**PHYSICAL COMPUTING AND CONTROL SYSTEMS**
**COURSE CODE: 5379**

**COURSE DESCRIPTION:** In Physical Computing and Control Systems course, students will explore basic development, building, and programming of various computing devices. Students will also work hands-on in teams and document their progress. Topics discussed include hardware, software, programming, electronic theory and computing devices, including motor controls, gear ratios, torque, friction, sensors, timing, program loops, logic gates, timing sequences, and propulsion systems. 21st century skills of collaboration, creativity, decision-making, and teamwork are stressed throughout the course.

**OBJECTIVE:** Given the necessary equipment, software, supplies, and facilities, the student will be able to successfully complete the following core standards for courses that grant one unit of credit.

**PREREQUISITE:** Introductory Computer Science course

**COMPUTERS REQUIRED:** One computer per student

**CREDIT:** 1 unit (120 hours)

**RECOMMENDED GRADE LEVEL:** 9-12

**COURSE SUGGESTION:**

Students are expected to have an understanding of computer programming, at least through object-oriented programing. This course is designed to be language-agnostic. Local advisory committees should be involved in deciding which language(s) to offer in a particular district/school.

## A. GENERAL SAFETY

**Proficient professionals know the academic subject matter, including safety as required for proficiency within their area. They will use this knowledge as needed in their positions. The following accountability criteria are considered essential for students in any program of study.**

1. Review school safety policies and procedures.
2. Review classroom safety rules and procedures.
3. Review safety procedures for using equipment in the classroom.
4. Identify major causes of work-related accidents in office environments.
5. Demonstrate safety skills in an office/work environment.

## B. STUDENT ORGANIZATIONS

**Proficient professionals know the academic subject matter, including professional development, required for proficiency within their area. They will use this knowledge as needed in their positions. The following accountability criteria are considered essential for students in any program of study.**

1. Identify the purpose and goals of a Career and Technology Student Organization (CTSO).
2. Explain how CTSOs are integral parts of specific clusters, majors, and/or courses.
3. Explain the benefits and responsibilities of being a member of a CTSO.
4. List leadership opportunities that are available to students through participation in CTSO conferences, competitions, community service, philanthropy, and other activities.
5. Explain how participation in CTSOs can promote lifelong benefits in other professional and civic organizations.

## C. TECHNOLOGY KNOWLEDGE

**Proficient professionals know the academic subject matter, including the ethical use of technology as needed in their positions. The following accountability criteria are considered essential for students in any program of study.**

1. Demonstrate proficiency and skills associated with the use of technologies that are common to a specific occupation.
2. Identify proper netiquette when using e-mail, social media, and other technologies for communication purposes.
3. Identify potential abuse and unethical uses of laptops, tablets, computers, and/or networks.
4. Explain the consequences of social, illegal, and unethical uses of technology (e.g., piracy; illegal downloading; cyberbullying; licensing infringement; inappropriate uses of software, hardware, and mobile devices in the work environment).
5. Discuss legal issues and the terms of use related to copyright laws, Creative Commons, fair use laws, and ethics pertaining to downloading of images, photographs, Creative Commons, documents, video, sounds, music, trademarks, and other elements for personal use.
6. Describe ethical and legal practices of safeguarding the confidentiality of business-related information.
7. Describe possible threats to a laptop, tablet, computer, and/or network and methods of avoiding attacks.

## D. PERSONAL QUALITIES AND INTERPERSONAL SKILLS

**Proficient professionals know the academic subject matter, including positive work practices and interpersonal skills, as needed in their positions. The following accountability criteria are considered essential for students in any program of study.**

1. Demonstrate creativity and innovation.
2. Demonstrate critical thinking and problem-solving skills.
3. Demonstrate initiative and self-direction.
4. Demonstrate integrity.
5. Demonstrate work ethic.
6. Demonstrate conflict resolution skills.
7. Demonstrate listening and speaking skills.
8. Demonstrate respect for diversity.
9. Demonstrate customer service orientation.

10. Demonstrate teamwork.

## E. PROFESSIONAL KNOWLEDGE

**Proficient professionals know the academic subject matter, including positive work practices and interpersonal skills, as needed in their positions. The following accountability criteria are considered essential for students in any program of study.**

1. Demonstrate global or "big picture" thinking.
2. Demonstrate career and life management skills and goal-making.
3. Demonstrate continuous learning and adaptability skills to changing job requirements.
4. Demonstrate time and resource management skills.
5. Demonstrates information literacy skills.
6. Demonstrates information security skills.
7. Demonstrates information technology skills.
8. Demonstrates knowledge and use of job-specific tools and technologies.
9. Demonstrate job-specific mathematics skills.
10. Demonstrates professionalism in the workplace.
11. Demonstrates reading and writing skills.
12. Demonstrates workplace safety.

## F. INTRODUCTION TO PHYSICAL COMPUTING

**Computer scientists and engineers demonstrate an understanding of the importance and global impact of the integration of computer science and electronic engineering to develop computer software and hardware to solve real-world problems. The following accountability-criteria are considered essential for students in the Information Technology programs of study.**

1. Analyze sources and uses of computing devices in society and industry.
2. Illustrate the global history of computing and automation.
3. Debate the impact of computing and automation on culture and society.
4. Demonstrate how the Internet of Things (IoT) has addressed the needs of society.
5. Create a model of a solution to a real-world problem or scenario.
6. Diagram the conversions of high-level languages to lowest level (machine language).

