

DEPARTMENT OF PHYSICS, COMPUTER SCIENCE & ENGINEERING

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Faculty**Professors:** Brash, Doughty, Hibler, Zhang**Associate Professors:** Cueman, Flores, Gerousis,

Lambert, Riedl, Selim, Siochi, Wang

Assistant Professors: Collins, DeJong, Fersch,

Gianvecchio, Perkins

Lecturer: Gore**Instructors:** Baird, Cole, Koehl**Emeriti:** Buoncristiani, Caton, Game, Moore, G. Webb,

J. Webb

Mission Statement

Our Mission is to:

- introduce all CNU students to the richness of science and engineering as a human endeavor and to emphasize their importance and utility in our lives,
- enhance awareness of the interaction between science and the other disciplines,
- prepare our graduates to enter careers as competent scientists, engineers and educators,
- give our students the lifelong learning and leadership skills that enable them to grow in their professions and advance to positions of leadership, and
- be recognized widely as a group of individuals engaged in and contributing to our various communities.

The Department of Physics, Computer Science and Engineering offers majors in fields of science and high technology. The **applied physics** major allows students to specialize in the design of instrumentation used in the scientific measurement process; to experiment with micro-processor-based control systems; to design and implement computer models and simulations of physical processes; and to study electronic and optical materials and their applications to modern devices. The **computer engineering** major is a specialized degree with emphasis on hardware and software design and integration in computer systems, and has extensive job opportunities. The **computer science** major allows students to specialize in computer architecture, data structures and operating systems, scientific computing, artificial intelligence applications and software engineering. The **information systems** major prepares students to analyze, design and implement systems that enable businesses and organizations to make effective and efficient use of today's most valuable resource: information. The **Bachelor of Science in Information Science** major is an applied major intended to address the broad scope of

modern business, information and technology problems.

Minors in applied physics, computer science, or information science may be arranged to support most majors; this is particularly appropriate for science, mathematics, or business majors as preparation for advanced study or employment.

In addition to its commitment to serve the science student, the department also supports the liberal arts mission of CNU by striving to increase the understanding of the uses of science and technology for solving contemporary problems and to increase public awareness of the relations between science and technology and the realm of human values. Many of our course offerings fulfill the liberal-learning core requirements, and are designed to complement the programs of students in the liberal arts, social sciences, and in business. CPSC 110, 125, 150, 250, 215, 216, 355, PHYS 105L, 141, 142, 143, 144 and 344 are examples of such courses.

A departmental brochure with detailed descriptions of these programs, including typical texts for courses and topics for undergraduate research projects, and with degree-progress sheets for each specialty, can be requested by mail or by telephone: (757) 594-7065. More information can also be viewed at www.cnu.edu.pcs.

Equipment

The department has three state-of-the-art teaching classrooms (with touch-sensitive smartboards, multiple video projectors and video switching) for computer science and physics instruction, as well as five teaching-research labs at CNU: the Hunter Creech Computer Lab, the Laboratory for Multimedia Computing, the Engineering Electronics Lab, the Engineering Projects Lab and the Information Systems Lab. In addition, it has two general-purpose fully-computerized physics laboratories and a large commons area for student-faculty collaborations and study. All classrooms are equipped with video projection systems, and three rooms feature fully networked clusters of 22 to 46 computers. Finally, the department has three research labs in the Applied Research Center at Jefferson National Laboratory: the Laser and Photonics Lab, the Solid-State Sensors and Materials Lab, and the Advanced Circuits Lab. These research labs include instrumentation for cryogenics, study of electronic and optical properties of matter, lasers and laser-based metrology, digital design, and high-speed data acquisition.

Research Projects

The Department of Physics, Computer Science and Engineering emphasizes research for both its undergraduate and graduate students. As a consequence, there are always on-going projects involving faculty members and students in a variety of research areas. Current and recent projects are sponsored by the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the Thomas Jefferson National Accelerator Facility (TJNAF), and the Piedmont Wetlands Research Program. Students who would like to assist with the research projects will find departmental members able to provide challenging opportunities for independent study. All students desiring a degree in applied physics, computer science or computer engineering must complete a senior research project, and students majoring in information science must complete a significant case study of a business problem under the guidance of a professional.

Five Year BS/MS Program

The department has programs leading to a dual BS and MS degree in Applied Physics and Computer Science after five years of study. By putting in an extra year to obtain the MS, lifetime earnings and the potential for diverse opportunities and job satisfaction increase significantly. Our programs are very flexible and students will still receive the BS degree once they complete the requirements, even if they decide not to finish the MS program. Our MS in Applied Physics and Computer Science has concentrations in Computer Science, Computer Systems Engineering and Instrumentation, and Applied Physics that correspond to our undergraduate majors of Computer Science, Computer Engineering, and Applied Physics. By taking a total of six graduate credits during the Junior and Senior year and one graduate course during the summer, the MS requirements can be completed in the following year. Interested students should talk to their advisor early in their program since course sequencing is critical to success. Enrollment in the program requires a GPA of 3.0 or better. Application to these programs should be made during the second semester of the Junior year. An application should include a current transcript and two letters of recommendation. We have detailed brochures with five-year plans for each concentration available in our departmental office and online at www.pcs.cnu.edu.

The Bachelor of Science Degree in Computer Engineering

The Bachelor of Science degree in computer engineering is accredited by the Engineering Accreditation Commission of ABET. Computer Engineering encompasses design and analysis of both hardware and software systems. Engineering problem solving, a key component of our Computer Engineering program, is practiced in all areas studied for this degree. Computer Engineering is the application of knowledge and technology to the exciting, challenging, and ever-changing field of computer systems.

Computer Engineering majors are prepared for employment in positions such as Digital Design Engineers, Software Systems Analysts, Computer Architects, Scientific and Technical Programmers, Microprocessor-based Systems Designers, Instrumentation Systems Designers, Integrated Circuit Designers, and Systems Engineers.

The Educational Objectives of the Computer Engineering Program are to ensure that within three years after graduation:

1. Our graduates will have established themselves in professional positions in industry, government, or non-profit organizations that utilize the skills and abilities associated with liberally-educated computer engineers, and/or will be enrolled in programs of graduate study.
2. Our graduates, collectively, will be competent working with both electronic hardware and software, and thus will have applied their knowledge and skills in a wide variety of fields. Furthermore, our graduates will have demonstrated their commitment to professional growth and life-long learning.
3. Our graduates will be leading lives of significance by taking on leadership roles, demonstrating independent work, and/or serving society in part through their professional contributions.

