Sir Isaac Newton: On the Shoulders of Giants

WCU
WEST CHESTER
UNIVERSITY

Student Handbook For Physics majors

Department of Physics
West Chester University of Pennsylvania

Sir Isaac Newton: On the Shoulders of Giants

Key can be found at:
http://spencertomberg.com/Newton%20descriptions.html

1. Inertia: Newton's First Law of Motion
2. Newton's Second Law
3. Newton's Third Law
4. The Fundamental Theorem of Calculus
5. "Thus 2/0 is double to 1/0 & 0/1 is double to 0/2, for multiply the 2 first & divide the 2ds by 0, & there results 2/1:1/1 &1/1:1/2"
6. The Limit Definition of a Derivative
7. Finite Difference Equations
8. Newton's Method, also called the Newton-Raphson Method.
9. Sine and Cosine Taylor Series Expansion
10. Same as #9
11. Newton's Binomial
12. A vector's statement of Newton's Third Law
13. These equations demonstrate the principal of inertia.
14. The Universal Law of Gravitation
15. The Gravitational Constant
16. Kepler's Third Law --The Law of Periods
17. Kepler's Second Law--The Law of Areas
18. Escape Speed
19. Terminal Speed subject to a Drag Force
20. Hooke's Law
21. Coulomb's Law
22. Bernoulli's Equation
23. Buoyant Force
24. Tension and Compression
25. The Color Wheel
26. Newton's Rings
27. Wave Interference Condition
28. Heat Transfer by Conduction
29. Heat Transfer by Radiation
30. Speed of Sound in a Medium
31. Air pressure in a sound wave

Department of Physics & Engineering

West Chester University of Pennsylvania

Website: http://www.wcupa.edu/sciences-mathematics/physics

Department contact information: Department of Physics & Engineering
127 Merion Science Center
West Chester University
West Chester, PA 19383

Office Manager: Donna Baun

Phone: 610.436.2497

Fax: 610.436.3013

My Academic Advisor: _____

Office Phone Number: _____

Please remember to see your Academic Advisor at least once each semester to review your schedule for the following semester and to have your scheduling flag removed so that you are permitted to schedule your classes. Keep your advisor apprised if the semester is going well or if you are encountering difficulties.

This Handbook does not take the place of the Undergraduate Catalog or the class schedule. And it certainly does not replace face-to-face advisement conducted with Physics professors. You may also derive valuable insights by speaking with other majors in Physics.

Other sources of Academic Policy, Rules and Regulations, Degree Requirements, etc.:

Ram's Eye View
Undergraduate Catalog

These documents can be accessed on-line.

Most Honored and Esteemed Physics Major,

On behalf of the Faculty, staff and the other majors in our three Physics programs, I would like to welcome you to the Department of Physics & Engineering at West Chester University of Pennsylvania. Our Department has a long tradition of excellence. For over 50 years, the Department has been recognized as the home of one of the region's top Physics programs. The alumni of our programs are reminders of our rich history, one that emerges from the Faculty's devotion to educational excellence and its engagement in research at the cutting edge of modern Physics. West Chester University is among the most selective schools in the region (currently with an acceptance rate of 42%), and the Department of Physics & Engineering is more selective still. You have our pledge of support as you undertake the challenges ahead.

Our undergraduate program begins with courses designed to help you build a strong foundation, regardless of your prior background in Physics. Upper division courses deepen your understanding of the basics while introducing more modern and advanced topics. All Physics programs in the Department include a capstone, upper-division sequence of laboratory courses, where you have a singular opportunity among Physics departments nationwide to choose from many different experiments, ranging from classic work that measures fundamental constants of nature to experiments that probe the quantum mechanical properties of matter. In these laboratory courses, you will develop techniques and skills that permit you to critically analyze the experimental uncertainties in your data and present your experimental results professionally in written and in oral formats. We also strongly encourage our majors to participate in current research with Physics faculty or with faculty from other departments.

Our aim is to prepare you for whatever career path you choose – in industry or consulting, teaching at the secondary school level, transitioning to engineering fields or continuing your education in graduate school. We believe that a strong background in Physics is good preparation for whatever lies ahead. To help you develop a program that is appropriate for your goals and to meet the challenges that lie ahead, we encourage you to speak with your advisor often – even before you take your first Physics course here.

We also believe in making the Department a pleasant and productive place for students and the Faculty. As one illustration, we gather for tea weekly at 3 p.m. on Thursdays when classes are in session. As another, we grant access to Merion Hall to our students and to three of the Physics rooms most often used by students. Our Society of Physics Students is a very active group and welcomes your participation.

I wish you continued success as a member of the Department of Physic & Engineering.

Sincerely,

Anthony J. Nicastro, Ph.D.
Professor and Chair
Department of Physics & Engineering

The faculty of Physics & Engineering

Aptowicz, Dr. Kevin B.
Professor
B.S. Electrical Engineering, Columbia University
M.S. Electrical Engineering, University of Colorado
Ph.D. Applied Physics, Yale University

Schmucker Science South 227
610-436-3010
kaptowicz@wcupa.edu

Areas of scholarly interest: Aerosol particle characterization via elastic light scattering; Physics of soft matter, investigating phase transitions with colloidal particles, jamming transitions

Caler, Dr. Michelle A.
Instructor
B.A. Astronomy/Physics, Colgate University
M.S. Physics, the University of Pennsylvania
Ph.D. Physics, the University of Pennsylvania

Merion Science Center 135
610-436-2320
mcaler@wcupa.edu

Areas of scholarly interest: Characterizing QSO absorption line system hosts and neighbors, QSO variability, luminosity function estimates, statistical methods in astrophysics, variable star monitoring

Chen, Dr. Tianran
Associate Professor
B.S. Physics, Zhejiang University, Hangzhou, China
Ph. D. Physics, University of Minnesota, Minneapolis

Merion Science Center 128
610-436-3563
tchen@wcupa.edu

Areas of scholarly interest: Computational materials physics; theory in nanocrystal assemblies, superconducting grains and topological insulators

Huang, Dr. Zhongping
Professor
B.S. Energy Engineering, Zhejiang University, Hangzhou, China
M.S. Energy Engineering, Zhejiang University, Hangzhou, China
Ph.D. Mechanical Engineering, University of Kentucky

Merion Science Center 130
610-436-6932
Zhuang2@wcupa.edu

Areas of scholarly interest: Artificial Organs, Hemodialysis, Cryobiology, Lyophilization and Freeze Drying, HVAC and Cryogenics.

Kandalam, Dr. Anil K.
Associate Professor
B.S. Physics, Osmania University, Hyderabad, India
M.S. Physics, University of Hyderabad, Hyderabad, India
Ph. D. Physics, Michigan Technological University

Schmucker Science South 403A
610-738-0596
akandalam@wcupa.edu

Areas of scholarly interest: Computational materials physics; investigating bare and supported nanoclusters/nanoparticles; novel cluster-assembled materials, nano-bio hybrid systems, and catalytic activity of metal-based nanoparticles.

