Burlington County Institute of Technology

Medford Campus

Career and Technical Programs

Career Cluster: *Information Technology*
Program Name: *Computer Engineering, General*
Program Title: *Computer Engineering*
CIP Code: *140901*

Board Approval Date: August, 2023

Program of Study

- ➔ Grade 9
  - Freshman Engineering Clinic
  - Computer Aided Design (CAD) Fundamentals: EGR 110
- ➔ Grade 10
  - Sophomore Engineering Clinic
  - Analog Circuits
  - Intro to Computer Science I - C++ Programming CSE 110
- ➔ Grade 11
  - Computer Architecture /Digital Electronics
  - Intro to Computer Science II - Python
  - Intro to Embedded Systems - Arduino and Raspberry Pi
- ➔ Grade 12
  - Machine Learning with Python
  - Green Engineering
  - Robot Vehicles
  - Senior Project

➔ Program Descriptor

- The Computer Engineering Technology program caters to students with a keen interest in advancing their engineering education or directly entering the workforce. It encompasses a well-rounded curriculum that combines theoretical knowledge with hands-on practical applications. The program covers a range of essential competencies, including mastering the engineering design process, using measurement tools and an array of hand tools, and creating 3D models from real-world objects. Additionally, students gain proficiency in crafting prototypes using additive and subtractive manufacturing techniques, as well as in developing software programs using C++ and Python. The curriculum also hones abilities in data collection and analysis, construction of machine learning image classification systems, and working with embedded systems. Furthermore, students become adept at safely operating diverse electronics measurement equipment, while also acquiring a deep understanding of the design and analysis of both passive and active electronic components within circuits. Notably, the program places a strong emphasis on nurturing essential soft skills, such as effective written and oral communication, collaborative teamwork, critical thinking, and efficient time management. This multifaceted approach equips graduates with a comprehensive skill set, positioning them for success in their chosen careers and further educational pursuits.

➔ Program Outcome

- Upon successfully completing the Computer Engineering Technology Academy, graduates will hold the essential skills and competencies necessary for embarking on entry-level employment opportunities, while also laying a solid groundwork for their pursuit of higher education. This course equips students with the potential to accumulate as many as 12 credits, which can be applied towards an Associate's Degree in Computer Engineering Technology, thanks to the collaborative partnership with Rowan College at Burlington County (RCBC).

➔ Work Based Learning Opportunities

- Simulated workplace
- Cooperative Education Experience

➔ Industry Valued Credentials

- Autodesk certified user
- Arduino certification

- OSHA 10

➔ Post-Secondary Articulations

- Rowan College at Burlington County
  - Computer-Aided Design (EGR 110)
  - Analog Circuits (EET 121)
  - C++ Programming (CSE 110)
  - Digital Electronics (EET 240)

Course Descriptions

1. Grade 9
    a. *Freshman Engineering Clinic* - The purpose of this course is to introduce the engineering design process to the students. Students will develop a sense of engineering ethics, critical thinking, and technical documentation while working on various projects. Additionally, presentations will be given on individual or team projects to establish oral communication skills and confidence in their work. Mechanical and electrical topics will be incorporated in lecture and lab modules. Lecture topics include: measurement, tool safety, technical communication, using analytic and computer-based tools, and the engineering design process.
    b. *Computer Aided Design (CAD) Fundamentals* - This course covers beginning to intermediate 2-dimensional and 3-dimensional design in industry standard modeling software with an emphasis on developing manual sketching skills to transfer to CAD. Students will develop design and analysis skills on physical objects in order to model them and create standard design drawings. The students will also learn how to use proper measurement techniques and the uncertainty involved in measurement.
2. Grade 10
    a. *Sophomore Engineering Clinic* - Within this course, a proactive approach towards interdisciplinary teamwork will be fostered, alongside the cultivation of students' proficiency in engineering-related professional and technical writing. An emphasis on effective communication strategies, coupled with the refinement of engineering design capabilities, will be a cornerstone of the curriculum. Through engaging experiences, students will delve into the realm of standard measurement devices, hand tools, machine tools, and the rapid prototyping techniques integral to the manufacturing process. An important facet of the course involves encouraging students to actively collaborate with the advanced manufacturing shop, thereby amplifying their practical exposure. The hands-on exercises carried out during the course will yield valuable data, which will subsequently be documented through the lens of technical writing.