The major in computer engineering focuses on an applied approach. There is a comprehensive laboratory component to provide hands-on experiences. Computers are used throughout the curriculum as part of the engineering design process. Commercial EDA (Electronic Design Automation) software is used extensively. In addition to requiring successful completion of the liberal learning curriculum, the major in computer engineering requires successful completion (a grade of C- or better) of the following courses in major and elective studies:

1. ECON 201 or 202;
2. CHEM 121/121L-122;
3. PHYS 201/201L-202/202L, 340, 341;
4. MATH 140, 240, 320;
5. ENGR 121, 211/211L-212/212L, 213;
6. CPEN 214, 315/315L, 371W, 414, 431, 498W;
7. CPSC 125, 150/150L-250/250L, 270, 410, 427;
8. Six hours from professional electives: CPEN 422, 495; CPSC 360, 420, 425, 428, 440, 450, 470, 471, 480, 495; PHYS 421; PCSE 495 (only one 495 course allowed with advisor's permission); CPSC 501 or 502 (with advisor's permission).

Because of the tight prerequisite structure, it is strongly recommended that students take their major courses in the following order:

First year: CPSC 125, 150/150L, MATH 140-240, ENGR 121;

Second year: CPEN 214, 315/315L, CPSC 250/250L, CPSC 270, ENGR 213, PHYS 201/201L-202/202L, 340;

Third year: CPEN 371W, 414, CPSC 427, ENGR 211/211L-212/212L, MATH 320, PHYS 341; CHEM 121/121L, ECON 201 or 202;

Fourth year: CPEN 431, CPEN 498W, CPSC 410, two professional electives, CHEM 122.

The Bachelor of Science degree in Computer Foundations

This program is designed to prepare students in the foundations of computer hardware and software. Students in this program can choose to major in **applied physics, computer science** or **information systems**.

The Major in Applied Physics

The Applied Physics program builds a broad foundation in the traditional core areas of physics, including classical mechanics, electromagnetism, optics, quantum physics, and relativity. Physics majors gain expertise in computer engineering, computer science, and mathematics through required support courses. Our students extend their capacity for critical thinking through upper level major electives, as well as courses that comprise the CNU Liberal Learning Core.

Students in the Applied Physics program have an opportunity to apply their knowledge through undergraduate research experiences with both department faculty and industry partners. The Department has faculty with vibrant research programs and enjoys a strong relationship with the Thomas Jefferson National Accelerator Facility (JLab). Our department also provides opportunities for undergraduate research in Applied Physics at the nearby NASA Langley Research Center.

Physicists have a wide range of career options. They work in a variety of areas from basic research at universities and government laboratories to education to healthcare to manufacturing to consulting and analysis firms. Their jobs involve working as software developers, engineers and science/lab technicians and managers, or even patent lawyers.

Degree studies requirements are those of the Bachelor of Science degree. In addition to requiring the successful completion of the liberal learning curriculum, the Applied Physics major requires the successful completion, a grade of C- or better, of all courses in the major.

1. CPEN 214, 371W;
2. CPSC 150/150L-250/250L;
3. PHYS 201/201L-202/202L, 303,340, 341, 351, 401, 402, and 404;
4. ENGR 121 211/211L;
5. MATH 140, 240, 250, 320;

6. Select two: ENGR 212/212L; MATH 440, PHYS 352, 395, 402, 406, 421, 431, 441, 495.
7. PCSE 498W (3 credit Capstone course).

The Major in Computer Science

Computer science is becoming more important in multiple disciplines ranging from business to scientific research. Examples of jobs include network analysis, web development, database administration, and developing or analyzing software systems.

Computer science majors at CNU take core courses that provide a background in computer engineering, computer science, mathematics, and physics. The major and support courses continue building this background. Advanced courses in the program provide additional study in data structures, programming languages, computer organization, operating systems, and algorithms, with additional electives to extend the student's knowledge in an area of his/her choice.

Graduates will be prepared for further study in graduate school or employment as computer scientists or researchers in various high technology laboratories. Students pursuing the major in computer science are strongly encouraged to pursue studies in other academic fields in which there are significant applications of computer science. A minor in business, economics, mathematics, science, or psychology would be a viable choice. Students interested in the scientific or engineering applications of computers are strongly urged to take MATH 380 and PHYS 441. See your advisor or departmental brochures for more details on the computer science major.

Degree studies requirements are those of the Bachelor of Science degree. In addition to requiring the successful completion of the liberal learning curriculum, the Computer Science major requires the successful completion, a grade of C- or better, of all courses in the major.

1. CPEN 214, 371W;
2. CPSC 125, 150/150L-250/250L, 270, 280, 360, 410, 420;
3. MATH 140, 240;
4. PHYS 151/151L-152/152L or PHYS 201/201L-202/202L and PHYS 340 or MATH 235 or 260;
5. MATH 240;
6. ENGR 213;
7. PHYS 341;
8. CPSC 330 or CPEN 414;
9. Select three: CPSC 425, 427, 428, 440, 450, 460, 470, 471, 480, 485, 495; any 500 level course with advisor's permission; MATH 380; PHYS 421, 441; with courses numbered 495 and above used no more than twice;
10. CPSC 498 (3 credit Capstone course).

The major in computer science requires satisfactory

completion of an exit test administered by the department. See the assessment section of the general requirements of all baccalaureate degree programs for more information. See your advisor or departmental brochures for more details on the computer science major.

The Major in Information Systems

The major in information systems prepares students to analyze and design systems that enable businesses and organizations to make effective and efficient use of today's most valuable resource: information. What information is needed, who needs it, and how to distribute and manage it are key elements in achieving an organization's strategic goals.

The field of information systems has expanded tremendously in its focus during the past decade. With the rise of the internet, it is no longer sufficient to prepare only for traditional business and organizational needs such as payroll. Applications that formerly required trained specialists are now self-service operations, mediated by the internet (e.g., airline reservations). In this climate of accelerated change, ubiquitous computing, and 24/7 access, the information systems major must be well-rounded with a thorough grounding in computer science. In addition, the IS major must be able to interact with people and understand the way organizations behave. Without these technical and organizational skills, it is not possible to analyze and design information systems.

Graduates will be prepared for further study in graduate school or employment as systems analysts, systems designers, or network designers or managers.