Mitchell, Dr. Brandon J.
Assistant Professor
B.A. Adolescence Ed., SUNY Fredonia
M.S. Physics, Lehigh University
Ph.D. Physics, Lehigh University

Schmucker Science South 402A
610-436-3387
bmitchell@wcupa.edu

Areas of scholarly interest: Epitaxial growth of III-Nitrides and their material and structural properties; Energy-transfer mechanisms of defect centers in gallium nitride (GaN); Rare-earth doping of GaN for optoelectronic (LED) and spintronic applications, which involves the characterization of their optical, electrical and magnetic properties

Morrison, Dr. Ian A.
Assistant Professor
A.B. Physics/Astronomy, Bowdoin College
M.A. Physics, UCSB
Ph.D. Physics, University of California Santa Barbara

Merion Science Center 132
610-436-3297
imorrison@wcupa.edu

Areas of scholarly interest: High-energy theoretical physics, including classical and quantum gravity, AdS/CFT, early-universe cosmology, conformal field theory, quantum field theory in curved spacetime, and quantum entanglement

Nicastro, Dr. Anthony J.
Professor and Chairman of the Department
B.S. Physics, University of Delaware
B.S. Mathematics, University of Delaware
M.S. Astrophysics, University of Delaware
Ph. D. Physics, University of Delaware

Merion Science Center 108
610-436-2540
anicastro@wcupa.edu

Areas of scholarly interest: Physics of liquid crystals investigating order-disorder phase transitions; Theoretical and experimental biophysics, long-term survival of genetic material, biomechanics, astrobiology

Placone, Dr. Jesse K.
Assistant Professor
B.S. Biomedical Engineering, Johns Hopkins University
Ph.D. Materials Science and Engineering, Johns Hopkins University

Merion Science Center 103
jplacone@wcupa.edu

Area of scholarly interest: Biomaterials, 3D printing, Cell and Tissue engineering. Focuses on the development, functionalization, and characterization of 3D printed materials for tissue engineering applications; interrogates cell-cell and cell-substrate interactions to provide well characterized systems for investigating cancer metastasis to bone.

Pfeil, Dr. Shawn
Associate Professor
B.S. Physics, University of California San Diego
M.A. Physics, University of California Santa Barbara
Ph.D. Physics, University of California Santa Barbara

Schmucker Science South 229
610-430-4084
spfeil@wcupa.edu

Areas of scholarly interest: Biomedical physics, device physics, protein folding, microfluidics, nanophotonics, fluorescence spectroscopy, single-molecule spectroscopy

Sudol, Dr. Jeffrey J.
Associate Professor
B.S. Physics, Macalester College
Ph.D. Physics, University of Wyoming

Merion Science Center 130
610-436-2572
jsudol@wcupa.edu

Areas of scholarly interest: Solar Physics, investigating magnetic field changes during solar flares, dynamics of the early evolution of planetary systems

Thornton, Dr. Robert J.
Professor
B.S. Physics, Lehigh University
B.S. Mechanical Engineering, Lehigh University
Ph.D. Astronomy, University of Hawaii

Merion Science Center 129
610-436-2614
rthornton@wcupa.edu

Areas of scholarly interest: Image analysis, design and engineering of cryogenic microwave detectors

Waite, Dr. Matthew M.
Associate Professor
B.S. Physics, Gettysburg College
Ph.D. Physics, University of Delaware

Merion Science Center 133
610-436-2573
mwaite@wcupa.edu

Areas of scholarly interest: Surface science and materials science, investigating thin film growth and characterization, spintronics applications, production of nanoparticles

The Department of Physics & Engineering

All educational and administrative functions of the Department of Physics and Engineering are housed in the Merion-Schmucker complex of buildings. The majority of the Department's courses are offered in classrooms and laboratories within this complex, and all the Faculty's research laboratories are located in the complex, though Physics professors have been involved in research projects that have taken them and their students to other universities and to places as far away as Japan and Chile.

The Department offers undergraduates a broad and thorough understanding of the fundamentals of Physics. The educational emphasis of the Department is to provide a balance between theoretical and applied Physics. Though the minimum requirements for each degree program is specified in the sample curricula found in this Handbook, you may take Physics, Mathematics or other science courses in addition to the courses required by the University, the College of the Sciences and Mathematics and your major in the Department. The University also offers an Honors Program, and Physics majors have been invited to join that program in the past and have found it to be a rewarding experience. Students with a strong interest in another field have the option of declaring a double major. Many students choose to supplement their classroom experience with research. Both volunteer and some paid positions do exist in individual groups in Physics. If you have an interest in conducting supervised research, please speak with the faculty member whose project interests you; the research specialties of the Faculty are listed in this Handbook.

Students whose academic focus is in another field but wish to engage in further study in Physics have the option of declaring a minor in Physics. The minor consists of 19 credit hours; details of specific requirements can also be found in this Handbook as well as the Undergraduate Catalog.

Expectations of Academic Integrity

Students in all Physics programs are expected to adhere to the highest professional ethical standards for academic integrity and conduct. If you are in any doubt as to whether a particular action or submission engenders an ethical issue, do not hesitate to consult with your course instructor, research supervisor, or any of the Faculty of Physics. Please also consult the University's policies on student academic integrity which can be found in the Undergraduate catalog and the WCU Student Handbook.

Research Opportunities for Students

Members of the Faculty of Physics hold the doctoral degree and most are actively engaged in research; their areas of research are indicated above. Their works are nationally and internationally recognized with publications in prestigious journals. Undergraduates interested in participating in research activities are encouraged to speak with faculty members directly, asking whether their current projects can involve a student. If circumstances permit, undergraduate research can be undertaken for course credit as PHY 490 Introduction to Research. This course may be taken multiple times and can provide from 1 to 9 credits. Permissions of the faculty

member and the Department Chair are required. Generally, a minimum cumulative GPA of 2.75 is required to undertake research with a faculty member.

Scholarships/Awards

The Robert M. Brown Endowed Scholarship for Physics was established in 1997 by Mr. Robert M. Brown. Partial tuition scholarships are awarded annually on a competitive basis to students in the physics program.

In addition, the Dr. Michael F. Martens Award, established by the West Chester Lions Club, is given annually to students who have shown outstanding achievement in Physics. Awards are determined by the department's faculty. Other awards include the Benjamin Faber Award in Physics and mathematics, the Diane and Roger Casagrande Scholarship for students in pre-engineering or communication studies and the Russell K. Rickert Award for Research Excellence. In addition to these, the Physics/Philosophy Prize is awarded to a student who has made a notable contribution on a topic related to the interface of science and theology. These awards are granted annually at an induction ceremony for new members of the West Chester University Chapter of Sigma Pi Sigma, the national Physics honor society.

Undergraduate Degree Programs in Physics

The Department of Physics & Engineering offers three undergraduate degree programs:

1. The B.S. in PHYSICS is designed as preparation for graduate school or careers in government or industry. The curriculum includes a strong foundation in physics, mathematics and the humanities. Courses in the curriculum also develop communication skills and include a strong element of laboratory work that develops technical and analytical skills. A wide choice of electives in the program provides the flexibility to develop a minor in a related area of interest.