b. *Analog Circuits* - This course introduces the basics of analog electronics, circuit analysis, and knowledge of electronics measurement equipment. Each week a new topic is introduced along with a hands-on activity to be performed in class. Safety while performing labs will be emphasized to protect students and equipment.
c. *C++ Programming*- This course is an introduction to the fundamental concepts of programming and problem solving. It focuses on simple data types, control structures, and introduction to array and string data structures and algorithms, as well as debugging techniques and the social implications of computing. It emphasizes good software engineering principles and developing fundamental programming skills in the context of a language that sports the object-oriented paradigm. The lab component provides hands-on programming experience that is vital for beginning programmers in various fields of engineering.

3. Grade 11
    a. *Computer Architecture / Digital Electronics* - This course is an introduction to the theory and design of logic circuits used in computers and other digital systems. Topics covered in this course include numbers systems used in digital electronics, logic gates, combinational and sequential logic function and design, registers and counters, programmable logic devices, finite state machines, and digital computer systems. It emphasizes the representation of information, computer system logic, circuit analysis and design, processor architecture, and input/output devices.
    b. *Intro to Computer Science II* - This course builds upon the work completed in Intro to Computer Science I. It introduces the python programming language by reviewing concepts from CS I (data types, control structures, arrays, algorithms and debugging). The course then moves onto fundamental concepts of data structures and algorithms (such as queues, stacks, linked lists, hash tables, trees, and graphs). Additional lecture time will be devoted to standard python libraries. The assignments will provide hands-on programming experience.
    c. *Embedded Systems*- This course will introduce students to microprocessors and microcontrollers from instruction sets and architecture to peripherals and softwares. By the end of this course, students will be able solve a real world problem using an embedded system in their design solution. In using the embedded device, students will also learn how to use a modern integrated development environment. Project based learning and teamwork will be emphasized
4. Grade 12

a. *Machine learning with Python* -Engaging in data analysis, students will construct a machine learning model encompassing various facets. The curriculum will encompass teachings on utilizing regression, classification, and clustering techniques. In a practical application, students will embark on the development of a real-world project that effectively employs their acquired machine learning model.
b. *Green engineering* - The primary objective of this course is to impart knowledge to students regarding renewable energy sources. Throughout the course, students will gain insights into various categories of renewable energy sources, as well as an understanding of the advantages and disadvantages associated with each type. A collaborative approach will be fostered as students work together in small teams to conceive, design, and implement a renewable energy solution tailored to benefit the local community.
c. *Robot vehicles* - This course provides an introduction to robotics and vehicles.. The students will learn the basics of mechanical, electrical, and software engineering in relation to creating a robotic vehicle. Studies will include lessons on gearing, powertrains, electric motors, battery management, sensors, and software-based decision making. The students will create a robot vehicle that utilizes engineering design principles.
d. *Senior Project* - During this course, senior students will be presented with a distinctive opportunity. They can opt to either continue their engagement with the EET Clinic or embark on the development of a self-conceived real-world design solution aimed at addressing a problem of their choosing. Following a well-structured timeline, students will participate in status meetings and adhere to milestone dates, all the while meticulously documenting their research findings and progression. Those engaged in the Clinic will skillfully manage tasks and delegate responsibilities to junior peers. Conversely, seniors collaborating on team projects will actively seek out domain experts and explore existing solutions, culminating in the creation of their own distinct design. At its core, the overarching aim of this course is to familiarize students with workplace schedules and the dynamics of collaborative teamwork, while collectively working towards a shared objective.