The core courses provide a background in computer science, mathematics, and physics. The major and support courses develop information systems foundations in both technical and organizational areas. Because of the wide variety of information systems needs, students also select additional courses in multimedia, data structures, programming languages, networking, psychology and business.

Degree studies requirements are those of the Bachelor of Science degree. In addition to requiring the successful completion of the liberal learning curriculum, the Information Systems major requires the successful completion, a grade of C- or better, of all courses in the major.

1. CPEN 371W;
2. CPSC 125, 150/150L-250/250L;
3. ENGR 213;
4. MATH 140; 235 or 260;
5. MATH 125 or PHYS 341;
6. PHYS 151/151L- 152/152L or PHYS 201/201L-202/202L;
7. ACCT 201 and ECON 201;
8. BUSN 303;

9. PSYC 303;
10. CPSC 215, 270, 350-351, 430, 440;
11. Select four (at least two at the 300 level or higher): CPSC 216, 335, 336, 355, 360, 425, 427, 428, 446, 485, 495; any CPSC 500 level course with advisor's permission; PSYC 201, 202, 313; BUSN* 311, 323, 370 or 371; ACCT 202, ECON 202; with courses numbered 495 and above used no more than twice;
12. CPSC 445W (3 credit Capstone course).

* The prerequisites for 300-level business courses include successful completion of the following courses with a C or better: ENGL 123, ENGL 223, ACCT 201-202, ECON 201, 202, MATH 125, MATH 135 or 140, CPSC 110 or a passing grade on the CPSC 215 readiness exam..

The Bachelor of Science in Information Science Degree

Managers of information are increasingly asked to solve complex problems arising in the business world that require drawing on a diverse set of skills. The Bachelor of Science in Information Science (B.S.I.S.) degree therefore emphasizes problem solving and offers a broad range of courses to address the needed skills. The B.S.I.S. program consists of courses chosen from the fields of business, computer science, economics, mathematics, and psychology. Students are urged to take the courses CPSC 125, 215, 150/150L-250/250L, 350, and 351 early in their academic careers. These six courses cover the fundamental concepts of computer technology, the basics of spreadsheet and database software, the function and architecture of computer hardware and software, programming, information science concepts, management of information systems, systems and decision theory, and organizational models.

Unlike the other majors in this department, the B.S.I.S. is a professional degree, so does not require the Bachelor of Science sequence as specified in the *General Requirements for Graduation*. In addition to requiring successful completion of the liberal learning curriculum, the Bachelor of Science in Information Science degree requires, for major and elective studies, successful completion (a grade of C- or better) of the knowledge areas and electives shown in the following table, and a capstone course and project:

1. The Computer Science Requirements:
CPSC 125, 150/150L-250/250L, 335.
2. The Business Requirements:
ACCT 201-202, ECON 201, 202, BUSN 303.
3. The Mathematics and Science Core:
MATH 125, 135 or 140, 235; PHYS 151/151L-152/152L.
4. The Information Science Major Requirements:
CPSC 215, 216, 350, 351

5. Major Electives:

Select five: CPSC 270, 355, 430, 440, 485; PSYC 201-202, 303, 313; BUSN* 311, 323, 370 or 371.

6. The Capstone Course: CPSC 445W or BUSN 440.

Finally, the major in information science requires satisfactory completion of an exit test administered by the department. (*See assessment section of the General Requirements for Graduation.*)

* The prerequisites for 300-level business courses include successful completion of the following courses with a C or better: ACCT 201-202, ECON 201, 202, BUSN 303, MATH 125, MATH 135 or 140, CPSC 110 or a passing grade on the CPSC 215 readiness exam.

The Minor in Applied Physics (26 credits)

A minor in applied physics requires satisfactory completion of PHYS 201-202-303, 351 and at least 12 additional credits in physics or engineering courses at the 300 level or higher. Persons who are majoring in biology, computer engineering, computer science, and mathematics are especially suited for such a minor program.

The Minor in Computer Science (23 credits)

The minor in computer science requires a minimum of 23 credits in computer science, including: CPSC 125, 150/150L- 250/250L, 270, and nine additional credits in computer science at the upper (300-400) level. Note that classes taken to fulfill any major requirements may not be applied toward these nine additional credits. The following courses are suggested for a minor concentration in specific application areas: (1) Business application: CPSC 335, 350, 440; (2) Natural science applications: CPEN 214, CPEN 315/315L or CPSC 330, 420; (3) Mathematics application: CPSC 350, 420, 470. *Computer Engineering majors desiring a minor in computer science must select from options 1 or 3.*

The Minor in Information Science (23 credits)

The minor in information science requires CPSC 125, 215, 150/150L, 250/250L, 335, 350 and 351.

Teacher Preparation in Computer Science

Those students who wish to become teachers should apply to the five-year Master of Arts in Teaching (M.A.T.) program. Application to the program must be made in spring of the junior year and will require: 3.0 GPA, passing scores on the PRAXIS I exam or SAT score of 1100 with at least 530 in critical reading and mathematics subtests; essay specifying the reason for applying to the program; and two letters of recommendation. Students will earn a **B.S. in Computer Foundations, computer science** after the first four years and then complete an additional year of study leading to an M.A.T. degree. Students majoring in computer science can prepare to teach elementary school, pre-kindergarten through grade six,

all core subjects, or secondary school, grades six through 12, in the content area of computer science. The courses and degree requirements for the M.A.T. are found in the graduate catalog. Students accepted into this program must complete one of the following tracks in addition to the liberal learning curriculum:

Elementary level (PK-6) Track

Major courses required:

See major requirements for the B.S. in Computer Foundations, computer science major.

Support courses required:

ENGL 123, 223; MATH 125; HIST 111; GOVT 101; COMM 201 or THEA 230; two science courses and a science lab; HIST 121; GEOG 201; PSYC 207 or 208; SOCL 314/314L; PSYC 312; NSCI 310; MATH 109; ENGL 316; ENGL 310 or 430.

Graduate courses* required (senior year):

Select six credits: ENGL 532, PSYC/TCHG 544; MATH 570.

Secondary level (6-12) Track: Computer Science Endorsement

Major courses required:

See major requirements for the B.S. in Computer Foundations, Computer Science major.

Support courses required:

Select two: MATH 125; COMM 201 or THEA 230; PSYC 207 or 208; PSYC 312; SOCL 314/314L.

Graduate courses* required (senior year):

CPSC 501 and a CPSC 500-level elective. These courses replace two electives in the major.

*See the graduate catalog for course descriptions.