2. The B.S. in EDUCATION in PHYSICS provides a solid background in physics, mathematics, and related sciences for a teaching career at the secondary level and leads to certification to teach physics in the public schools of Pennsylvania.

3. The B.S. in PHYSICS/B.S. in ENGINEERING is a cooperative, dual-degree, five-year engineering program with The Pennsylvania State University at University Park, Case Western Reserve University, Columbia University, or with Thomas Jefferson University. In these programs, a student spends three years at West Chester University and two at one of our affiliated universities and earns two degrees, a B.S. in Physics from West Chester University and a B.S. in the engineering field taken at the affiliated university.

For admission to the Physics program, most students should have completed, in addition to the general University requirements, one year each of high school chemistry and physics, and a minimum of three years of mathematics, including algebra and trigonometry, and be prepared to start calculus. Any student with a deficiency must complete WRT 120 and MAT 161 with grades of C- or better to be admitted to the program.

The Physics programs can also be found on the Internet:

http://www.wcupa.edu/sciences-mathematics/physics/

BACHELOR OF SCIENCE - PHYSICS

120 semester hours

1. General education requirements, see **pages 89-127** of the Under-graduate Catalog (48 semester hours).
2. Physics courses (44 semester hours)
   PHY 170, 175, 180, 240, 300, 310, 320, 350, 370, 420, and 430; an additional nine credits in physics must be chosen from available electives at or above the 300 level
3. Mathematics courses (18 semester hours)
   MAT 161*, 162, 261, 311, and 343
   *Also fulfills general education requirement.
4. Chemistry courses (8 semester hours)
   CHE 103* and 104; **CRL** 103* and 104
   *Also fulfills general education requirement.
5. Free electives (17 semester hours)

Students must maintain a GPA of 2.0 or greater in their physics courses. Transfer students must take 15 or more physics credits at West Chester at the 300 level and above for graduation.

BACHELOR OF SCIENCE IN EDUCATION - PHYSICS

120 semester hours

1. General education requirements, see **pages 89-127** of the Under-graduate Catalog (48 semester hours).
2. Physics concentration requirements (52 semester hours)
   a. Physics: **PHY** 170, 180, 240, 300, 310, 320, 330, and 410 or 430
   b. Mathematics: **MAT** 161*, 162, 261, and **MAT** 343 or PHY 370
   c. Sciences: **CHE** 103* and 104; **CRL** 103* and 104; **SCB** 350; and an elective in **astronomy***, **biology***, and **computer science***

   *Also fulfills general education requirement.
3. Professional education requirements, (33-36 semester hours) see page 145
4. Electives (5 semester hours)

Students must maintain a GPA of 2.0 or greater in their physics courses. Transfer students must take nine or more physics credits at West Chester at the 300 level and above for graduation.

COOPERATIVE PHYSICS/ENGINEERING PROGRAM

The Department of Physics offers multiple 3+2 Physics-Engineering Programs. These are dual-degree programs in which a student typically spends three years at West Chester and two years at one of our partner institutions, after which a student holds a B.S. in Physics from West Chester University and a bachelor's degree in engineering from the partner institution. Currently, WCU has agreements with Penn State University (main campus), Thomas Jefferson University, Columbia University, and Case Western Reserve University.

Admission to one of the affiliate engineering institutions is contingent, among other things, upon a recommendation from the Department of Physics and the student having maintained the overall average for the specific engineering program. Check with an advisor in Physics for updates on program availability, course and GPA requirements.

Requirements:

1. General education requirements, see **pages 89-127** of the Undergraduate Catalog. (48 semester hours)

2. Physics
   PHY 170, 175, 180, 240, 260, 300, 310, 320, and BME 120; an additional nine credits in physics at or above the 300 level must be chosen, depending on the engineering area selected

3. Mathematics
   CSC 141*; **MAT** 161*, 162, 261, and 343
   *Also fulfills general education requirement.

4. Chemistry
   CHE 103* and 104; **CRL** 103* and 104
   *Also fulfills general education requirement.

Minor in Physics (19 semester hours)

The program can be used as technical preparation to complement work in other scientific or nonscientific areas, e.g., business majors interested in careers in technologically oriented industries, majors interested in technical or scientific sales, English majors interested in technical writing, or social science majors interested in the area of energy and the environment.

Required: PHY 170 and 180; also PHY 240. In addition, students must select eight credits of physics courses at the 300 level or above, chosen under advisement with the Department of Physics. Transfer students must take a minimum of six credits at West Chester at the 300 level or above. A 2.0 GPA or better must be maintained in all physics courses.

Pre-Medical Program for Physics Students

A student in any major may apply to the Pre-Medical Program, including Physics. Students interested in pursuing admission to medical school or other health professional schools should consider applying to the Program in addition to pursuing their degree in Physics. The Pre-Medical Program prepares students for applying to health professional school in medicine, in medical physics and for careers in research in medicine. Supervised by a Pre-Medical Committee, the program consists of an individualized selection of course work, personal counseling, academic support and optional junior-year medical research at a medical school or research institute. Students in the program are expected to maintain the high standards of performance necessary for health professional school admission. Pursuing jointly the B.S. in Physics and preparing for admission to medical school will require more than the 120 credits of the B.S. Physics alone.

Students who are interested in careers in medical physics are also encouraged to avail themselves of the services offered by the Pre-Medical Program office. Generally, students complete a B.S. in Physics and then go on to graduate work in a masters-level program in Medical Physics lasting two years. Such a program meets the academic and career interests of technically prepared college graduates who seek to combine their interests in graduate physics with growing career opportunities in the field of medicine. The practice of modern medical physics requires highly educated and well-trained problem solvers to aid in development, implementation and on-going maintenance of highly technical clinical equipment.

For additional information or to apply, contact the Pre-Medical Program office, Room 117 Schmucker South, 610.436.2978.

Department of Physics & Engineering

ADVISING POLICIES, PROCEDURES AND PRACTICES

The Department of Physics & Engineering embraces the concept that effective academic advising is a collaborative process between the student and the faculty advisor. The Department believes that effective advising should assist students in achieving their academic, professional and personal goals. Faculty advisors strive to provide accurate and timely information that can serve as the basis for students making decisions regarding their academic program of study. The effectiveness of academic advising is contingent upon individual students taking ownership and responsibility for their educational and career goals by assuming an active role in the classroom and apprising themselves of the policies and requirements for graduation. The Department is responsible for providing a supportive environment where students receive quality academic advising, and, when circumstances warrant, be referred to other campus resources that will provide students assistance to help students succeed.

Academic advising in Physics programs

Academic advising is a critical component for the successful completion of any of the Physics degree programs. The academic advisor's role is to insure that the requirements for the major are clearly delineated on the student's program of study and apprised of potential logistical issues. The advising sheet for the student's program of study is an important reference document in this connection. The advisor also serves as a consultant for the student as the academic plan is prepared and executed, serves as a source of information about University academic policies and procedures, and serves as a resource to discuss and investigate options available to the students after graduation. Though the academic advisor serves as a source of information and advice, ultimately it is the student's responsibility to ensure that all programmatic requirements for the degree are met. With the student's active involvement in the advising process, the student is empowered to make informed decisions about their program of study and their academic plan.