Curriculum Maps

Course: Safety	Unit: OSHA 10	Length: 1 Week

Standards

- 9.3.12.AG-FD.1 Develop and implement procedures to ensure safety, sanitation and quality in food product and processing facilities.
- 9.3.12.AC-CST.5 Apply practices and procedures required to maintain jobsite safety.
- 9.3.12.AR.2 Analyze the importance of health, safety and environmental management systems, policies and procedures common in arts, audio/video technology and communications activities and facilities.
- 9.3.12.ED.4 Evaluate and manage risks to safety, health and the environment in education and training settings.
- 9.3.HT-RFB.2 Demonstrate safety and sanitation procedures in food and beverage service facilities.
- 9.3.HU-ED.5 Evaluate safety and sanitation procedures associated with the early childhood education environment to assure compliance and prevent potential hazards.
- 9.3.LW.4 Conduct law, public safety, corrections and security work tasks in accordance with employee and employer rights, obligations and responsibilities, including occupational safety and health requirements.
- 9.3.LW-ENF.8 Explain the appropriate techniques for managing crisis situations in order to maintain public safety.
- 9.3.MN.3 Comply with federal, state and local regulations to ensure worker safety and health and environmental work practices.
- 9.3.MN-HSE.3 Demonstrates a safety inspection process to assure a healthy and safe manufacturing environment.

- 9.3.MN-HSE.5 Evaluate continuous improvement protocols and techniques in health, safety and/or environmental practices.
- 9.3.12.TD.5 Describe transportation, distribution and logistics employee rights and responsibilities and employers' obligations concerning occupational safety and health.
- 9.3.12.TD-HSE.1 Describe the health, safety and environmental rules and regulations in transportation, distribution and logistics workplaces.
- 9.3.12.TD-OPS.3 Comply with policies, laws and regulations in order to maintain safety, security and health and mitigate the economic and environmental risk of transportation operations.

Essential Question(s)

- Why is it important to practice safety?
- What do safe practices look like in my industry?
- How can I keep myself and others safe?

Content

- Walking working surfaces
- Emergency action plans
- Fire protection
- Electrocution hazards
- Personal protective equipment
- Hazard communication
- Materials handling, storage, use and disposal.

Skills

- Explain why OSHA is important to workers.
- Explain workers rights under OSHA
- Discuss employer responsibilities under OSHA.
- Discuss the use of OSHA standards.

- Explain how OSHA inspections are conducted.
- Utilize helpful worker safety and health resources.
- Identify hazards in the workplace associated with walking and working surfaces.
- Identify best practices for eliminating or controlling hazards associated with walking and working surfaces in the workplace.
- Recognize employer requirements to protect workers from walking and working surface hazards.
- Recognize benefits of an Emergency Action Plan.
- Identify elements of the Fire Protection Plan.
- Identify conditions under which evacuation actions may be necessary in an emergency situation.
- Identify conditions under which shelter-in-place may be necessary in an emergency situation.
- Identify characteristics of an effective emergency escape route.
- Recognize the five types of fire extinguishers, including the types of fires they can extinguish.
- Review requirements for proper maintenance of portable fire extinguishers.
- Identify major electrical hazards.
- Describe types of electrical hazards.
- Describe electrical protection methods.
- Recognize employer requirements to protect workers from electrical hazards.
- Recall employer responsibilities toward affected employees regarding PPE.
- Identify when face and head protection should be used.
- Recall which types of hand and foot protection should be used in a specific situation.
- Recognize the differences between respirator types.
- Identify the differences between full-body protection levels.
- Identify the employer's responsibilities under the HCS, including training requirements.
- Identify components of a Hazard Communication program.
- Describe requirements of the different types of Hazard Communication labels.
- Locate pertinent information about chemicals on labels, including other forms of hazard communication, to ensure "right to understanding" provisions of GHS requirements.
- Identify types of material handling equipment.
- Describe hazards associated with material handling activities (e.g., storage, use, and disposal).