Teacher Preparation in Physics

Those students who wish to become teachers should apply to the five-year Master of Arts in Teaching (M.A.T.) program. Application to the program must be made in spring of the junior year and will require: 3.0 GPA; passing scores on the PRAXIS I exam or SAT score of 1100 with at least 530 in critical reading and mathematics subtests; essay specifying the reason for applying to the program; and two letters of recommendation. Students will earn a **B.S. in Computer Foundations, applied physics** after the first four years and then complete an additional year of study leading to an M.A.T. degree. Students majoring in applied physics can prepare to teach elementary school, pre-kindergarten through grade six, all core subjects, or secondary school, grades six through 12, in the content area of applied physics. The courses and degree requirements for the M.A.T. are found in the graduate catalog. Students accepted into this program must complete one of the following tracks in addition to liberal learning curriculum:

Elementary level (PK-6) Track

Major courses required:

See major requirements for the BS in Computer Foundations, Applied Physics major.

Support courses required:

ENGL 123, 223; MATH 125; HIST111; GOVT 101; COMM 201 or THEA 230; two science courses and a science lab; HIST 121; GEOG 201; PSYC 207 or 208; SOCL 314/314L; PSYC 312; NSCI 310; MATH 109; ENGL 310 or 430, ENGL 316.

Graduate courses* required (senior year):

Select six credits: PSYC/TCHG 544; ENGL 511, 530, 532; or MATH 570.

Secondary level (6-12) Track: Physics Endorsement

Major courses required:

See major requirements for the B.S. in Computer Foundations, Applied Physics major.

Support courses required:

MATH 125; COMM 201 or THEA 230; PSYC 207 or 208, 312; SOCL 314 and 314L.

Graduate courses* required (senior year):

Select six credits: PHYS 501, 502, or 504 (these courses can replace PHYS 401, 402, or 404 required for the major).

*See the graduate catalog for course descriptions.

THE CURRICULUM IN COMPUTER ENGINEERING

CPEN 214. Digital Logic Design (3-3-0)

Pre or corequisite: ENGR 121 or PHYS 152 or 202 or consent of instructor.

Fall and Spring.

Introduction to logic circuits; combinatorial logic circuits; memory elements; sequential logic circuits; register transfer logic. Hands-on experience with devices emphasized.

CPEN 315. Digital System Design (3-3-0)

Prerequisite: CPEN 214, Computer Engineering or Physics major, or consent of instructor.

Pre or Corequisite: CPEN 315L, ENGR 121.

Spring.

Digital design methodology and techniques; control and timing; machine organization, instruction sequencing and data for flow control; control unit design; and techniques.

CPEN 315L. Digital System Design Lab (1-0-3)

Corequisite: CPEN 315.

Spring.

Advanced sequential circuit design and implementation, design with programmable logic, digital circuit simulation.

The use of modern Electronic Design Automation (EDA) tools is emphasized. Lab fees apply each term

CPEN 371. WI: Computer Ethics (2-2-0)

Prerequisite: ENGL 223; ENGR 121 or CPSC 125.

Fall and Spring.

This course covers contemporary ethical issues in science and engineering. A framework for professional activity is developed, which involves considerations and decisions of social impact. Current examples will be studied, discussed, and reported: IEEE and ACM codes of ethics, software and hardware property law, privacy, social implications of computers, responsibility and liabilities, and computer crime. Partially satisfies the University Writing Intensive requirement.

CPEN 414. Computer Architecture (3-3-0)

Prerequisites: CPEN 315 or CPSC 330.

Spring.

The basic issues and techniques in computer architecture and design. Survey of architectures; instruction set design; software influences on architecture; processor implementation and simulation; pipelining; memory and I/O subsystems; special purpose architectures.

CPEN 422. Microprocessors (3-3-0)

Prerequisite: CPSC 250/250L, CPEN 315.

Spring.

In depth study of current microprocessor issues; interfacing and data communications; buses and memory/peripheral connections; parallel interfaces; serial interfaces; analog interfaces. Applications by means of the case study method.

CPEN 431. Computer Engineering Design (4-2-2)

Prerequisite: CPEN 315, CPSC 270, PHYS 340.

Fall.

Engineering design course focuses on applications of computer engineering. Engineering skills developed through supervised design projects. Design projects incorporate techniques and concepts developed in previous courses. Topics include field programmable gate arrays (FPGA) implementation, micro-programmable controllers, device interfacing, design for test and design for manufacturing techniques. Development systems and Electronic Design Automation software are used throughout the course. May be taken as research intensive.

CPEN 495. Special Topics (3-3-0)

Topics vary, determined by the special interests and needs of students and the expertise of faculty.

CPEN 498. WI: Computer Engineering Capstone Project (credits vary 1-3*)

Prerequisite: ENGL 223; CPEN 371W (or consent), senior standing.

Capstone design project where senior student completes a practical computer engineering project, including probabilistic aspects of the design, by applying the engineering knowledge and judgment they have acquired during their college career. A formal oral presentation and a written report are required as well the artifact that is the design. Partially satisfies the University Writing Intensive requirement. May be taken as research intensive. *Repeatable twice for a maximum of three credits.

THE CURRICULUM IN COMPUTER SCIENCE

CPSC 110. Introduction to Computing (3-3-0) AIIF

Prerequisite: high-school algebra or one semester of college-level mathematics.

Fall and Spring.

Designed for persons majoring in other than the computer sciences. Introduction to computers, their capabilities, limitations, and implications. Applications such as spreadsheets, presentation, multimedia, and webpage development. Computer terminology, hardware and software organization.

CPSC 125. Foundations of Computer Science (3-3-0) AIIF

Prerequisite: High school algebra or one semester of college-level mathematics.

Fall and Spring.

The function and architecture of computer hardware. Data and instruction representation. Networks, operating systems and their functions. Algorithms, programming languages, and software engineering. Artificial intelligence, theory of computation, and applications. This course includes a hands-on component.

CPSC 130. Beginning Programming Lab (1-0-2)

Laboratory course for students who do not pass the CPSC 150 readiness exam. This course teaches beginning programming using hands-on activities in a specific programming language. Laboratory exercises emphasize basic programming structures such as loops and conditional statements.

CPSC 150. Computers and Programming I (3-3-0) AIIF

Prerequisite: MATH 128 or CPSC 130 or a passing score on the CPSC 150 readiness exam.

Fall and Spring.

