# DEPARTMENT OF PHYSICS, COMPUTER SCIENCE AND ENGINEERING

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### Faculty

**Professor:** Brash, Doughty, Heddle, Wang, M. Zhang
**Associate Professor:** Flores, Gerousis, Lambert, Riedl, Selim, Siochi
**Assistant Professors:** Backens, Collins, Conner, DeJong, Fersch, Mohammadi, Monaghan
**Lecturer:** Gore
**Instructor:** Baird, L. Cole, Perkins
**Emeriti:** Anyiwo, Buoncristiani, Caton, Game, Hibler, 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 engineering, 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 high-speed data acquisition systems; to design and implement computer models and simulations of physical processes; and to study phenomena in astrophysics and effects of space weather. The **electrical engineering** major offers specializations in digital systems, communication and signal processing, and control and instrumentation. The **computer engineering** major is a specialized degree with emphasis on hardware and software design and integration in computer systems. The **computer science** major allows students to specialize in data structures and operating systems, scientific computing, artificial intelligence applications, software engineering, mobile programming, robotics, and security. 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, 140, 150, PHYS 105L, 141, 142, 143 and 144 are examples of such courses.

A departmental brochure with descriptions of these programs can be requested by mail or by telephone: (757) 594-7065. More information can also be viewed at cnu.edu/academics/departments/pcse.

### Equipment

The department has four state-of-the-art teaching classrooms (with smartboards, multiple video projectors and video switching) for computer science and physics instruction, as well as four teaching-research labs: the Hunter Creech Computer Lab, the Laboratory for Multimedia Computing, the Engineering Electronics Lab and the Engineering Projects Lab. In addition, it has three general-purpose fully-computerized physics laboratories, two student research and four faculty research labs. These research labs include instrumentation for non-destructive testing, high-speed data acquisition, wireless communications, robotics and unmanned systems.

### 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 National Institute of Aerospace. 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, information systems, computer engineering or electrical 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 B.S. degree once they complete the requirements, even if they decide not to finish the MS program. Our M.S. 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 9-12 graduate credits during the 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 adviser 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 cnu.edu/academics/departments/pcse.

**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 program 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, and by serving society in part through their professional contributions.

The student outcomes for the CNU computer engineering program specify that, by the time of graduation, our graduates will have:

- an ability to apply knowledge of mathematics, science, and computer engineering

- an ability to design and conduct experiments, as well as to analyze and interpret data

- an ability to design hardware and software systems to meet desired needs within realistic constraints

- an ability to function on multi-disciplinary teams

- an ability to identify, formulate, and solve software and hardware engineering systems problems

- an understanding and appreciation of professional and ethical responsibility

- an ability to communicate effectively orally and in writing

- the liberal education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context

- a recognition of the need for, and an ability to engage in life-long learning

- a knowledge of contemporary issues

- an ability to use the techniques, skills, and engineering design automation tools necessary for effective computer engineering practice

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 of the following courses with no more than two grades below *C-* :

1. ECON 201or 202;
2. CHEM 121/121L-122;
3. PHYS 201/201L-202/202L, 341;

4. MATH 140 or 148, 240, 320;
5. ENGR 121, 211/211L-212/212L, 213, 340;
6. CPEN 214, 315/315L, 371W, 414, 431, 498W;
7. CPSC 125, 150/150L-250/250L, 270, 327, 410, 420;
8. Six hours from professional electives: CPEN 422, 495; CPSC 360, 425, 428, 440, 450, 470, 471, 475, 480, 495; PHYS 421; PCSE 495 (only one 495 course allowed with adviser's permission); CPSC 501 or 502 (with adviser'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 or 148 and MATH 240; ENGR 121;
Second year: CPEN 214, 315, 315L, CPSC 250, 250L, CPSC 270, ENGR 213, 340, PHYS 201, 201L, 202, 202L;
Third year:   CPEN 371W, 414,  CPSC 327, ENGR 211, 211L, 212, 212L , MATH 320, PHYS 341; CHEM 121, 121L, ECON 201 or 202;
Fourth year: CPEN 431, CPEN 498W, CPSC 410, CPSC 420, two professional electives, CHEM 122.

