energy budget and transport phenomena, global warming, and the interaction between humankind's activities and the earth's weather. Offered alternate years.

PHYS 151 - Introductory Physics (4 Hours)
A two-semester introduction to the basic principles of classical and contemporary physics. Topics include classical mechanics, waves, heat and thermodynamics, electricity and magnetism, optics, and modern physics. The basic ideas and tools of calculus are presented and used as needed. Laboratory investigation, computer modeling, and context-rich problem-solving are emphasized as modes of inquiry into the phenomena being presented. Six contact hours each week. PHYS 151 is a prerequisite for PHYS 152. Students intending to major in physics, chemistry, or computer science, and those intending to participate in the cooperative engineering programs should be enrolled concurrently or previously in MATH 131- MATH 132.
Curriculum: NS,SP

PHYS 152 - Introductory Physics (4 Hours)
A two-semester introduction to the basic principles of classical and contemporary physics. Topics include classical mechanics, waves, heat and thermodynamics, electricity and magnetism, optics, and modern physics. The basic ideas and tools of calculus are presented and used as needed. Laboratory investigation, computer modeling, and context-rich problem-solving are emphasized as modes of inquiry into the phenomena being presented. Six contact hours each week. Students intending to major in physics, chemistry, or computer science, and those intending to participate in the cooperative engineering programs should be enrolled concurrently or previously in MATH 131- MATH 132.
Prerequisite(s): PHYS 151

Curriculum: NS,SP

PHYS 205 - Modern Physics (3 Hours)
Developments in 20th century physics, including the theory of special relativity, black-body radiation, the photoelectric effect, Compton scattering, Rutherford scattering, the Bohr atom, deBroglie waves, wave particle duality, and introductory quantum physics. Students should be enrolled concurrently or previously in MATH 132.
Prerequisite(s): PHYS 152

PHYS 210 - Digital Electronics (4 Hours)
An introduction to the study and applications of digital electronics and microprocessor interfacing. Theoretical presentations are accompanied by laboratory work emphasizing the design of and experimentation with digital circuitry. Six contact hours per week. A special fee ($30) is charged for this course.
Curriculum: NS,SP

PHYS 215 - Analog Electronics (4 Hours)
An introduction to analog circuits. The theoretical basis for the uses of active and passive circuit elements is presented along with applications in power supplies, measurement circuits, and amplifiers. Laboratory work providing hands-on usage of the devices discussed is a key component to the course. Two three-hour class/laboratory sessions per week. Offered alternate years.
Prerequisite(s): PHYS 152 or PHYS 210

PHYS 220 - Quantum Computing (3 Hours)
Quantum computing harnesses the fundamental principles of quantum physics to perform calculations and communications beyond the capabilities of classical computers. This interdisciplinary course introduces the foundational concepts and practical applications of quantum computing, integrating physics, computer science, mathematics, and information theory. Core topics include qubits, superposition, and two-state systems of polarized photons and spin-1/2 particles. Applications covered are quantum entanglement, quantum key distribution, superdense coding, and quantum state teleportation. Students will gain hands-on experience through physics laboratories and by constructing and executing quantum circuits on both simulated and real quantum computers. No prior background in physics or coding is required.
Prerequisite(s): MATH 131 OR MATH 220 OR CSCI 210 OR CSEC 353

PHYS 250 - Mathematical Physics (3 Hours)
An introduction to the application of mathematics to physical systems. Topics included are Taylor and Fourier series, Fourier transforms, generating approximate solutions, and complex variables. Each of these areas of mathematics will be related to applicable systems drawn from physics and chemistry. Numerical techniques on various computers will be employed. The course is designed to be of value to upper-division physics, chemistry, and mathematics majors.
Prerequisite(s): MATH 132

PHYS 271 - Guided Research in Physics (1 Hour)
A guided research course intended to provide interested students an opportunity to do research prior to PHYS 400 or a Senior Project. Students will work with a faculty member to develop and execute a research project. Students will be required to spend at least three hours per week on the research project.
Prerequisite(s): PHYS 151-152 and instructor permission

PHYS 272 - Guided Research in Physics (1 Hour)
A guided research course intended to provide interested students an opportunity to do research prior to PHYS 400 or a Senior Project. Students will work with a faculty member to develop and execute a research project. Students will be required to spend at least three hours per week on the research project.
Prerequisite(s): PHYS 151-152 and instructor permission

PHYS 273 - Guided Research in Physics (1 Hour)
A guided research course intended to provide interested students an opportunity to do research prior to PHYS 400 or a Senior Project. Students will work with a faculty member to develop and execute a research project. Students will be required to spend at least three hours per week on the research project.
Prerequisite(s): PHYS 151-152 and instructor permission