Object-oriented programming in Java. This course is an introduction to problem solving and programming. Topics include objects, classes, methods, loops, arrays, containers and inheritance. Agile programming methods are introduced. Emphasis is placed on good design, testing and coding.

CPSC 150L. Computers & Programming I Laboratory (1-0-3) AIIF

Pre or corequisite: CPSC 150.

Fall and Spring.

Laboratory course supports the concepts in CPSC 150 lecture with hands-on programming activities and language specific implementation. Laboratory exercises stress sound design principles, programming style, documentation, and debugging techniques. Lab fees apply each term

CPSC 215. Software Packages for Business Applications (3-3-0) AIIF

Prerequisite: a grade of C- or higher in CPSC 110, or a passing score on the CPSC 215 readiness exam.

Fall and Spring.

For students majoring in business or information science and those wanting a more in-depth understanding of and competence in the use of spreadsheets, databases and database management. Covers creation of complex spreadsheets using Microsoft Excel, and database queries and management using Microsoft Access.

CPSC 216. Multimedia and Web Publishing (3-3-0) AIIF

Prerequisite: CPSC 110 or 125 or experience using computers (see instructor).

Spring.

Basic multimedia concepts – graphics, audio, video; internet concepts; design, development, and publishing of web pages; interactive web pages; publishing tools, server management and tools. This course includes a hands-on component.

CPSC 250. Computers & Programming II (3-3-0) AIIF

Prerequisite: a grade of C- or higher in CPSC 150/150L or equivalent transfer credit.

Fall and Spring.

Continuation of CPSC 150. Further study of object-oriented design and verification, programming style, documentation and debugging. Algorithm development and analysis with emphasis on simple data structures such as lists. Recursion, internal search/sort algorithms.

CPSC 250L. Computers & Programming II Laboratory (1-0-3) AIIF

Prerequisite: a grade of C- or higher in CPSC150/150L; Pre or corequisite: CPSC250.

Fall and Spring.

Laboratory course supports the concepts in CPSC 250 lecture with hands-on programming activities and language specific implementation. Laboratory exercises stress sound design principles, programming style, documentation, and debugging techniques. Lab fees apply each term

CPSC 270. Data and File Structures (3-3-0)

Prerequisite: a grade of C- or higher in CPSC 125, 250/250L. Pre or corequisite: ENGR 213.

Fall and Spring.

Study of objects and data structures. Trees, graphs, heaps with performance analysis or related algorithms. Structure, search, sort/merge and retrieval of external files. Programming assignments will involve application of the topics covered.

CPSC 280. Introduction to Software Engineering (3-3-0)

Prerequisite: CPSC 250.

Fall and Spring.

This course introduces the theory and practice of building reliable software systems. It covers the life-cycle of software development and its existing models, methods for modeling, designing, testing and debugging software, and techniques to choose appropriate models to build systems involving individuals or teams of developers.

CPSC 330. Computer Organization (3-3-0)

Prerequisite: CPSC 250/250L, CPEN 214.

Fall.

Study of computer organization and architecture. Examine functional organization of a von-Neumann computer including computer micro-operations, control organizations, basic instruction sets, addressing modes, CPU design, memory organization, and Input-Output organization. More advanced topics including vector processing and multiprocessors will also be introduced.

CPSC 335. Data Communication Systems (3-3-0)

Prerequisites: CPSC 125 or 330; CPSC 250/250L; MATH 135 or 140.

Spring.

A broad overview of communications issues to include encoding, media, interfaces, error detection and correction, data compression, protocols, the OSI model, and LANs. Standard network applications such as ftp, telnet, gopher, and web browsers are discussed. Students will be required to design and implement a communications software project.

CPSC 336. Network Implementation and Administration I (3-3-0)

Prerequisite: CPSC 335.

Fall.

Study of TCP/IP based networks for a UNIX environment and the integration of different types of hardware and operating systems. Routing, domain name servers, and mail servers. Network application development tools: sockets and rpc. Projects include the configuration of a UNIX network. Introduction to Information Systems profession. Tools and techniques for profiling organizations and analyzing their goals and needs to determine and specify

information systems requirements. Practical experience in real-life information systems analysis.

CPSC 350. Information Systems Analysis (3-3-0)

Prerequisites: CPSC 150/150L or consent of instructor.

Fall.

Introduction to Information Systems profession. Tools and techniques for profiling organizations and analyzing their goals and needs to determine and specify information systems requirements. Practical experience in real-life information systems analysis.

CPSC 351. Information Systems Design and Implementation (3-3-0)

Prerequisites: CPSC 250/250L, CPSC 350.

Spring.

Lecture/project-based course for systematic design, implementation, and maintenance of computer information systems. From given requirements for a computer information system course guides student in methods, tools, and techniques for realizing the desired system.

CPSC 355. Electronic Commerce (3-3-0) AIIF

Prerequisite: CPSC 110.

Spring.

Electronic commerce is the process of electronically conducting all forms of business between entities in order to achieve the organization's objectives. Electronics commerce technologies embrace such activities as electronic trading, EDI, electronic banking, electronic mail, on-line services, and all forms of messaging, multimedia communications and video-conferencing. This course will concentrate on the impact of EDI to the following issues: security, social impact, marketing, governance and financial transactions.

CPSC 360. Programming Language Concepts (3-3-0)

Prerequisite: a grade of C- or higher in CPSC 250.

Fall and Spring.

Basic concepts dealing with information binding, arithmetic, string handling, data structures, storage and mapping, input/output, and execution environment. Specialized concepts concerning recursion, multiprocessing, list processing, and language extensibility. Several programming languages will be examined.

CPSC 410. Operating Systems I (3-3-0)

Prerequisites: CPSC 270; CPEN 214. Pre or corequisite: CPSC 330 or CPEN 414.

Fall.

Introduction to operating systems, I/O processing, interrupt structure and multiprocessing-multiprogramming, job management, resource management, batch and interactive processing, deadlock problem, computer net-working through teleprocessing and system performance evaluation.

CPSC 420. Algorithms (3-3-0)

Prerequisites: CPSC 270, MATH 240.

Spring.

The application of analysis and design techniques to numerical and non-numerical algorithms which act on data structures. Examples will be taken from areas such as combinatorics, numerical analysis, systems programming, and artificial intelligence.

CPSC 425. Object Oriented Programming and Design (3-3-0)

Prerequisites: CPSC 270 or consent of instructor.

Spring.

Basic object-oriented design and applications of an object oriented programming language. It introduces object-oriented design methods and provides guidance in the effective implementation of object oriented programs.