**The Bachelor of Science Degree in Electrical Engineering**

Electrical engineers design and fabricate electrical devices and systems that have become an indispensable part of our lives. The program of study is to provide each graduate with a firm foundation in electrical engineering principles while gaining the tools to adapt to the technical changes and career opportunities they will experience in the future. The electrical engineering undergraduate curriculum begins with a solid foundation in mathematics and science. After the freshman year, we adopt a comprehensive approach by covering traditional electrical engineering areas in circuits, electronics, digital systems, control and communication. Adequate elective freedom is available to allow specialization in three emphasis areas: digital systems, control and instrumentation, communication and signal processing. The goal is to prepare our students with one or more most common electrical engineering specialties. Emphasis is placed on understanding principles through theoretical investigation and experimental verification.

The Program Educational Objectives of the Electrical 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 electrical engineers, and/or will be enrolled in programs of graduate or professional study.

2. Our graduates, collectively, will be competent working on both traditional and emerging electrical engineering positions, and thus will have applied their knowledge and skills in a wide variety of engineering related 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 student outcomes for the electrical engineering program specify that, by the time of graduation, our graduates will have:

- an ability to apply knowledge of mathematics, science, and electrical engineering
- an ability to design and conduct experiments, as well as to analyze and interpret data
- an ability to design hardware and software systems to meet desired needs within realistic constraints
- an ability to function on multidisciplinary teams
- an ability to identify, formulate, and solve software and hardware engineering systems problems
- an understanding and appreciation of professional and ethical responsibility
- an ability to communicate effectively orally and in writing
- the liberal education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context
- a recognition of the need for, and an ability to engage in life-long learning
- a knowledge of contemporary issues
- an ability to use the techniques, skills, and engineering design automation tools necessary for effective electrical engineering practice

The curriculum in electrical engineering has mixtures of the particular and the general, theoretical, and experimental, along with strong components in design and integration. Compared to a purely theoretical approach, we adopt a curriculum that focuses on analysis and design using current technologies, and the one that emphasizes an applied approach. There is a comprehensive laboratory component to provide a hands-on experience. Most of the EE courses have either a dedicated laboratory companion course or a laboratory component built into it. This approach is inherently more interesting to students, and leads students toward more individual learning. Degree studies requirements are those of the Bachelor of Science degree. In addition to requiring successful completion of the liberal learning curriculum, the electrical engineering major requires successful of the following courses with no more than two grades below C-:

1. ECON 201or 202;
2. CHEM 121/121L-122;
3. PHYS 201/201L-202/202L, 341;
4. MATH 140 or 148, 240, 320;

5.  MATH 250 or 335 or ENGR 213;
6.  CPSC 150/150L-250/250L, 327
7.  CPEN 214, 371W;
8.  ENGR 121, 211/211L, 212/212L, 340;
9.  EENG 221, 311/311L, 321/321L, 361/361L, 498W;
10. Minimum of twelve hours professional electives from following list, at least one of the three areas of emphasis must be completed:
    a.  Digital Systems: CPEN 315/315L, CPEN 414;
    b.  Control: EENG 421, CPEN 422;
    c.  Communication: EENG 461, EENG 481

**The Bachelor of Science degree in Computer Foundations**
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 successful completion of the following courses with no more than two a grades below *C*-:

1.  CPEN 214;
2.  CPSC 150/150L-250/250L;
3.  PHYS 201/201L-202/202L, 301, 303, 304, 340, 341, 351, 402, and 406;
4.  Select one: PHYS 401 or 404[1];
5.  ENGR 211/211L;
6.  MATH 140 or 148, 240, 250, 320;
7.  PCSE 498W (3 credit Capstone course).

8.  Select two: ENGR 212/212L; MATH 350 or 355, any 300-level or higher PHYS course(s) that is not already listed as required above.

[1]The student must take either PHYS 401 or 404 as part of their degree requirements. Students planning on graduate school in physics are encouraged to complete the other as a major elective. Students in the five-year program should take the cross-listed graduate course PHYS 501 or 504.