PHYS 274 - Guided Research in Physics (1 Hour)
A guided research course intended to provide interested students an opportunity to do research prior to PHYS 400 or a Senior Project. Students will work with a faculty member to develop and execute a research project. Students will be required to spend at least three hours per week on the research project.
Prerequisite(s): PHYS 151-152 and instructor permission

PHYS 321 - Intermediate Physics Lab (1 Hour)
An introduction to the use of experimental apparatus and modern laboratory techniques. Experiments may involve the use of lasers, optical and magnetic spectrometers, interferometers, photomultipliers, radioactive sources and detectors, and standard laboratory electronics. Student work is directed to the observation of important physical effects and often involves reproducing some of the pivotal experimental results in the development of modern physics. Upon the completion of the assigned experiment, students will be expected to demonstrate through written reports competency with the apparatus and an understanding of the physical phenomena measured.
Prerequisite(s): PHYS 205 or permission of the instructor

PHYS 322 - Advanced Physics Lab (1 Hour)
This course will build upon the skills developed in PHYS 321. Students will continue to work with new and familiar laboratory equipment, keep a record of their experiments in a laboratory notebook, and report their findings in a journal style technical report. Laboratory exercises will become less procedurally descriptive for the students in preparation for PHYS 400.
Prerequisite(s): PHYS 321 or permission of the instructor

Curriculum: CC

PHYS 335 - Continuum Mechanics (3 Hours)
An introduction into the study of three-dimensional objects through the determination of internal conditions caused by external forces. Numerous constitutive equations will be presented that describe properties of the material such as stress, strain, elasticity, plasticity, and fluid flow. Tensor analysis will be introduced and used extensively in the physical description of mechanical deformation.
Prerequisite(s): EPHY 255

Corequisite(s): MATH 203, MATH 307, or permission of the instructor

PHYS 340 - Electricity and Magnetism (3 Hours)
A rigorous treatment of classical electromagnetic theory. Beginning with a review of the calculus of vector fields, these tools are applied to the study of electric and magnetic phenomena. Static electric and magnetic fields are treated, including their interactions with matter. Dynamical effects, including radiation, are derived from the synthesis of Maxwell's Equations.
Prerequisite(s): EPHY 255

PHYS 350 - Computational Physics (3 Hours)
This course encourages the student to think critically and creatively about research questions using computational tools. The student will learn computational methods for simulating physical systems to solve a variety of problems. Students will be introduced to object oriented programming; no prior programming experience is necessary. Topics covered will include numerical solutions to differential equations, simulation and visualization of particle motion, and Monte Carlo simulations of thermal systems. Additional topics may include planetary motion, fractals, numerical integration, and quantum systems. Offered alternate years.
Prerequisite(s): PHYS 152 and MATH 132 or permission of instructor

PHYS 381 - Special Topics in Physics (3 Hours)
These courses focus on areas of physics not specifically covered in the general curriculum and are designed to meet the needs and interests of advanced students in physics.

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These courses focus on areas of physics not specifically covered in the general curriculum and are designed to meet the needs and interests of advanced students in physics.

PHYS 391 - Independent Study (3 Hours)
An independent exploration of a specialized area of physics under the guidance of a member of the department.
Prerequisite(s): permission of the instructor, a cumulative GPA of 3.25 or greater, and approval of the Committee on the Curriculum

PHYS 392 - Independent Study (3 Hours)
An independent exploration of a specialized area of physics under the guidance of a member of the department.
Prerequisite(s): permission of the instructor, a cumulative GPA of 3.25 or greater, and approval of the Committee on the Curriculum

PHYS 400 - Physics Research (3 Hours)
Students select a research topic in a specialized area of physics or astronomy. Projects are student-designed in consultation with a faculty member. A proposal (including a literature review and a research plan) must be submitted to the faculty member no later than the second week of the term in which the research is to be completed. The project will culminate in a formal written report by the end of that term.
Prerequisite(s): PHYS 322 and/or permission of instructor

Curriculum: EL

PHYS 430 - Introductory Quantum Mechanics (3 Hours)
An intermediate formulation of nonrelativistic quantum mechanics using Shroedinger's equation. In particular, the study of finite, infinite, and periodic potential barriers and wells will lead to a description of the hydrogen atom, simple molecules, and solids, and the nucleus at a more sophisticated level than that developed in PHYS 205. Offered alternate years.
Prerequisite(s): EPHY 255 or CHEM 311

PHYS 435 - Optics (3 Hours)
An intermediate course in dynamical electromagnetic systems, including geometric and physical optics. Emphasis will be placed upon the nature of electromagnetic waves and their diffraction and interference. Offered alternate years.
Prerequisite(s): PHYS 340