CPSC 427. C++ Programming (3-3-0)

Prerequisite: CPSC 250/250L and consent of instructor; or CPSC 270.

Fall.

Designed for students who already know how to program, but do not know C++. This is a comprehensive introduction to C++. The course will emphasize basic C++, in particular memory management, inheritance, and features needed for low level programming.

CPSC 428. Cryptography and Network Security (3-3-0)

Prerequisite: CPSC 250, MATH 135 or 140, ENGL 223.

Spring.

Study of encryption algorithms and network security practices. Security issues, threats and attacks. Symmetric ciphers ("secret-key encryption"): classical and contemporary algorithms, standards and applications. Public-key encryption: theoretical background, practical implementations, key-management, hash algorithms. Network security practices: authentication, IP security, electronic mail and web security. System security.

CPSC 430. Simulation Modeling (4-4-0)

Prerequisites: MATH 125; MATH 135 or 140; MATH 235 or 260; CPSC 250/250L.

Fall.

Course on the quantitative analysis of management problems. It is the Information Science equivalent of engineering courses in Operations Research. Emphasis on essence of systems modeling and simulation, prospects for obtaining computer solutions, and extracting the most value out of the system's model and its computer solution rather than mathematics of quantitative analysis.

CPSC 440. Database Management Systems (3-3-0)

Prerequisite: CPSC 270.

Fall and Spring.

Database (DB) concepts. Relational, hierarchical and network models. Query languages, data sub-languages and schema representations. The DB environment: DB administration, security, dictionaries, integrity, backup and recovery. May be taken as research intensive.

CPSC 445. WI: Information Systems Laboratory (3-3-0)

Prerequisite: ENGL 223; CPSC 350, 440. Spring.

A major project that includes a study of the factors necessary for successful implementation and operation of information systems; the traditional life cycle approach to managing and controlling application development and alternative development approaches. Written and oral presentation of project. Partially satisfies the University Writing Intensive requirement. May be taken as research intensive.

CPSC 446. Network Implementation and Administration II (3-3-0)

Prerequisite: CPSC 336.

Spring.

A continuation of CPSC 336 to emphasize implementation and administration of information servers such as ftp, web and database servers for multiple platforms (emphasizing UNIX) with consideration for functionality and security. Interoperability of OS platforms for resource sharing and current web enhancements in the industry are also covered. Students are required to enhance the networks created in CPSC 336 with server implementations.

CPSC 450. Operating Systems II (3-3-0)

Prerequisites: CPSC 410.

Spring.

A continuation of CPSC 410 with emphasis on the area of intra-system communications.

CPSC 460. Introduction to Compilers (3-3-0)

Prerequisites: CPSC 260, 330.

Spring.

A study of the problems of translating procedure oriented languages; lexicographic analysis, syntax checking, code generation and optimization, error detection and diagnostics.

CPSC 470. Theoretical Computer Science (3-3-0)

Prerequisites: CPSC 260, 270; MATH 240.

Fall.

Presentation of basic results relating to formal models of computation. Emphasis is placed on developing skills in understanding rigorous definitions in computing and in determining their logical consequences.

CPSC 471. Applied Artificial Intelligence (3-3-0)

Prerequisite: CPSC 270.

Fall.

This course is an introduction to some of the basic elements of artificial intelligence. Its emphasis is on those elements of artificial intelligence that are most useful for practical applications. Topics include recent developments such as neural nets, genetic algorithms, and fuzzy logic. Useful classical algorithms such as heuristic search and standard learning methods are also covered. Programming assignments are required.

CPSC 480. Software Design and Development (3-3-0)

Prerequisites: CPSC 270.

Fall.

Presentation of a formal approach to state-of-the-art techniques in software design and development. Application of such techniques in a team environment.

CPSC 485. Principles and Applications of Multimedia (3-3-0)

Prerequisite: CPSC 250.

Fall.

The purpose of this course is to learn the principles and techniques of multimedia focusing on digital images and audio. Technical topics include: the nature of sound and images and their digital representation; the different media types and formats; capture, editing, and publication techniques; workflow automation and programming; multimedia relevant web protocols. The course will also address copyright issues, graphic design, and human interface principles. A semester project is required.

CPSC 495. Special Topics (credits vary 1-3)

Topics vary, determined by the special interests and needs of students and the expertise of faculty.

CPSC 498. Capstone Project in Computer Science (3-3-0)

Prerequisite: CPSC 270 and senior standing; or consent of the instructor.

Directed projects or research under the supervision of a faculty member.

THE CURRICULUM IN ENGINEERING

ENGR 121. Engineering Design (3-3-0)

Pre or corequisite: MATH 130 or 140.

Spring.

An introduction to the methods of modeling, analysis, design and computer programming in the solution of engineering problems. A consideration of the impact of technological artifacts on society. Questions of professional ethics. Student design projects required.

ENGR 211. Introduction to Electric Circuits and Electronics (3-3-0)

Prerequisites: PHYS 202/202L; MATH 240. Pre or corequisite: MATH 320.

Fall.

A study of the basic experimental laws of electrical circuits; Ohm's Law and Kirchhoff's Laws of voltage and current. Analysis techniques for DC circuits. Properties of the basic circuit elements; resistor, inductors, capacitors. AC circuits, sinusoidal AC circuits, and their solution by phasor methods. Introduction to the operational amplifier.

ENGR 211L. Introduction to Electric Circuits and Electronics Laboratory (1-0-3)

Pre or corequisite: ENGR 211.

Fall.

Lab fees apply each term

ENGR 212. Electronics (3-3-0)

Prerequisite: ENGR 211/211L.

Spring.

Electronic measurements techniques. Analysis of AC circuits with an emphasis on characteristics of solid state electronic devices. Operational amplifiers and integrated circuits. Students will be taught to design, construct, and test circuits which perform a variety of specific tasks. Introduction to sensor-actuator instrumentation systems.

ENGR 212L. Electronics Laboratory (1-0-3)

Pre or corequisite: ENGR 212.

Spring.

Lab fees apply each term

ENGR 213. Discrete Structures for Computer Applications (3-3-0)

Prerequisite: CPSC 150/150L.

Fall and Spring.

The concepts of modern algebra (symbolic logic, set theory, algebraic structures, groups, fields, lattices and Boolean algebra) applied to sequential machines and computer system design. Emphasis on applications to realistic problems in computer science and engineering. Case studies requiring programming.