- Identify methods to prevent hazards associated with material handling equipment.
- Recognize employer requirements to protect workers from material handling hazards
- Identify the main causes of machinery accidents.
- Recognize basic machinery parts that expose workers to hazards.
- Recognize workplace situations involving machinery that requires guarding.
- Identify the requirements for safeguards.
- Identify types of machine guards including types of devices used to safeguard machines.
- Identify strategies to control chemical hazards.
- Identify strategies to control biological hazards.
- Identify strategies to control physical hazards.
- Identify strategies to control ergonomic hazards.
- Identify OSHA requirements pertaining to bloodborne pathogens.
- List the potential routes of exposure from bloodborne pathogens.
- Identify the risks associated with Human Immunodeficiency Virus (HIV), Hepatitis B, and Hepatitis C Virus.
- Identify methods of preventing transmission of bloodborne pathogens & managing occupational exposures.
- Restate methods of the safe disposal of sharps.
- Recount steps which should be taken in the event of an exposure to a potential bloodborne pathogen.
- Recognize risk factors associated with work-related musculoskeletal disorders (MSD)s.
- Identify good posture.
- Describe safe lifting techniques.
- Identify ergonomic control methods for eliminating/reducing work-related MSDs.
- Identify the number one cause of death for U.S. teens.
- List eight risk factors for young drivers.
- Identify the biggest risk factor for young drivers.
- Define distracted driving.
- Provide examples and/or causes of distracted driving.
- Identify the biggest risk factor for distracted driving
- Discuss the risk of having other young passengers in the car.
- List some actions employers should take to keep employees safe while driving.

- List some actions employees can take to safely drive on the job.
- Define the term violence.
- Recall who is at risk for encountering workplace violence.
- Describe workplace violence prevention strategies.
- Identify how to StartSafe and StaySafe to prevent or lessen workplace violence.
- Recognize the costs of workplace accidents.
- Recognize the benefits of implementing an effective safety and health program.
- Describe the elements of an effective safety and health program.
- Identify three methods to prevent workplace hazards.

Assessments

- OSHA 10 Assessment and Certificate

Course: CTE	Unit: Career Awareness	Length: Woven Throughout

Standards

- 9.2.12.CAP.1: Analyze unemployment rates for workers with different levels of education and how the economic, social, and political conditions of a time period are affected by a recession.
- 9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
- 9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.

- 9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.
- 9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans. ·
- 9.2.12.CAP.6: Identify transferable skills in career choices and design alternative career plans based on those skills.
- 9.2.12.CAP.7: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest.
- 9.2.12.CAP.8: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors.
- 9.2.12.CAP.9: Locate information on working papers, what is required to obtain them, and who must sign them.
- 9.2.12.CAP.10: Identify strategies for reducing overall costs of postsecondary education (e.g., tuition assistance, loans, grants, scholarships, and student loans)
- 9.2.12.CAP.11: Demonstrate an understanding of Free Application for Federal Student Aid (FAFSA) requirements to apply for postsecondary education
- 9.2.12.CAP.12: Explain how compulsory government programs (e.g., Social Security, Medicare) provide insurance against some loss of income and benefits to eligible recipients.
- 9.2.12.CAP.13: Analyze how the economic, social, and political conditions of a time period can affect the labor market.
- 9.2.12.CAP.14: Analyze and critique various sources of income and available resources (e.g., financial assets, property, and transfer payments) and how they may substitute for earned income
- 9.2.12.CAP.15: Demonstrate how exemptions, deductions, and deferred income (e.g., retirement or medical) can reduce taxable income.
- 9.2.12.CAP.16: Explain why taxes are withheld from income and the relationship of federal, state, and local taxes (e.g., property, income, excise, and sales) and how the money collected is used by local, county, state, and federal governments. ·
- 9.2.12.CAP.17: Analyze the impact of the collective bargaining process on benefits, income, and fair labor practice. ·

- 9.2.12.CAP.18: Differentiate between taxable and nontaxable income from various forms of employment (e.g., cash business, tips, tax filing and withholding). ·
- 9.2.12.CAP.19: Explain the purpose of payroll deductions and why fees for various benefits (e.g., medical benefits) are taken out of pay, including the cost of employee benefits to employers and self-employment income.
- 9.2.12.CAP.20: Analyze a Federal and State Income Tax Return
- 9.2.12.CAP.21: Explain low-cost and low-risk ways to start a business.
- 9.2.12.CAP.22: Compare risk and reward potential and use the comparison to decide whether starting a business is feasible.
- 9.2.12.CAP.23: Identify different ways to obtain capital for starting a business

Essential Question(s)

- How does one prepare for a career?
- How does one improve marketability?
- Why is career planning important?
- What are the risks in starting a business?