**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, 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. See your adviser 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 successful completion of the following courses with no more than two grades below *C*-:

1.  CPEN 214, 371W;
2.  CPSC 125, 150/150L-250/250L, 270, 280, 327, 360, 410, 420;
3.  MATH 140 or 148, 240;
4.  PHYS 151/151L-152/152L or PHYS 201/201L-202/202L and PHYS 340 or ENGR 340 or MATH 235 or 260;
5.  ENGR 213;
6.  PHYS 341;
7.  Select three: CPSC 425, 428, 440, 450, 460, 470, 471, 475, 480, 485, 495; any 500 level course with adviser's permission; MATH 380; PHYS 421, 441; with courses numbered 495 and above used no more than twice;
8.  CPSC 498 (3 credit Capstone course).

**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 successful completion of the following courses with no more than two grades below *C-*:

1. CPEN 371W;
2. CPSC 125, 150/150L-250/250L;
3. ENGR 213;
4. MATH 140 or 148; 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, 327, 335, 336, 355, 360, 425, 428, 446, 475, 485, 495; any CPSC 500 level course with adviser'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 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 of the following courses with no more than two grades below *C-*:

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 or 148, 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, 475, 485; PSYC 201-202, 303, 313; BUSN 311, 323, 370 or 371.

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

**The Minor in Applied Physics (26 credits)**

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

**The Minor in Computer Science (20 credits)**

The minor in computer science requires a minimum of 20 credits in computer science, including: CPSC 125, 150/150L- 250/250L, 270 or 280, and six 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 six 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, CPSC 270, 330, 420; (3) Mathematics application: CPSC 270, 350, 420. *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 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. See the *Graduate Catalog* for application instructions and requirements. 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; 310 or 430, and 316;
- COMM 201 or THEA 230;
- CPSC 110;
- MATH 109, 125;
- HIST 111, 121, 122;
- POLS 101;
- GEOG 210;
- PSYC 208, 312;
- SOCL 314/314L;
- BIOL 107 or 108; CHEM 103; PHYS 141; PHYS 105L or BIOL 109L;
- NSCI 310.

*Support courses may change based on regulations from the Virginia Department of Education.

Graduate courses* required (senior year):
Select six credits from a), b), or c):
   a) MATH 570;
   b) PSYC/TCHG 544;
   c) MLAN 511, ENGL 530.

**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, and 312; SOCL 314/314L.

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: CPSC 125 or ENGR 121 or PHYS 152 or 202.*
*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: grade of C- or higher in CPEN 214.*
*Restricted to CPEN, EE, or PHYS majors.*
*Pre or Corequisite: CPEN 315L.*
*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 with a C- or higher; 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 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 327, CPEN 214 .*
*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 315/315L , CPSC 270.*
*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)**
*Prerequisite: as announced.*
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 with a C- or higher and senior standing.*
*Pre or corequisite: CPEN 371W or consent of instructor.*
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 writing intensive requirement. May be taken as research intensive. **This course is repeatable twice for a total of three credits.**

## THE CURRICULUM IN COMPUTER SCIENCE

**CPSC 110. Introduction to Computing (3-3-0) LLFR**
*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. Satisfies the logical reasoning foundation requirement.

**CPSC 125. Foundations of Computer Science (3-3-0)**
*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 130L. Beginning Programming Lab (1-0-2)**
*Fall.*
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 140. Introduction to Computer Programming with Multimedia (3-3-0) LLFR**
*Fall.*
This course is an introduction to computer programming via multimedia using a simple yet powerful language. Topics include programming language concepts, data types & operations, expressions, symbolic logic, conditionals, loops, functions, and basic data structures. Assignments will be multimedia-oriented, such as a simple photo shop-like application, an animation generator, and a simplified iTunes-like application.

**CPSC 150. Computers and Programming I (3-3-0) LLFR**
*Prerequisite: C- or higher in one of the following: MATH 128, CPSC 125, CPSC 130L, ENGR 121, or a passing score on the CPSC 150 readiness exam.*
*Fall and Spring.*
This course is an introduction to problem solving and programming. Topics include using primitive and object types, defining Boolean and arithmetic expressions, using selection and iterative statements, defining and using methods, defining classes, creating objects and manipulating arrays. Emphasis is placed on designing, coding and testing programs using the above topics. Satisfies the logical reasoning foundation requirement.