ENGR 340. Mathematical Methods for Engineers and Scientists (3-3-0)

Prerequisite: MATH 240

Spring.

Introduction of mathematical methods and concepts that are essential for engineers, computer scientists, physicists, as well as members of related disciplines. Topics include linear algebra, complex variables, mathematical transformations and numerical analysis.

THE CURRICULUM IN PHYSICS

PHYS 105L. Elementary Physics Laboratory (1-0-3) AINW

Pre or corequisite: PHYS 141 or 142 or 143 or 144.

Fall and Spring.

Physics laboratory experiences to accompany PHYS 141, 142, 143, 144. For nonscience students. The laboratories introduce fundamental physics principles and the application of these principals to society. Lab fees apply each term

PHYS 141. How Things Work (3-3-0) AINW

Prerequisite: high-school Algebra.

Fall and Spring.

Designed for non-science majors. Physical concepts including mechanics, heat, sound, electromagnetism and nuclear physics are studied in the context of everyday phenomena. Investigation begins with whole objects and looks inside them to see what makes them work. Because it concentrates on concepts rather than math, and on familiar objects rather than abstract constructs, this course offers students with many different learning styles substantial insights into our modern world.

PHYS 142. Energy: Principles, Problems and Societal Impact (3-3-0) AINW

Prerequisite: high-school Algebra.

Spring.

Designed for non-science majors. Topics include Energy Principles, Mechanical energy, Electromagnetic energy, Thermodynamic energy, Nuclear energy, Solar energy and other energy Systems. Energy conservation, environmental issues and societal impact issues will be discussed.

PHYS 143. Physics Unveiled: The Magic and The Mystery (3-3-0) AINW

Prerequisite: high-school Algebra.

Fall and Spring.

Designed for non-science majors. This course provides an introduction to the revolutionary developments in our understanding of the magical mysteries of the physical world that evolved during the 20th century. It is intended for non-science majors and provides a background for other courses in physics and astronomy. Basic physical concepts in mechanics, electromagnetism and quantum physics will be applied to investigations of topics such as flight, space travel, medicine, communication and industry. Course topics will cover both the macroscopic world and microscopic phenomena. The course will focus on concept development with simple problem solving.

PHYS 144. Introduction to Astronomy (3-3-0) AINW

Prerequisite: high-school Algebra.

Fall and Spring.

Designed for non-science majors. This course provides an introduction to, and survey of modern astronomy. The course will cover the observation, natural history and physical theories governing star and planet formation and evolution, galaxy formation, galactic structures and the beginning, evolution and end of the universe as a whole. The approach will be primarily descriptive although some

computation and computer work will be necessary. This course provides the background for more advanced courses in astronomy and astrophysics.

PHYS 151-152. Intermediate Physics (3-3-0) AINW

Prerequisite for PHYS 151: high school Algebra and Trigonometry or consent of instructor.

Prerequisite for PHYS 152: PHYS 151

Fall and Spring.

A presentation of the major concepts of physics, using algebra and trigonometry. For science students (but not for engineering, physics, or mathematics students). Topics covered include mechanics, thermodynamics, waves, electromagnetism, optics, and modern physics.

PHYS 151L-152L. Intermediate Physics Laboratory (1-0-3) AINW

Pre or corequisite for PHYS151L: PHYS 151

Pre or corequisite for PHYS152L: PHYS 152

Fall and Spring.

Physics laboratory activities to accompany the lecture part of the course. The laboratories introduce fundamental physical principles, rudimentary data analysis, and computer-aided control and data acquisition. Lab fees apply each term

PHYS 201. General Physics (3-3-0) AINW

Pre or co requisite: MATH 140

Fall and spring.

The first semester presentation of the major concepts of physics from a contemporary point of view, using algebra, trigonometry, calculus and computers. For students in the physical and life sciences, mathematics, or engineering. Topics covered include mechanics, heat, sound, electromagnetism, optics, and modern physics.

PHYS 201L. General Physics Laboratory (1-0-3) AINW

Pre or corequisite: PHYS 201

Taught in the fall semester only. The first semester of physics laboratory experiences to accompany the lecture part of the course. The laboratory introduces fundamental physical principles, data analysis skills, and data analysis tools. Computer use is integrated throughout the laboratory exercise. Lab fees apply each term

PHYS 202. General Physics (3-3-0) AINW

Prerequisite: PHYS 201; Pre or corequisite: MATH 240.

Fall and spring.

A continuation of the major topics of physics from a contemporary point of view, using algebra, trigonometry, calculus and computers. For students in the physical and life sciences, mathematics, or engineering. Topics covered include mechanics, heat, sound, electromagnetism, optics and modern physics.

PHYS 202L. General Physics Laboratory (1-0-3) AINW

Pre or corequisite: PHYS 202

Taught in the spring semester only. The second semester of physics laboratory experiences to accompany the lecture part of the course. The laboratory introduces fundamental physical principles, data analysis skills, and data analysis tools. Computer use is integrated throughout the laboratory exercise. Lab fees apply each term

PHYS 303. General Physics (3-3-0)

Prerequisite: PHYS 202. Corequisite: MATH 250.

Fall.

A presentation of the major concepts of physics from a contemporary point of view, using algebra, trigonometry, calculus and computers. For students in the physical and life sciences, mathematics, or engineering. Topics covered include heat, sound, optics, and modern physics.

PHYS 338. Apprenticeship in Teaching Physics (3-1-4)

Prerequisites: junior standing, 15 credits in major.

Pre or corequisite: MATH 320.

As needed.

The student will work directly with a faculty member from the Department of Physics and Computer Science in designing laboratory experiments and demonstrations, and teaching parts of laboratories and giving demonstrations in classes. Special emphasis will be given to the use of learning technologies, including computers and multimedia in the classroom.

PHYS 340. Methods of Theoretical Physics (3-3-0)

Prerequisites: MATH 240; PHYS 303 is recommended.

Corequisite: PHYS 202/202L.

Spring.

Survey of the theoretical methods used for analyzing and predicting physical phenomena. Topics include linear systems of equations, matrices, vectors, complex variables, and linear transforms. Computers will be used to implement these methods for a variety of physical systems.

PHYS 341. Design and Analysis of Experiments (3-3-0)

Prerequisites: PHYS 151/152 or PHYS 202/202L and MATH 140.

Fall.

An introduction to the field of experimental design, with particular reference to the use of advanced statistical techniques for experimental analysis. Topics include propagation of experimental uncertainties, distributions about the mean, estimating means and errors, statistical inference, analysis of variance, single factor experiments, block designs and Latin squares, factorial experiments, and nested experiments.