PHYS 440 - Statistical and Thermal Physics (3 Hours)
A survey of thermal phenomena. Topics include classical thermodynamics temperature, heat, work, energy, entropy; the thermodynamic laws; classical and quantum statistics describing systems of distinguishable and indistinguishable particles. Offered alternate years.
Prerequisite(s): PHYS 152

PHYS 445 - Solid State Physics (3 Hours)
A survey of matter in the solid phase. Fundamentals of crystallography and band structure will be treated along with selections from the topics of superconductivity, ferromagnetism, photovoltaics, amorphous solids, luminescence, and defects. This course is intended primarily for physics majors, although students majoring in chemistry and computer science will find topics relevant to their fields. Offered alternate years.
Prerequisite(s): PHYS 205 or CHEM 311, or permission of instructor

PHYS 450 - Internship in Physics (Unpaid) (3 Hours)
Students in this course are placed in an industrial or research facility and follow an arranged set of readings relevant to their internship experience. Students will be expected to demonstrate through a written report upon completion of the internship an understanding of the physical phenomena used and their applications. Application required; see Internship Program. Offered as needed. A special fee ($200) is charged for this course.
Curriculum: EL

PHYS 455 - Field Study (3 Hours)
A Field Study is an experiential learning course combining elements of workplace experience, observation, and research. Students are expected to work closely with a faculty field study supervisor to develop learning objectives and a plan of study appropriate to the discipline. Assignments may include a reflective journal, activity reports, and one or more directed research papers appropriate to the discipline. Workplace experience requirements should be similar to those of internships. Students should not receive compensation from workplace experience if they are receiving three-hour course credit.

PHYS 457 - Internship in Physics (Paid) (3 Hours)
This course provides an opportunity for students to gain practical experience in the field of physics by using the principles, concepts, and methods covered in physics course offerings. Satisfactory completion of a paid internship requires at a minimum 130 hours (160 recommended) working at the host site, a reflective journal, final written or oral report, and satisfactory evaluation from the site supervisor. A special fee ($400) is charged for this course.
Prerequisite(s): Junior or senior status, an overall minimum Randolph-Macon College GPA of 2.25, and departmental approval

Curriculum: EL

PHYS 481 - Selected Topics in Physics (3 Hours)
A course in seminar or tutorial format which allows the student to study through individual readings, conferences, or laboratory work advanced topics not covered in the normal curriculum. This course is intended for students who have demonstrated ability and a thorough understanding of physics and appropriate mathematics.
Prerequisite(s): permission of instructor

PHYS 482 - Selected Topics in Physics (3 Hours)
A course in seminar or tutorial format which allows the student to study through individual readings, conferences, or laboratory work advanced topics not covered in the normal curriculum. This course is intended for students who have demonstrated ability and a thorough understanding of physics and appropriate mathematics.
Prerequisite(s): permission of instructor

PHYS 491 - Independent Study (3 Hours)
An independent study under the guidance of a member of the department. At least a 3.25 cumulative GPA and approval by the curriculum committee are required.

PHYS 496 - Senior Project (3 Hours)
Extensive work in some area of departmental research interest. Students will be required to show diligence and independence in their chosen study. A departmental faculty member must consent to supervise and review the student's work. A formal paper and an oral examination are required. Student earns a total of six hours for the full senior project experience (496, 497, and 498).
Prerequisite(s): permission of department

Curriculum: CS,EL

PHYS 497 - Senior Project (3 Hours)
Extensive work in some area of departmental research interest. Students will be required to show diligence and independence in their chosen study. A departmental faculty member must consent to supervise and review the student's work. A formal paper and an oral examination are required. Student earns a total of six hours for the full senior project experience (496, 497, and 498).
Prerequisite(s): permission of department

Curriculum: CS,EL

PHYS 498 - Senior Project (3 Hours)
Extensive work in some area of departmental research interest. Students will be required to show diligence and independence in their chosen study. A departmental faculty member must consent to supervise and review the student's work. A formal paper and an oral examination are required. Student earns a total of six hours for the full senior project experience (496, 497, and 498).
Prerequisite(s): permission of department

Curriculum: CS,EL

PHYS 499 - Senior Seminar in Physics (3 Hours)
This course provides a capstone experience for senior physics majors. Students will hear presentations by faculty and other physics professionals, prepare and deliver oral presentations on their own research activities, and gain familiarity with current professional literature in physics. Reading and discussions in the history and philosophy of physics will familiarize students with the larger cultural context in which the discipline has developed.
Prerequisite(s): EPHY 255, PHYS 340, and PHYS 400, or permission of department

Curriculum: CS