**CPSC 150L. Computers & Programming I Laboratory (1-0-3)**
*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)**
*Prerequisite or corequisite: MATH 135 or 140 or 148, or a passing score on the CPSC 215 Readiness Test.*
*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)**
*Prerequisite: CPSC 125 or 140 or consent of 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)**
*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)**
*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 327. C++ Programming (3-3-0) [Formerly CPSC427, equivalent]**
*Prerequisite: CPSC 250/250L.*
*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 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 or 148.*
*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, 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.*
*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)
*Prerequisite: A grade of C- or higher in CPSC 110 or 125 or 150 or 215.*
*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 327 and CPEN 214.*
*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.*
*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 428. Cryptography and Network Security (3-3-0)
*Prerequisite: CPSC 250, MATH 135 or 140 or 148, 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 (3-3-0)
*Prerequisites: MATH 125; MATH 135 or 140 or 148; 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 250 and 250L.*
*Fall.*
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 with a C- or higher; 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  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  330, 360.*
*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 270, 360; 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 the mathematical and computational foundations of artificial intelligence. Its emphasis is on those elements of artificial intelligence that are most useful for practical applications. Topics include heuristic search, problem solving, game playing, knowledge representation, logical inference, planning, reasoning under uncertainty, expert systems, machine learning, and language understanding. Programming assignments are required.

### CPSC 475. Android Mobile Computing (3-3-0)
*Prerequisite: A grade of C- or higher in CPSC 250.*
*Spring.*
This course covers core concepts of the Android programming platform and its key components using the Android SDK and the Java programming language.  Topics discussed include application lifecycle, user interface design, activities and intents, data persistence, networking, messaging, location-based applications, and android services.

### 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)
*Prerequisite:  as announced.*
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: A grade of  C- or higher in CPSC 270 and senior standing; or consent of the instructor.*
Directed projects or research under the supervision of a faculty member.

## The Curriculum in Electrical Engineering

### EENG 221. Signals and Systems (3-3-0)
*Prerequisite: A grade of C- or higher in MATH 240.*
*Spring.*
This course covers the fundamental concepts of continuous-time and discrete-time signals (singularity functions, complex exponentials, Fourier representations, Laplace and Z transforms, sampling) and representations of linear, time invariant systems (difference and differential equations, block diagrams, system functions, poles and zeros, convolution, impulse and step responses, frequency responses).

## EENG 311. Electric Circuits II (3-3-0)

*Prerequisite: A grade of C- or higher in ENGR 211.*
*Corequisite: EENG 311L.*
*Fall.*

This course covers advanced concepts of electric circuits including sinusoidal steady state response, sinusoidal steady-state power, three-phase circuits, Laplace and Fourier transforms, frequency selective circuits and active filters.

## EENG 311L. Electric Circuits II Lab (1-0-3)

*Pre or corequisite: A grade of C- or higher in EENG 311.*
*Fall.*

Laboratory experiences to accompany the lecture part of this course. The laboratory activities emphasize design and analysis principles taught in the lecture. Lab experiments include characterizing and testing Sinusoidal steady state response of RLC circuits, Sinusoidal steady state power, three-phase circuits, frequency selective circuits and active filters.

## EENG 321. Control Systems (3-3-0)

*Prerequisite: A grade of C- or higher in EENG 221.*

This course deals with the fundamental principles for analysis and design of control systems. Topics include dynamic modeling, dynamic response, basic properties of feedback, root-locus design method, frequency-response design method, and state-space design.

## EENG 321L. Control System Laboratory (1-0-3)

*Pre or Corequisite: EENG 321.*

Laboratory experiences to accompany the lecture part of this course. The laboratory activities stress fundamental principles of the lecture course. These include the modeling of dynamic systems, various design techniques of feedback controller, and implementation of control systems.

## EENG 361. Communication Systems I (3-3-0)

*Prerequisite: A grade of C- or higher in EENG 221.*

This course covers topics in digital and analog communications, including modulation techniques, noise considerations, performance aspects, and selected applications.