Responsibilities of the academic advisor:

- Assist students as they develop their academic program of study by exploring their individual interests, abilities and goals, by aiding students in the formulation of an academic plan and by counseling students in the selection and sequencing of courses that meet their degree requirements. The advisor will give each student an advising sheet appropriate for the program in which the student is enrolled.

- Identify University resources that may be of value to students and make appropriate referrals.

- Apprise students of relevant University policies if changes to a student's academic plan are contemplated.

Responsibilities of the student:

- Schedule meetings with the academic advisor at appropriate times during the semester. These include discussions regarding a coming semester's course selections and apprising the academic advisor as to academic progress during the semester.
- Be aware of pre-requisites for courses to be taken.
- Be aware of important, relevant deadlines and then meet them.
- In processing required forms, obtain required signatures.
- Review University policies and procedures as needed.
- Develop and clarify the values and goals that impact academic decisions and communicate them effectively to the academic advisor.
- Monitor progress and, if necessary, modify the academic plan for future semesters.
- Understand the requirements for the major (and minor, if applicable).
- Understand the general education requirements
- Have knowledge of the Undergraduate Catalog and the information contained in the Undergraduate Course Schedule.
- Examine the academic record for accuracy on a regular basis and monitor progress towards completion of the degree.
- Save all academic advising, course registration information and grade reports.
- Seek advisement prior to taking a course at some other institution and provide official transcripts for courses taken elsewhere.
- Recognize the need for resources when circumstances warrant and use them.

Academic Coordinator

The scheduling and some advising needs of first-year physics majors are served by professional staff, and Academic Coordinator (AC). The Academic Coordinator for Physics majors is Ms. Jessica McMahan, whose office is Room 121B of Anderson Hall. The AC is an expert in university systems and structures, and will be very useful when needing assistance in navigating them, including (a) the technical process of scheduling and registering for classes, (b) seeking information about various campus offices, (c) negotiating university policies related to academic and other areas, including general education, degree, and other university requirements, and (d) seeking additional support or access to faculty advisors as needed. The Academic Coordinator works with your assigned Faulty Advisor and your Department Chair to coordinate support for you, especially during your first year at West Chester University.

Ms. Jessica McMahan
Anderson 121B
610-436-1733
jmcmahan@wcupa.edu
http://meetme.so/JessicaMcMahan
Monday-Friday 10:00am-6:00pm (by appointment)
Drop-in hours: Wednesdays 3:00-5:00pm

The Academic Plan

The foundation of a student's academic plan is the advising sheet apropos to the Physics program being followed by the student. The academic advising sheet should frequently be reviewed in its totality and from this a general plan should be developed in which the student identifies the courses needed to complete all degree requirements and minor requirements over the remaining semesters of study. This plan should be shared with the academic advisor for comments and suggestions. The plan will likely be tentative and based upon course availability, the possible need to repeat courses, and other unforeseen circumstances. Students should create the plan in writing and update their plan every semester.

Completing the Academic Advising Sheet

The Academic Advising Sheet represents one of the most important tools for a student to monitor progress towards a degree. It identifies both met and unmet requirements and needs to be updated every semester. This document must be brought to every advising session. As a student creates an academic plan, the student needs to determine where a particular course fits on the advising sheet and plan accordingly.

Courses on the advising sheet fall into three general categories:

1. Specifically identified courses such as PHY 170 or CHE 103. When a course is specifically identified, that course alone satisfies the program requirements, unless a substitution or waiver is petitioned and approved by the Department.

2. Named courses with the course number unspecified. WRT 2XX indicates that a 200-level WRT course must be taken. SPK or PHY without a specific number indicates that an elective with those prefixes must be taken.

3. Unspecified distribution requirement courses. The advising sheet contains entries that indicate that, for example, any Behavioral and Social Science course needs to be taken. The Undergraduate Catalog specifies which courses fall into the various categories of the University's general education requirements.

In addition, advising sheets inform students of special requirements particular to the program and the Department.

Advisors and advisees should regularly monitor progress towards the completion of a degree via the degree audit tool.

Department of Physics & Engineering: Advising Structure

Prior to matriculation, each student is scheduled for an advising session with the Chair of the Department who insures that the Fall semester schedule is appropriate. The Chair also counsels the new students regarding strategies for success and cautions them about the likely pitfalls to avoid. The Chair also apprises them of their responsibilities in future meetings with their academic advisor, and gives them a copy of the Student Handbook which includes the advising sheet for the student's program of study. The Department Chair also mentions that the student will be assigned a permanent advisor, and gives the name of the advisor.

Currently, the advising structure in Physics is:

Pre-matriculation	**A. J. Nicastro**
B.S. Ed. Physics majors and post-baccalaureate teaching certification students:	**J. J. Sudol**
B.S. Physics majors:	**M. A. Caler** **T. Chen** **A. K. Kandalam** **I. A. Morrison** **S. Pfeil** **M. M. Waite** **J. J. Sudol**
B.S. Physics/Engineering dual-degree majors:	**K. B. Aptowicz** **B.J. Mitchell** **R. J. Thornton**

The following pages list the requirements for each of the three Physics programs. You should use the appropriate sections to plan and record your academic progress. The ultimate responsibility for constructing each semester's schedule is the student's. For University policy information and degree requirements, refer to the WCU Undergraduate Catalog for the year you entered the University. This is your contract with the University and specifies your General Education requirements, provided you maintain full-time status as a student. You may review your requirements with your Academic Advisor. Students are expected to utilize campus e-mail.

Every semester a Scheduling Flag is placed on your account. This Flag generates a 'hold' that prevents you from scheduling until you meet with your Academic Advisor; your advisor removes the flag. This system is designed to assist your selection of the most appropriate coursework to meet graduation requirements in a timely fashion.

SOCIETY OF PHYSICS STUDENTS

blue

Department of Physics &Engineering
West Chester University of Pennsylvania

B.S. Physics Curriculum – Schedule for Graduate School Track & Applied Track
Last Updated: June 17, 2019

Semester 1

FYE	First Year Experience	4
MAT 161	Calculus I	4
WRT 120	Effective Writing I	3
	Gen Ed / Free Elective	3
	Gen Ed / Free Elective	3
	Total Credits	**17**

Semester 2

PHY 170	Physics I	4
MAT 162	Calculus II	4
WRT 2XX	Effective Writing II	3
	Gen Ed / Free Elective	3
	Total Credits	**14**

Semester 3

PHY 180	Physics II	4
MAT 261	Calculus III	4
MAT 321	Linear Algebra	3
	Gen Ed / Free Elective	3
	Total Credits	**14**

Semester 4

PHY 240	Intro. to Modern Physics	3
MAT 343	Differential Equations	3
PHY 175	Computational Physics	3
	Gen Ed / Free Elective	3
	Gen Ed / Free Elective	3
	Total Credits	**15**