PHYS 344. Introduction to Astrophysics (3-3-0) AINW

Prerequisite: two math courses above 110; PHYS 141, 142, 143, 144 OR either PHYS 151-152 or PHYS 201-202.

Spring.

This is a one semester introduction to the field of astrophysics. It focuses on several important areas of study – the energy sources of stars, what happens when stars die, the behavior of white dwarfs, neutron stars and black holes, the formation of stars and solar systems, and the large scale structure of the universe, including the formation, evolution and eventual end of the universe as a whole. This quantitative course is aimed at interested students with some background in introductory physics or astronomy. All required mathematical techniques will be explained as they are needed during the semester.

PHYS 351. Modern Physics (3-3-0)

Prerequisite: PHYS 303 or consent of instructor.

Spring.

A survey of the developments in atomic and nuclear physics. This course provides an introduction to quantum mechanics and its application to contemporary measurement systems.

PHYS 352. Device Physics (3-3-0)

Prerequisite: PHYS 351 or consent of instructor.

Fall, even-numbered years.

The physical principles which underlie the operation of technologically important electronic and optical devices. The course deals with semi-conductor devices: junction, field effect and charge coupled devices, as well as devices based upon electro-optical effects.

PHYS 401. Models of Dynamical Systems (3-3-0)

Prerequisite: CPSC 250/250L or consent of instructor; PHYS 340; MATH 320.

Fall.

Continuous and discrete models of dynamical systems. The classical models of deterministic dynamical systems such as orbital dynamics and fluids. Nonlinear systems including continuous and discrete chaos theory. Variational methods, inertial tensor, stability, Einstein summation, Lyapunov exponent, bifurcation diagrams, phase space, Poincare projections, Universality, Cantor set, entropy and fractal dimensions. Emphasis on computer solutions using both procedural languages and symbolic manipulation.

PHYS 402. Quantum Physics (3-3-0)

Prerequisites: PHYS 351, 401; MATH 250, 320; MATH 260 or PHYS 340.

Spring, odd-numbered years.

Study of the quantum mechanics of simple physical systems. Topics include the wave function, Schrodinger's equation, one-dimensional systems, the harmonic oscillator, angular momentum, the hydrogen atom, approximation methods, scattering, and electromagnetic radiation.

PHYS 404. Electromagnetism (3-3-0)

Prerequisite: MATH 250, PHYS 303 or consent of instructor. Spring, odd-numbered years.

The electrostatics and electrodynamics of discrete and continuous systems. Electrostatics, magnetostatics, solution of Maxwell's equations, interaction of electromagnetic radiation with matter and relativistic electrodynamics.

PHYS 406. Thermodynamics (3-3-0)

Prerequisites: MATH 250, PHYS 303, CHEM 103 or 121, or consent of instructor. Spring.

The formulation of the basic concepts of thermodynamics; first and second laws, energy, temperature, entropy, enthalpy, reversibility and irreversibility, ideal gases, models of real gases. Thermodynamic cycles and their applications to engineering systems and mixtures and solutions.

PHYS 421. System Design Lab (Data Acquisition) (3-3-0)

Prerequisite: ENGR 211/211L; CPEN 214; CPSC 250/250L. Fall.

May be taken as research intensive. The use of computers as data acquisition systems; coupling tasks to micro and mini-computers; controlling single and integrated systems and processes. Development of software and integration of existing digital and analog devices. Applications by means of the case study method.

PHYS 431. Optical Physics (3-3-0)

Prerequisite: PHYS 303, 340. Fall, odd-numbered years.

This course lays the foundation of modern optical science. It presents an overview of the properties of light, describes the basic principles for the control and detection of light beams, and surveys optical devices in use today.

PHYS 441. Modeling and Simulation (3-3-0)

Prerequisite: CPSC 250/250L or consent of instructor; PHYS 340 and MATH 320 or just MATH 380. Spring, odd-numbered years.

May be taken as research intensive. The modeling and simulation of physical systems. Applying software methodologies to the solution of physical problems. Lectures will typically involve a short review of some physics topic such as Keplerian motion, followed by an extensive discussion on the modeling and/or simulation of the problem. A large component of the course will be a project. Students will be able to "design" their own project drawing from any area in the complete spectrum of the physics curriculum. The project might entail modeling physical systems (examples: mechanics, optics, fluids, waveguides, atmospheric propagation, or nonlinear systems.) Alternatively, the student may choose to write a simulation (examples: interplanetary spaceflight, orbital adjustment and insertion, or powered flight.)

PHYS 495. Special Topics (credits vary 1-3)

Topics vary, determined by the special interests and needs of students and the expertise of faculty.

TOPICS COURSES AND INDEPENDENT STUDY

PCSE 195. Special Topics (credits vary 1-3)

Topics vary, determined by the special interests and needs of students and the expertise of faculty.

PCSE 295. Special Topics (credits vary 1-3)

Topics vary, determined by the special interests and needs of students and the expertise of faculty.

PCSE 299. Elementary Independent Study in Applied Physics and Computer Science (credits vary 1-3)

May be taken as research intensive.

Directed research or projects under the direction of a faculty advisor. This course is subject to the University policy on independent study (see index).

PCSE 395. Special Topics (credits vary 1-3)

Topics vary, determined by the special interests and needs of students and the expertise of faculty.

PCSE 399. Intermediate Independent Study in Applied Physics and Computer Science (credits vary 1-3)

May be taken as research intensive.

Directed research or projects under the direction of a faculty advisor. These courses are regulated under the University Policy on Independent Study (see General Academic Policies section of this catalog for details).

PCSE 495. Special Topics (credits vary 1-3)

Topics vary, determined by the special interests and needs of students and the expertise of faculty.

PCSE 498. WI: Capstone Project in Applied Physics (credits vary 1-3*)

Prerequisite: ENGL 123, 223; CPEN 371.

Directed research or projects under the direction of a faculty advisor. Partially satisfies the University Writing Intensive requirement. May be taken as research intensive. *This course can be repeated twice for a maximum of three credits.

PCSE 499. Advanced Independent Study in Applied Physics and Computer Science (credits vary 1-3)

Prerequisite: consent of instructor and Department Chair.

May be taken as research intensive. Directed research or projects under the direction of a faculty advisor. This course is regulated under the University Policy on Independent Study (see General Academic Policies section of this catalog for details).