Content

- There are strategies to improve one's professional value and marketability.
- Career planning requires purposeful planning based on research, self-knowledge, and informed choices.
- An individual's income and benefit needs and financial plan can change over time.
- Securing an income involve an understanding of the costs and time in preparing for a career field, interview and negotiation skills, job searches, resume development, prior experience, and vesting and retirement plans
- Understanding income involves an analysis of payroll taxes, deductions and earned benefits.
- There are ways to assess a business's feasibility and risk and to align it with an individual's financial goals

Skills

- Act as a responsible and contributing community member and employee.

- Attend to financial well-being.
- Consider the environmental, social and economic impacts of decisions.
- Demonstrate creativity and innovation.
- Utilize critical thinking to make sense of problems and persevere in solving them.
- Model integrity, ethical leadership and effective management.
- Plan education and career paths aligned to personal goals.
- Use technology to enhance productivity, increase collaboration and communicate effectively.
- Work productively in teams while using cultural/global competence.

Assessments

- Career Research Project
- Resume/Cover Letter

Course: Freshman Engineering Clinic Length: 1 marking period

Standards

- 9.3.ST-ET.1 Use STEM concepts and processes to solve problems involving design and/or production.
- 9.3.ST-ET.2 Display and communicate STEM information.
- 9.3.ST-ET.3 Apply processes and concepts for the use of technological tools in STEM.
- 9.3.ST-ET.4 Apply the elements of the design process.
- 9.3.ST-ET.5 Apply the knowledge learned in STEM to solve problems.
- 9.3.ST-ET.6 Apply the knowledge learned in the study of STEM to provide solutions to human and societal problems in an ethical and legal manner.

Essential Question(s)

- What is the engineering design process?
- How do you communicate effectively in teams?

Content

- Mastery of the Design Process:
  - Understand the stages of the design process from concept to implementation.
  - Apply iterative problem-solving techniques within the design process.
  - Demonstrate proficiency in generating and refining design concepts.
- Effective Team Collaboration:
  - Develop strong communication skills for effective teamwork.
  - Contribute positively to team dynamics and group decision-making.
  - Recognize the value of diverse perspectives within a team.
- Understanding of Engineering Ethics:
  - Identify ethical considerations in engineering design and decision-making.
  - Analyze and evaluate potential ethical dilemmas and their implications.
  - Demonstrate ethical decision-making in engineering scenarios.
- Comprehension of Product Lifecycle:
  - Outline the stages of a product's lifecycle, from conception to disposal.
  - Understand the importance of sustainability and environmental impact at each stage.
  - Apply lifecycle thinking to design, considering long-term implications.
- Proficiency in Reverse Engineering:
  - Understand the process of reverse engineering to deconstruct and analyze existing products.
  - Demonstrate the ability to extract valuable information from reverse engineering efforts.
  - Apply reverse engineering principles to improve or redesign products.
- Application of Decision Analysis:
  - Learn various decision analysis techniques to evaluate design alternatives.

- Demonstrate the ability to quantify and compare potential solutions.
- Make informed decisions by considering factors such as cost, feasibility, and performance.

Skills

- Effective Communication:
  - Develop clear and concise verbal and written communication skills.
  - Tailor communication style to effectively convey technical concepts to both technical and non-technical audiences.
  - Use visual aids and presentations to enhance communication effectiveness.
- Proficient Team Collaboration:
  - Demonstrate active participation and positive contribution within a team.
  - Foster open communication, respect diverse viewpoints, and resolve conflicts constructively.
  - Recognize and leverage individual strengths to achieve team goals.
- Skillful Technical Documentation:
  - Create comprehensive and organized technical documents, such as reports and manuals.
  - Accurately document design decisions, procedures, and outcomes.
  - Adhere to industry standards for technical documentation and formatting.
- Thorough Solution Analysis:
  - Apply systematic methods to analyze potential solutions and their feasibility.
  - Compare and contrast alternative solutions based on technical, economic, and environmental factors.
  - Utilize decision matrices and other analytical tools to aid in solution selection.
- Effective Prototype Development and Testing:
  - Design and construct prototypes that accurately represent the intended product.
  - Apply relevant testing methods to assess prototype performance and identify areas for improvement.
  - Iterate prototype designs based on testing results to refine the final solution.
- Application of Design Process to a Problem:

- Understand and apply the stages of the design process, from problem definition to implementation.
- Employ creative problem-solving techniques to generate innovative design concepts.
- Follow a structured approach to iteratively refine and develop solutions.