Semester 5

PHY 300	Mechanics	3
PHY 370	Mathematical Physics	3
PHY 420	Quantum Mechanics	3
CHE 103	General Chemistry I	3
CRL 103	Exper. Gen. Chem. I	1
	Gen Ed / Free Elective	1
	Total Credits	**14**

Semester 6

PHY XXX	Physics Elective	3
PHY 350	Thermodynamics	3
CHE 104	General Chemistry II	3
CRL 104	Exper. Gen. Chem. II	1
	Gen Ed / Free Elective	3
	Gen Ed / Free Elective	3
	Total Credits	**16**

Semester 7

PHY 430	Electricity & Magnetism I	3
PHY 310	Intermediate Physics Lab I	3
PHY XXX	Physics Elective	3
	Gen Ed / Free Elective	3
	Gen Ed / Free Elective	3
	Total Credits	**15**

Semester 8

PHY 320	Intermediate Physics Lab II	3
PHY XXX	Physics Elective	3
	Gen Ed / Free Elective	3
	Gen Ed / Free Elective	3
	Gen Ed / Free Elective	3
	Total Credits	**15**

All students must take:

PHY 170, PHY 180, PHY 175, PHY 240, PHY 300, PHY 310, PHY 320, PHY 350, PHY 370, PHY 420, PHY 430

Recommended PHY XXX electives for students in the graduate school track: PHY 425 (QM-II) and PHY 435 (E&M-II)

Recommended PHY XXX electives for students in the applied track: PHY 330 (Electronics), PHY 410 (Optics)

Total number of credits in B.S. Physics Program = 120

A. Majors shall not be permitted more than one repeat of a Physics course.
B. Upper level courses (numbered 300 or above) must be completed with a grade of C or better.
C. All Physics electives must be at the 300 level or above.

goldenrod

Department of Physics & Engineering
West Chester University of Pennsylvania

Cooperative Physics-Engineering Dual-Degree Programs
Tentative curriculum for students entering in Fall 2019
Last modified June 17, 2019

B.S. Physics, West Chester University and B.S. Engineering,
from Case Western Reserve University, Columbia University,
Pennsylvania State University or Philadelphia/Thomas Jefferson University

Semester 1

MAT 161	Calculus I	4	M
ECO 111	Princ. Of Econ. (Macro)	3	SS
WRT 120	Effective Writing I	3	E
Gen Ed.	Arts Gen Ed	3	A
Gen Ed.	First Year Experience	4	G
	Total Credits	17	

Semester 2

MAT 162	Calculus II	4	
PHY 170	Physics I	4	
WRT 2XX[1]	Effective Writing II	3	E
Gen Ed.	Humanities Gen Ed. [1]	3	H
BME 120	Intro CAE	3	
	Total Credits	17	

Semester 3

MAT 261	Calculus III	4	
PHY 180	Physics II	4	
BME 220	Statics	3	
CHE 103	General Chemistry I	3	S
CRL 103	Exper. Gen. Chem. I	1	
	Total Credits	15	

Semester 4

MAT 315	Diff. Eq. & Linear Alg	3	
PHY 240	Intro. to Modern Physics	3	
Gen Ed.	Interdisciplinary	3	I
CHE 104	General Chemistry II	3	
CRL 104	Exper. Gen. Chem. II	1	
PHY 175	Computational Physics	3	
	Total Credits	16	

Semester 5

PHY 300	Mechanics	3	
PHY 310	Inter. Physics Lab I	3	WE, SE
PHY	Physics Elective[1]	3	
Gen Ed.	Diverse Communities	3	J
Gen Ed.	PHY180	3	H/E T
Gen Ed.	Science Gen. Ed.	3	S
	Total Credits	18	

Semester 6

PHY 320	Inter. Physics Lab II	3	WE, SE, Cap
PHY	Physics Elective[1]	3	
PHY	Physics Elective[1]	3	
	3-2 Elective Course[1]	3	H
	3-2 Elective Course[1]	3	SS
	Total Credits	15	

[1] Courses should be selected to fulfill program specific requirements. See appendix.

See Appendix for course specific recommendations.

WCU Physics Degree Requirements:

- Majors will not be permitted to repeat any physics course more than once.
- Upper level courses (numbered 300 or above) must be completed with a grade of C (2.0) or higher.
- All Physics electives must be numbered above 300. Speak with your advisor about the appropriate elective for your engineering discipline.

Additional information for students matriculating to **Case Western Reserve University**:

- Available majors are Biomedical Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Macromolecular Science, Materials Science, Mechanical and Aerospace Engineering, and Systems & Control Engineering.
- The minimum cumulative grade point average is a 3.0. Note: you must also have a cumulative GPA of 3.0 in your math and science classes.
- Complete a minimum of 90 credits hours at WCU.

Additional information for students matriculating to **Columbia University**:

- Available majors are Applied Mathematics, Applied Physics, Biomedical Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Computer Science, Earth and Environmental Engineering, Electrical Engineering, Engineering Mechanics, Engineering and Management Systems, Industrial Engineering, Material Science and Engineering, and Mechanical Engineering, and Operations Research.

To be competitive in the application process:

- The required minimum cumulative grade point average is a 3.30.
- A minimum grade of B (3.0) must be obtained on the first attempt in all science and mathematics prerequisite coursework (e.g. MAT 161, 162, 262, PHY 170, 180, CHE 103, and CSC 141).
- Online courses will not be accepted in the matriculation process.

Additional information for students matriculating to **Pennsylvania State University**:

- Available majors are Biological Engineering, Electrical Engineering, Energy Engineering, Engineering Science, Environmental Systems Engineering, General Engineering, Material Science and Engineering, and Mining Engineering. Other majors are <u>not</u> available.
- The required minimum cumulative grade point average is a 3.00. Original grades for courses that were repeated should be used in the calculation.
- A minimum grade of "C" (2.00) in MAT 161, MAT 162, PHY 170, and CHE 103 is required. These courses must be taken at WCU.
- The degree program with Penn State must be completed within three years and is not available to transfer students.

Additional information for students matriculating to **Philadelphia/Jefferson University**:

- Available majors Mechanical Engineering and (General) Engineering with concentrations in Architectural Engineering, Industrial and Systems Engineering, Composites Engineering and Textile Engineering.
- The required minimum cumulative grade point average is a 3.00. Original grades for courses that were repeated should be used in the calculation.

Appendix for Cooperative Physics-Engineering Dual-Degree Programs advising sheet

Course recommendations for students matriculating to **Case Western Reserve University**:

- Students are encouraged to take PHY370 as a physics elective.
- Each specific engineering major has unique additional **recommended** courses. Students should consult the website for the Dual Degree Program at Case Western pertaining to their major of interest for other recommended course. Note: If these courses cannot be fulfilled, they will be integrated into the curriculum, which may possibly extend the program timeline.

Course recommendations for students matriculating to **Columbia University**:

- Students should consult the document titled *The Combined Plan Program at Columbia University* for information about foundational and major-specific prerequisite coursework that must be completed at WCU. Some of the engineering majors have three or more major-specific prerequisite courses, which may require an additional course to be taken during one of the semesters.