## EENG 361L. Communication Systems Laboratory (1-0-3)

*Pre or Corequisite: A grade of C- or higher in EENG 361.*

Laboratory experiences to accompany the lecture part of this course. The laboratory activities stress fundamental principles of the lecture course including frequency response of systems, filtering, and various modulation techniques.

## EENG 421. Industrial Control and Data Acquisition (3-3-0)

*Prerequisite: A grade of C- or higher in EENG 321.*

Elements of industrial control systems: sensors, actuators, and controllers. This course will emphasize PID controllers and industrial process control, including PLC. Introduction of data acquisition systems, A/D and D/A conversion, sampling theory; case study on data acquisition systems will be studied as well as tools and methods used for realization, analysis and assessment of industrial control and data acquisition systems.

## EENG 461. Communication Systems II (3-3-0)

*Prerequisite: A grade of C- or higher in EENG 361.*

This course covers the fundamentals of wire and wireless communication systems, including data compression, error correction, modulation techniques, and channel access.

## EENG 481. Digital Signal Processing (3-3-0)

*Prerequisites: A grade of C- or higher in both EENG 221, MATH 320.*

This course presents time and frequency domain analysis, difference equations, z-transform, FIR and IIR digital filter design, discrete Fourier transform, FFT, and random sequences.

## EENG 498. WI: Electrical Engineering Capstone Project (Variable 1-3)

*Prerequisites: ENGL 223 and CPEN 371W each with a grade of C- or higher.*
*Restriction: senior standing.*
*Spring and fall.*

Capstone design project in which a senior student completes a practical electrical 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 Writing Intensive requirement. May be taken as research intensive.

# THE CURRICULUM IN ENGINEERING

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

*Pre or corequisite: MATH 130 or 140 or 148.*
*Fall.*

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.*
Introduction to basic solid state electronic devices including diodes and transistors and their operating principles. Modeling and analysis of electronic circuit biasing and small signal operation. Applications of discrete and integrated devices in analog electronic circuits.

**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.*
Fundamental mathematical tools used in the analysis of algorithms and data structures, including logic, sets and functions, recursive algorithms and recurrence relations, combinatorics and graphs.

**ENGR 340. Mathematical Methods for Engineers and Scientists (3-3-0)**
*Pre or corequisite: MATH 240.*
*Fall.*
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 non-science 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 or 148.*
*Fall and spring.*
This is a first semester, calculus-based introductory physics course. Basic principles of mechanics are developed. Topics include units, measurement, vectors, displacement, velocity, acceleration, force, equilibrium, mass, Newton's laws, work, energy and momentum.

### PHYS 201L. General Physics Laboratory (1-0-3) AINW
*Pre or corequisite: PHYS 201.*
*Fall.*
The first semester of physics laboratory experiences to accompany the lecture part of the course. The laboratory introduces experimental techniques, data analysis and data analysis tools, and technical report writing utilizing the fundamental physical principles introduced in the lecture portion of the course. 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.*
This is a second semester, calculus-based introductory physics course. The course covers electricity, including electrostatics and electric fields, Gauss's law, electric potential, capacitors, dielectrics, current, resistance, DC circuits, magnetic fields, inductance and AC currents.

### PHYS 202L. General Physics Laboratory (1-0-3) AINW
*Pre or corequisite: PHYS 202.*
*Spring.*
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 301. Intermediate Classical Mechanics (3-3-0)
*Prerequisite: A grade of C- or higher in PHYS 201 and MATH 250. Corequisite: MATH 320 .*
*Spring.*
This is the first semester of a two semester sequence in classical mechanics. This course will lay the foundation for

PHYS 401. The topics for this course include: conservative force analysis, motion under linear and quadratic friction, rocket motion, driven-damped harmonic motion, normal modes, motion in non-inertial reference frames, and analysis of rigid body rotation.

### PHYS 303. General Physics (3-3-0)
*Prerequisite: PHYS 202. Corequisite: MATH 250.*
*Fall.*
This is a one semester introduction to waves, thermodynamics and optics. Topics include oscillations, mechanical waves, sound, the Doppler effect, superpostion, standing waves, temperature, heat, equations of state, thermodynamic processes, heat engines, refrigerators, first and second laws of thermodynamics, entropy and geometric optics.