## G. OVERVIEW OF CIRCUITS AND ELECTRONICS

**Computer scientists and engineers demonstrate basic understanding of the significance and use of electronics in physical computing. The following accountability-criteria are considered essential for students in the Information Technology program of study.**

1. Identify the equations that calculate the resistance, current, and voltage of simple circuits.
2. Calculate circuit resistance, current, and voltage using Ohm's law and Kirchoff's Laws, including circuits with elements in series and/or parallel.
3. Differentiate analog and digital signals and their conversions.
4. Explain the use of microcontrollers, sensors, motors, registers, and other hardware components used in physical devices...

5. Create/build a circuit implementing electronic components.

## H. BASIC PROGRAMMING SKILLS AND APPLICATION

**Computer scientists and engineers design and develop a program that controls a device to solve a real-world problem. The following accountability-criteria are considered essential for students in the Information Technology programs of study.**

1. Prepare program documentation to include:
   a. statement of purpose and collection of requirements
   b. algorithms
   c. flow diagram
   d. inputs and outputs, from users or devices
2. Implement the programming design process:
   a. Make use of standard programming logic within pseudocode.
   b. Develop a program from the pseudocode.
   c. Apply different commenting styles and techniques (including header, procedural, inline).
   d. Debug the program for syntax and build errors.
   e. Execute the program to test the logical validity of an application program given appropriate data.
   f. Debug the program for runtime and logic errors...
3. Present results of a solution to a real-world problem.

## I. CONTROL SYSTEMS

**Computer scientists and engineers build a combination of control systems that supports complex execution, readability, and program performance. The following accountability criteria are considered essential for students in the Information Technology programs of study.**

1. Describe the purpose and scope of variables (e.g., local and global).
2. Choose the appropriate type of variables to store data that represents the properties of sensors and other components of a device used in a program (e.g., integers, Booleans, strings, doubles, floats, objects).
3. Summarize the differences of Sequential Programming and Event Driven Programming.
4. Develop a program that correctly utilizes conditionals (if, else if, else, switch) to produce multiple outcomes based on input received from a device's sensors or components.
5. Develop a program that correctly utilizes the different control structures (e.g., sequence logic, selection logic, iteration logic) to basically analyze and choose in which direction a program flows based on certain parameters and conditions of a device or its components.
6. Develop a program that correctly utilizes loops (e.g., for, while, do) to produce multiple outcomes based on input given from a device.
7. Trace execution flow of a program that uses a variety of programming constructs that can be used to control a device and its components (e.g., procedures, modules, objects).
8. Design and develop a program that combines control structures (e.g., conditionals, loops, event handlers) to manipulate a device and its components

9. Trace the execution flow of a program that uses a combination of control structures (e.g., conditionals, loops, event handlers) that were used to maneuver a device and control its components.
10. Design a solution to a real-world problem using learned programming techniques by demonstrating the manipulation of a device and its components.

## J. PHYSICAL COMPUTING ENVIRONMENTAL SAFETY

**Computer scientists and engineers practice appropriate safety practices. The following accountability-criteria are considered essential for students in the Information Technology programs of study:**

1. Identify increased ergonomic risks with new forms of human-machine interaction.
2. Analyze exposure to new human and machine risks, such as electromagnetic fields, diodes, capacitors, lasers, blue light eye strain, and electrostatic discharge (ESD), etc.
3. Practice preventative measures to reduce accidents that result from lack of understanding, knowledge, or control of robotic work processes.
4. Identify software used to reduce loss of data and unauthorized access of physical computing devices (e.g., encrypted passwords, antivirus software, firewalls, and hardened networking devices.)
5. Identify and use hardware to limit physical harm resulting from moving parts (e.g., hard-wired brakes, dead-man switches, and fail safes)
6. Identify and use appropriate safety attire.
7. Practice preventative safety measures when using lab equipment and tools.

## K. INNOVATION AND CREATIVITY

**Computer scientists and engineers understand the impact of innovation and creativity in the physical computing field. The following accountability-criteria are considered essential for students in the Information Technology program of study.**

1. Analyze laws protecting data, hardware, software, consumer safety, and intellectual property.
2. Conjecture on the positive and negative impacts of the interaction between devices and humans.
3. Compare and contrast advantages and disadvantages between machine learning and artificial intelligence.

## L. PROFESSIONAL DEVELOPMENT

**Computer scientists and engineers demonstrate an understanding of the potential career paths of professionals in Physical Computing field and the further education. The following accountability-criteria are considered essential for students in the Information Technology programs of study.**

1. Explore career opportunities in the physical computing field.
2. Select and research skills, education, career outlook, salaries/benefits, work environment, required certifications, etc.
3. Research current events concerning the ethical and social impacts of using various physical

computing devices (e.g., robots, drones, VR, autonomous vehicles, etc.)

Additional Materials and Resources

Course Academic Standards and Indicators

Computer Science Academic Standards and Indicators