Assessments

- Self assessment
- Presentations
- Technical Reports
- Final Project

Course: CAD (computer aided drawing) Length: Semester

Standards

- 9.3.ST-SM.2 Apply science and mathematics concepts to the development of plans, processes and projects that address real world problems.

Essential Question(s)

- What is needed in a technical drawing?

- How do you communicate effectively in teams?
- Why is it important to recognize different perspectives in drawings?
- Explain advantages and disadvantages of each type of pictorial drawing.
- How do you visually process object views drawn on paper?
- Why are standards used for drawing dimensions?
- Why is it important to be consistent in using a measurement system?
- Why are there so many tools to measure objects?
- What is the significance of statistical information?
- How can we use technology to reduce errors in manufacturing?
- How do you know when to use subtractive versus additive techniques in 3D modeling?
- What shapes do you see in complex objects that can assist the creation of a 3D model?
- When considering the degrees of freedom, how can subassemblies be manipulated to properly complete the assembly?
- How do technical drawings relate to quality in manufacturing?
- What are the benefits of creating an exploded view of an assembly?
- How significant is the information that is found in a title block?
- How do team members collaborate to complete a complex project?
- Why is it important to document the process of creating a complex object in CAD?

Content

- Engineering Drawings:
  - Demonstrate proficiency in creating various types of drawings, including multiview, perspective, and pictorial drawings.
  - Understand the application and significance of different line types in engineering drawings.
  - Create accurate and detailed multiview sketches and drawings using CAD software.
- Working in Teams:
  - Collaborate effectively within diverse teams, fostering open communication and respectful interaction.
  - Contribute to team tasks and decision-making processes to achieve common goals.

        - Recognize and leverage individual strengths to enhance team performance.
    - Engineering Ethics:
        - Identify ethical considerations in engineering practices and decision-making.
        - Analyze potential ethical dilemmas and make ethically sound choices.
        - Uphold ethical standards and integrity in all engineering activities.
    - Product Lifecycle:
        - Understand the stages of a product's lifecycle, from conception to disposal.
        - Consider sustainability and environmental impact throughout each lifecycle phase.
        - Apply lifecycle thinking to design and development processes.
    - Reverse Engineering:
        - Learn methodologies for deconstructing and analyzing existing products.
        - Extract valuable insights from reverse engineering efforts to inform design improvements.
        - Apply reverse engineering principles to develop innovative solutions.
    - Decision Analysis:
        - Apply decision analysis techniques to evaluate and compare design alternatives.
        - Consider quantitative and qualitative factors in decision-making.
        - Employ decision matrices and other tools to support informed choices.
    - Measurement Systems and Tools:
        - Familiarize with various measurement systems and their units.
        - Demonstrate proficiency in using measurement tools accurately.
        - Understand the concepts of accuracy, precision, error, and tolerance in measurements.
    - CAD Skills:
        - Navigate and utilize the menus and commands in 3D modeling software.
        - Create 2D and 3D shapes using CAD software, applying constraints as needed.
        - Construct assemblies and subassemblies, including exploded views.
    - Prototyping and 3D Printing:
        - Create 3D printed prototypes to visualize and test design concepts.
        - Understand the additive manufacturing process and its applications.
    - Documentation:
        - Develop comprehensive technical documentation, including design reports and manuals.
        - Adhere to industry standards for documentation, including drawing and dimensioning

standards.

- Introduction to Statistical Analysis:
  - Gain a foundational understanding of basic statistics concepts.
  - Use spreadsheets to organize and display statistical data effectively.
- Engineering Design Process:
  - Apply the stages of the engineering design process to solve engineering problems.
  - Develop creative solutions and iteratively refine designs.