Course recommendations for students matriculating to **Pennsylvania State University**:

- The 3-2 Elective courses should be selected to satisfy course requirements at Penn State. Recommended courses are: ENG 371 Technical Writing, an Art Course, a Health Course, or a course that fulfills the requirement of a particular major. See Penn State's 'Check Sheet.'

Course recommendations for students matriculating to **Philadelphia/Jefferson University**:

- Physics Elective courses: Students intending to pursue Mechanical Engineering should take PHY 330, PHY 350, and PHY 370.
- General Education courses: For WRT 2XX, students should select WRT 200, 204, or 206. Soc. Sci Gen. Ed., students should select PSY100, PSC101, or PSC343. For Humanities Gen. Ed., students should select HIS100, HIS151, or HIS 152. Details can be found on the WCU Department of Physics and Engineering homepage under Programs → Engineering. At the bottom of the page, click on the link for the B.S. Mechanical Engineering Full Checksheet.

Biomedical Engineering Curriculum

	Fall			Spring		
First Year	Course #	Title	Credits	Course #	Title	Credits
	MAT 161	Calculus I	4	MAT 162	Calculus II	4
	CHE 103	Gen. Chem I	3	CHE 104	Gen. Chem II	3
	BME 110	Intro. BME	3	PHY 170	Physics I	4
	WRT 120	Effective Writing I	3	CRL 103	Chem I lab	1
	Gen. Ed.	FYE	4	BME 120	Intro CAE	3
Total			17			15
Second Year	MAT 261	Calculus III	4	MAT 315	Diff. Eq. & lin. Alg.	3
	BIO 110	Gen. Biology	3	BIO 265	Hum. A&P	4
	PHY 180	Physics II	4	CHE 230	Intro. Organic Chem	3
	BME 220	Statics	3	WRT 2xx	Effective Writing II	3
	CRL 104	Chem II lab	1	BME 230	Dynamics	3
Total			15			16
Third Year	BME 310	Engr. Thermo.	3	BME 325	BME Lab II	2
	BME 315	BME Lab I	2	BME 345	Biotransport Phenomena	4
	MAT 125	Intro. Statics. & Prob.	3	BME 355	Bioinstrument.	3
	BME 335	Biomaterials	3	BME 365	Biomechanics	3
	PHI 180	Intro. Ethics	3	Gen. Ed	Hum	3
	ECO 112	Economics II	3			
Total			17			15

Fourth Year	BME 410	Sen. Design I	3	BME 420	Sen. Design II	1
	BME XXX	Tech. Elect I	3	BME XXX	Tech. Elect II	3
	BME 401	Sen. Seminar I	1	BME XXX	Tech. Elect III	3
	BME 450	Regulatory and GMP	3	BME 402	Sen. Seminar II	1
	Gen. Ed	Art	3	Gen. Ed	Diverse Comm.	3
	Gen. Ed	Interdisciplinary	3	Gen. Ed	Behav. & Soc.	3
Total			16			14
Total						125

Notes: 1 Enrollment in WRT 120 (3 credits) or WRT 123 (4 credits) is determined by the results of WRITE SURVEY. 2 Remedial Math (i.e. MAT Q20 and/or MAT Q30) or MAT 131 are required prerequisites for MAT 161, if the score earned on the Math Placement Exam (MPE) is below "5." Students transferring in the equivalent of WRT 120 are exempt from taking the WRITE SURVEY. Students transferring in the equivalent of MAT 131 (and beyond) are exempt from completing the MPE. The need for WRT 123, MAT Q20, MAT Q30, and MAT 131 increase the total credits requirement beyond 125. Please consult with the director of or an advisor in the program for course recommendations and planning.

Department of Physics & Engineering
West Chester University of Pennsylvania

B.S.Ed. Physics Curriculum

Semester 1

MAT 161	Calculus I	4	G
	Behavioral & Social Sci	3	
WRT 120	English Composition	3	G
SPK208 or SPK230	Public Speaking	3	G
ANT, PSY, SOC, ECO, GEO, PSC	Behavioral & Social Sciences	3	G
		16	

Semester 2

MAT 162	Calculus II	4	
PHY 170	Physics I	4	
WRT 200	English Literature	3	G
LIT or CLS	Humanities	3	W
_____	Arts	3	G
		17	

Semester 3

MAT 261	Calculus III	4	
PHY 180	Physics II	4	
CHE 103	Chemistry I	3	G
CRL 103	Chemistry I Lab	1	G
PHY 105	Structure of the Universe	3	
EDP 250	Ed. Psych.*	3	
		18	

* includes 20 hours of Stage 1 field experience (requires clearances)

Semester 4

MAT 343 or PHY 370	Differential Equations or Mathematical Physics	3	
PHY 240	Intro. to Modern Physics	3	
CHE 104	Chemistry II	3	
CRL 104	Chemistry II Lab	1	
EDA 103	Special Ed. I*	3	
EDF 300	Democracy & Education	3	I
		16	

* includes field experience (requires clearances)

Submit application for Formal Admission to Teacher Education (FATE) at the end of Semester 4.

Semester 5

PHY 300	Mechanics	3	
PHY 310	Inter. Physics Lab I	2	W
EDA 304	Special Ed. II*	3	
EDR 347	Literacy Development	3	
_____	Free Elective	3	G
		14	

* includes 20 hours of Stage 2 field experience (requires clearances)

Semester 6

PHY 320	Inter. Physics Lab II	2	W
LAN 382	Teaching ELL	3	J
EDS 306	Principles of Teaching*	3	W
HIS or PHI	Humanities	3	G
BIO ___	Biology Elective	3	G
_____	Free Elective	3	G
		17	

* includes Stage3 field experience (requires clearances)

Semester 7

PHY 330	Electronics	3	
PHY 410	Optics	3	
SCB350 or SCE350	Science Education*	3	- W
ANT, PSY, SOC, ECO, GEO, PSC	Behavioral & Social Sciences	3	G
_____	Free Elective	3	G
		15	

* includes Stage 3 field experience (requires clearances)

Semester 8

EDS 411 & 412	Student Teaching	12	
		12	

Total number of credits in B.S. Ed. Physics program = 125

Upper level courses (numbered 300 or above) must be completed with a grade of C or better.

Students must pass the PAPA Reading, Writing, and Mathematics exams prior to admission to Student Teaching. Students must pass the PRAXIS II Physics exam (#10265) before graduation from the B.S.Ed. Physics program. When registering for any PAPA or PRAXIS test, students should include #2659 (the Certification Office at WCU) as a score recipient.

'G' denotes a course that fulfills the University's General Education requirement. 'I' denotes a course that fulfills the General Education Interdisciplinary course requirement. 'J' denotes a course that fulfills the General Education Diverse Communities course requirement. For a list of approved General Education courses, consult the Undergraduate Catalog.