### PHYS 304. Electrostatics (3-3-0)
*Prerequisite: A grade of C- or higher in PHYS 202.*
*Corequisite: MATH 320.*
*Fall.*
This is the first semester of a two semester sequence in electricity and magnetism. This course will lay the foundation for PHYS 404. The topics for this course include Gauss's law, Coulomb's law, Laplace's equation, Poisson's equation, electric fields in matter, magnetostatics and magnetic fields in matter.

### 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, 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.*
*Fall.*
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 or 148.*
*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)
*Prerequisite: PHYS 202 and MATH 240.*
*Spring.*

This is a one-semester introduction to the field of astrophysics. It focuses on the application of calculus-based math to study modern astrophysics. Topics include: celestial mechanics, space weather, the nature of life-cycle of stars and the solar system.

### PHYS 351. Modern Physics (3-3-0)
*Prerequisite: PHYS 303.*
*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.*
*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. Advanced Topics in Mechanics (3-3-0)
*Prerequisite: PHYS 301, 340; MATH 250, 320.*
*Fall.*

This is the second semester of a two semester sequence in classical mechanics. It builds upon a foundation of mechanics studies in PHYS 301. The topics for this course include: scattering theory, the calculus of variations, Lagrangian mechanics, Hamiltonian mechanics, chaos theory, continuum mechanics, and special relativity with tensors.

### PHYS 402. Quantum Physics (3-3-0)
*Prerequisites: PHYS 301, 351; MATH 250, 320; MATH 260 or PHYS 340.*
*Spring.*

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

### PHYS 404. Electrodynamics (3-3-0)
*Prerequisite: PHYS 304, and MATH 250 and 320.*
*Spring, odd-numbered years.*

This is the second semester of a two semester sequence in electricity and magnetism. It builds upon a foundation of electrostatics studied in PHYS 304. The topics for this course include electromotive force, Faraday's law, Maxwell's equa-

tions, conservation laws, electromagnetic waves, potentials and fields, radiation and relativity.

### PHYS 406. Thermodynamics (3-3-0)
*Prerequisites: MATH 320, PHYS 351.*
*Spring.*

An in-depth review of classical thermodynamics as introduced in PHYS 303 (temperature; ideal gas law; zeroth, first, and second laws, heat capacity; phase changes, heat transport; thermodynamic processes; heat engines and refrigerators; reversibility, irreversibility and entropy) and an introduction to statistical physics (microstates and macrostates), the multiplicity function, the Boltzmann and Gibbs factors, the partition function, thermodynamic potentials, the cononical and grand cononical ensembles Fermi-Dirac and Bose-Einstein gases, Debye Theory.

### PHYS 421. System Design Lab (Data Acquisition) (3-3-0)
*Prerequisite: ENGR 211/211L; CPEN 214; CPSC 250/250L.*
*Fall.*

The investigation of advanced physics in an experimental laboratory. Design of experiments. The study of experimental techniques and methodologies with a focus on optimization and efficiency. The use computers as data acquisition systems. Development of data acquisition and analysis software.

### PHYS 431. Optical Physics (3-3-0)
*Prerequisite: PHYS 303, 304, 340.*
*Fall, odd-numbered years.*

A continuation of the fundamentals studied in PHYS 303. Topics include: electromagnetic waves in media, polarization, radiometry and photometry, the Fresnel equations, dispersion, matrix methods in geometrical optics, H-planes, interferometry, and diffraction.

### 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.*

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.

### PHYS 495. Special Topics (credits vary 1-3)
*Prerequisite: as announced.*
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 adviser. This course is subject to the University policy on independent study (see index).

**PCSE 395. Special Topics (credits vary 1-3)**
*Prerequisite: as announced.*
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 adviser. 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)**
*Prerequisite: as announced.*
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 223 with a C- or higher; CPEN 371.*
Directed research or projects under the direction of a faculty adviser. Partially satisfies the writing intensive requirement. 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 adviser. This course is regulated under the University Policy on Independent Study (see General Academic Policies section of this catalog for details).