- Communication and Collaboration:
  - Develop effective verbal and written communication skills for technical discussions.
  - Collaborate seamlessly within diverse teams, contributing to group tasks and decision-making.
  - Foster open communication, resolve conflicts constructively, and leverage diverse viewpoints.
- Technical Documentation:
  - Produce comprehensive technical documents, such as reports and manuals, adhering to industry standards.
  - Use clear and concise language to convey complex technical information accurately.
  - Apply appropriate formatting and citation practices in technical documentation.
- Analyzing Solutions:
  - Systematically evaluate potential solutions, considering technical, economic, and environmental factors.
  - Compare and contrast alternatives using quantitative and qualitative methods.
  - Utilize decision matrices and analysis tools to support informed decision-making.
- Prototyping and Design Process:
  - Develop, build, and rigorously test prototypes to validate design concepts.
  - Apply the stages of the design process to tackle real-world engineering problems.
  - Iterate on designs based on testing outcomes and feedback.

- Sketching and Dimension Standards:
  - Create accurate 2D and 3D sketches on paper, capturing relevant details.
  - Produce multiview sketches that accurately represent objects from various angles.
  - Apply dimension standards to sketches, ensuring clarity and consistency.
- Measurement Interpretation and Conversion:
  - Interpret measurements on technical drawings to identify dimensions accurately.
  - Convert measurements between SI and US units proficiently.
  - Describe dimension standards for CAD drawings and apply them appropriately.
- CAD Skills:
  - Navigate and manipulate menus, toolbars, and commands within CAD software.
  - Create drawings using CAD commands, placing dimensions accurately and employing appropriate standards.
  - Generate sectional, auxiliary, and multiple view drawings in CAD.
- Statistical Data Representation:
  - Determine and calculate basic statistical data, creating graphical representations for effective visualization.
  - Utilize spreadsheets and graphs to display statistical information comprehensively.
- Technical Language and Professional Interaction:
  - Use appropriate technical language during discussions, presentations, and conflict resolution.
  - Develop clear written communication when interacting with experts, vendors, and team members.
  - Contribute effectively to team projects, leveraging skills and fostering teamwork.
- Technical Reporting and Presentations:
  - Write comprehensive technical reports, effectively communicating findings and recommendations.
  - Prepare and deliver well-structured oral presentations to convey technical information clearly.
  - Communicate complex concepts to both technical and non-technical audiences confidently.

Assessments

- Self assessment
- Presentations
- Technical Reports
- Final Project
- Quizzes
- Written Tests
- Demonstration of sketching skills through activities
- Participation
- Team Presentation

Course: Sophomore engineering clinic	Length: Semester

Standards

- 9.3.ST-SM.3 Analyze the impact that science and mathematics has on society.
- 9.3.ST-SM.4 Apply critical thinking skills to review information, explain statistical analysis, and to translate,
- interpret and summarize research and statistical data.

Essential Question(s)

- What is the engineering design process?

- How do you communicate effectively in teams?

Content

- Design Process:
  - Understand and apply the stages of the design process from problem identification to solution implementation.
  - Utilize creative problem-solving techniques to generate innovative design concepts.
  - Iteratively refine designs based on feedback and testing results.
- Working in Teams:
  - Collaborate effectively within interdisciplinary teams, valuing diverse perspectives and contributions.
  - Demonstrate strong communication skills, active participation, and constructive teamwork.
  - Adapt to different team roles and responsibilities, fostering a cooperative environment.
- Engineering Ethics:
  - Identify ethical considerations in engineering design, decision-making, and interactions.
  - Analyze potential ethical dilemmas and make ethically sound choices.
  - Uphold ethical standards and integrity in all engineering activities.
- Product Lifecycle:
  - Understand the stages of a product's lifecycle, considering factors such as design, manufacturing, distribution, use, and disposal.
  - Recognize the importance of sustainability and environmental impact in each lifecycle phase.
  - Apply lifecycle thinking to design and development processes.
- Reverse Engineering:
  - Learn techniques for systematically deconstructing and analyzing existing products.
  - Extract relevant insights from reverse engineering efforts to inform design improvements.
  - Apply reverse engineering principles to develop innovative solutions.
- Decision Analysis:
  - Apply decision analysis methods to evaluate and compare potential design alternatives.
  - Consider both quantitative and qualitative factors in decision-making.
  - Utilize decision matrices and other tools to support informed choices.

During the course students will work in small teams to solve an engineering challenge. The steps of the design process will be emphasized. Additionally, collaboration and communication will be underscored. Technical writing will also be a highlighted area during this clinic period.