Requirements for Formal Admission to Teacher Education (FATE)

- Earned a minimum of 48 credits in courses numbered 100 level or higher
- Earned a minimum cumulative GPA of 2.8
- Earned passing scores on the PAPA test modules in Reading, Writing, and Mathematics
- Earned 3 credits in college-level English composition (WRT120)
- Earned 3 credits in college-level English literature (LIT or CLS), defined to be any course in which English is the native language of the authors of the texts required for the course
- Earned 6 credits in college-level mathematics (MAT161 and MAT162)
- Received Departmental approval (indicated by the signature of the B.S.Ed. Program Coordinator on the FATE application form)

A 2.8 GPA must be maintained to retain Formal Admission status. A 3.0 GPA is required for Teacher Certification.

Courses with Field Experiences require clearances. Consult the College of Education information page regarding clearances for more information.

Physics Major's General Education Requirements

for Students entering the university after Summer 2019

Basic Requirements: 120 Semester hours at or above the 100 level, and a GPA of at least 2.0

Students leaving for partner institutions in our 3+2 programs must complete all general education requirements prior to leaving WCU. Please check your degree progress report on myWCU.

***ACADEMIC FOUNDATIONS*:**				
Prefix	**Course**	**Semester**	**Grade**	**Credits**
FYE *(Waive if 24 or more transfer credits)*				**4**
WRT *(Waive if Academic Passport eligible)*	120 or 123 *(based on Write Survey result. Waive if Write Survey result is WRT 200)*			**3 – 4**
WRT *(Waive if Academic Passport eligible)*	200, 204, 205, 206, 208 or 220			**3**
MAT	**161**			**4**
SPK *(Waive if Academic Passport eligible)*	208 or 230 (199 transfer)			**3**
Diversity (J)[a]				**3**
Interdisciplinary (I)[b] *(Waive if Academic Passport eligible)*				**3**
Ethics (€) *(Waive for Fall 2019Spring 2020 transfer students)*				**3**

a. CAN be used to fulfill other requirements, such as a minor. A single course may fulfill the "I" and "J" requirements.

b. Interdisciplinary courses may **not** be used to fulfill a general education requirement in the distributive areas (science, behavioral and social sciences,

c. humanities, the arts). However, a course may simultaneously satisfy the interdisciplinary and diverse communities requirements.

***SCIENCE DISTRIBUTION*:** BIO, CSC, ESS, or GEO course from the approved general education course list under that category. Second Science Distributive course requirement met through CHE 103 course, required by the major. *(Waive if Academic Passport eligible)*

Prefix	Course	Semester	Grade	Credits
				3

For all unspecified course number see the approved list in the course catalog or your degree progress report on myWCU. Not every course with a given prefix will satisfy the requirements!

***BEHAVORIAL & SOCIAL SCIENCE DISTRIBUTION*:** Two **approved** courses with **different** prefixes **outside of the major** in the list: ANT, ECO, GEO, PSC, PSY, SOC. *(Waive if Academic Passport eligible)*

Prefix	Course	Semester	Grade	Credits
				3
				3

***HUMANITIES DISTRIBUTION*:** Two **approved** courses with **different** prefixes **outside of the major** in the list: HIS, LIT/CLS, PHI. *(Waive if Academic Passport eligible)*

Prefix	Course	Semester	Grade	Credits
				3
				3

***ART DISTRIBUTION*:** One **approved** course **outside of the major** in the list: ARH, DAN, FLM, MHL, THA *(Waive if Academic Passport eligible)*

Prefix	Course	Semester	Grade	Credits
				3

WRITING EMPHASIS:

6 credits of Writing Emphasis are met through PHY 310 Intermediate Lab I and PHY 320 Intermediate Lab II.

If 0 – 39 transfer credits, 9 credits of Writing Emphasis courses are required.

If 40 – 70 transfer credits, PHY 310 and PHY 320 are sufficient and no other Writing Emphasis courses are needed.

If 71 or more transfer credits, PHY 310 alone is sufficient and no other Writing Emphasis courses are needed.

Prefix	Course	Semester	Grade	Credits
PHY	**310**			**3**
PHY	**320**			**3**

***SPEAKING EMPHASIS*:**

- 9 credits of which 3 must come from SPK 208 or 230 (or SPK 199 transfer credit).

WAIVE remaining 6 credits in Speaking Emphasis requirement, if Fall 2019 – Spring 2020 transfer student. WAIVE SPK 208 or 230 (or SPK 199 transfer), if Academic Passport eligible.

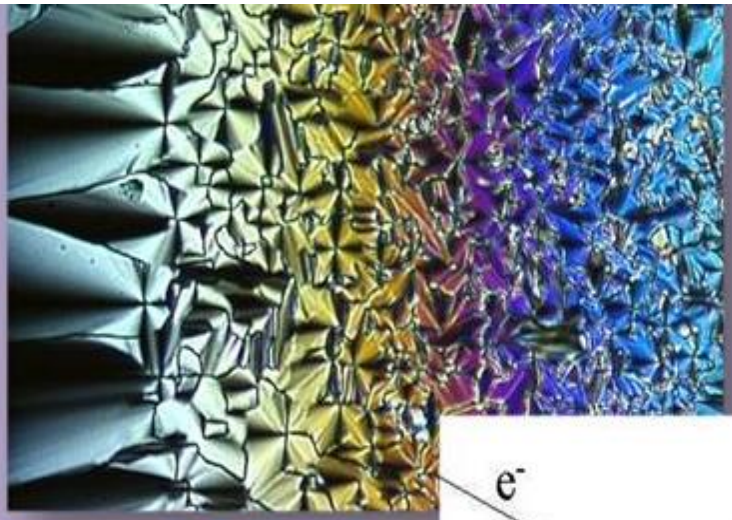
Prefix	Course	Semester	Grade	Credits
SPK	**208 or 230 (or SPK 199)**			**3**

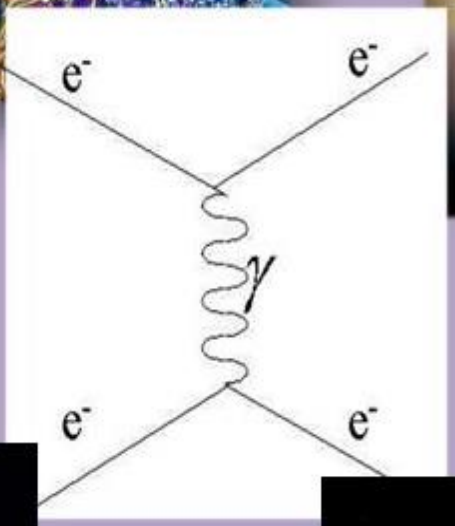
***FREE ELECTIVES*:**

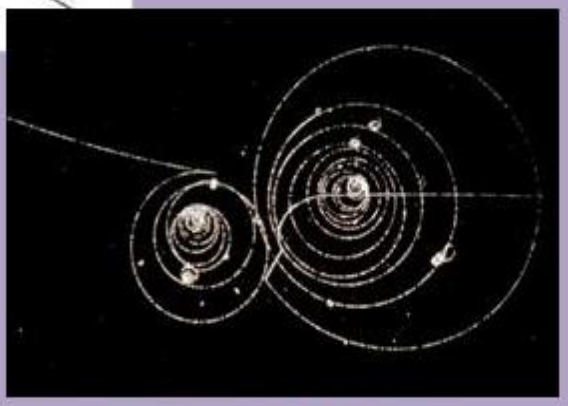
Only if needed to reach 120 credits minimum graduation requirement.

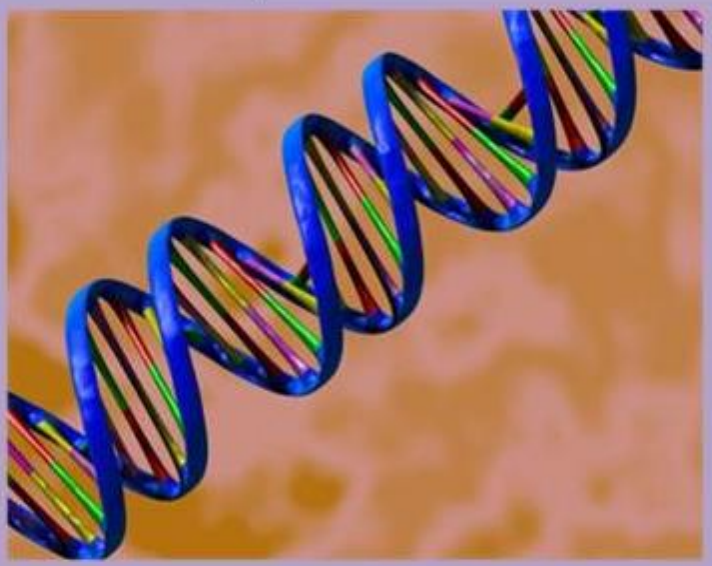
Prefix	Course	Semester	Grade	Credits

Revised 5/15/19

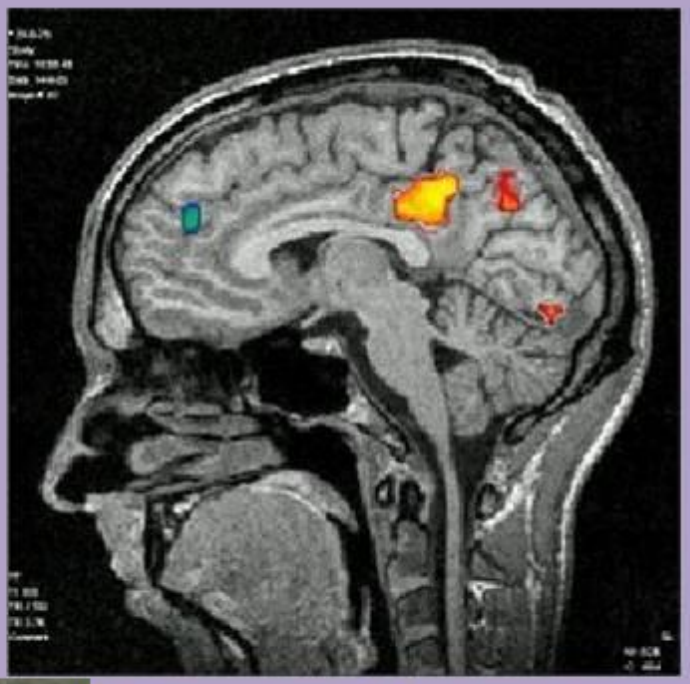


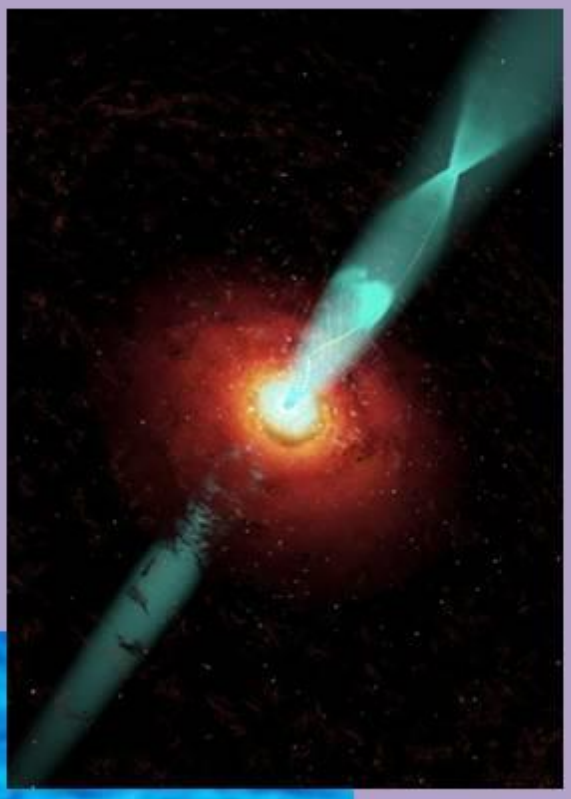


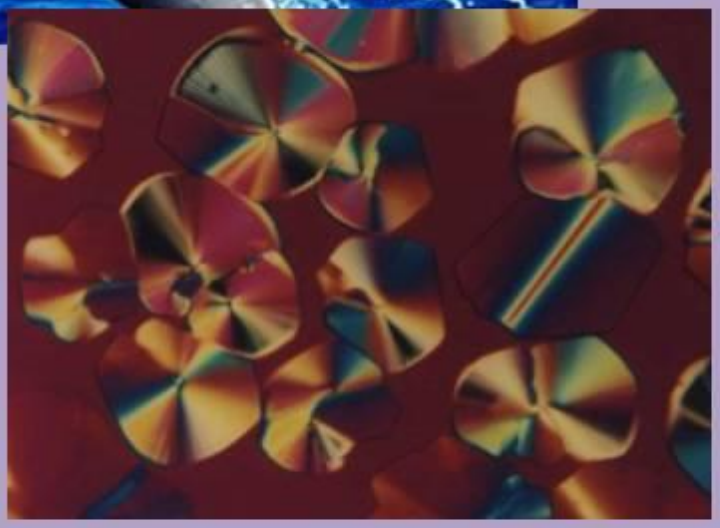




Top to bottom, left to right: Liquid crystal (photo: Kenneth D. Singer); Sun in three x-ray wavelengths (photo: SOHO-EIT Consortium, ESA, NASA); Negative nematic (photo: Kent State Liquid Crystal Institute); Feynman diagram of two electrons repelling; Spiral galaxy (photo: NASA); Kaon decay in a bubble chamber (photo: CERN); Jet breaking sound barrier: Flying Wings (photo: copyright © Andreas Zeitler); and model of a DNA strand.







Top to bottom, left to right: Functional MRI image – Project members: D.H.J. Poot, J. Siibers, A.J. den Dekker; A shock wave tracing a spiral path away from the black hole (Copyright © Dr Wolfgang Steffen); Whirlpool Galaxy (photo: NASA); Spinner Dolphin (photo: Alamy); Crab Nebula supernova remnant (photo: NASA); and pyramidic liquid crystal (photo: Zeev Luz).