Note, the students should choose a project that is different, more complex, and more involved than their freshman clinic experience.

Skills

- Communication:
  - Develop effective verbal and written communication skills for conveying technical concepts.
  - Tailor communication style to various audiences, both technical and non-technical.
  - Use visual aids and presentations to enhance communication clarity and impact.
- Collaborating in Teams:
  - Work collaboratively within diverse teams, valuing and leveraging individual strengths.
  - Contribute actively to team discussions, tasks, and decision-making processes.
  - Foster an open and respectful team environment, resolving conflicts constructively.
- Technical Documentation:
  - Create clear and organized technical documents, adhering to industry standards.
  - Articulate complex technical information accurately in written reports and manuals.
  - Use appropriate formatting and citation practices in technical documentation.
- Analyzing Solutions:
  - Systematically evaluate potential solutions, considering technical, economic, and environmental factors.
  - Compare and contrast alternative solutions using quantitative and qualitative methods.
  - Utilize decision matrices and analysis tools to support well-informed decision-making.
- Developing and Testing Prototypes:
  - Design, construct, and rigorously test prototypes to validate design concepts.
  - Apply iterative design and testing methodologies to refine prototypes.

        - Gather and analyze data from prototype testing to drive design improvements.
    - Applying the Design Process:
        - Understand and apply the stages of the design process to solve engineering problems.
        - Utilize creative problem-solving techniques to generate innovative design solutions.
        - Follow a structured approach to design, iteration, and implementation.

Assessments

- Self assessment
- Presentations
- Technical Reports
- Final Project

Course: Analog circuits Length: Semester

Standards

- 9.3.ST.6 Demonstrate technical skills needed in a chosen STEM field.

Essential Question(s)

- What are analog electronics?
- How are electrical circuits used in engineering?
- Why is it important to understand the purpose of a circuit breaker?
- Explain how wire gauge (AWG) relates to the current carrying capacity of that wire.
- How does voltage drop relate to the resistance of each component in a series circuit?

- How does the number of parallel resistors in a circuit change the total current and total resistance?

- Why is there a scale adjustment on the oscilloscope for time and amplitude?
- Why do capacitors behave differently in DC and AC circuits?
- How does a diode and a capacitor contribute to the output of an AC to DC power supply?

Content

- Electrical Fundamentals:
  - Understand the principles of conduction and the behavior of conductors.
  - Operate a continuity tester to identify circuit connections and faults.
  - Explain the concept of electrostatic charges and their relation to current flow.
  - Differentiate between current and voltage and understand their relationship.
- Circuit Protection and Power Sources:
  - Describe the purpose of overloads, fuses, and circuit breakers in electrical circuits.
  - Explain the functioning and applications of batteries in electrical systems.
  - Understand resistor color codes and their significance in component identification.
  - Define tolerance in resistor values and its impact on circuit performance.
- Electrical Quantities and Laws:
  - Define and calculate energy in electrical circuits.
  - Apply Ohm's Law to calculate current, voltage, and resistance relationships.
  - Understand the concepts of work and power in electrical circuits.
  - Analyze conductors and determine appropriate wire sizes for specific applications.
- Measurement Tools and Circuit Analysis:
  - Use a voltmeter to measure voltage in electrical circuits.
  - Analyze series resistor circuits and calculate total resistance.
  - Identify and interpret schematic symbols for various electronic components.
  - Apply voltage dividers in circuit analysis and design.
- Circuit Laws and Components:

        - Apply Kirchhoff's Voltage Law (KVL) in analyzing complex circuits.
        - Understand parallel resistor circuits and calculate total resistance.
        - Apply Kirchhoff's Current Law (KCL) to analyze current flow in circuits.
        - Measure voltage with respect to ground and explain its significance.
    - AC Circuits and Components:
        - Define alternating current (AC) and understand the properties of sine waves.
        - Operate function generators and understand their applications.
        - Use oscilloscopes to visualize and analyze electrical waveforms.
        - Identify capacitor types and their functions in circuits.
    - Capacitors and Diodes:
        - Convert between different units of capacitance and understand their meanings.
        - Analyze capacitors in parallel or series configurations in circuits.
        - Calculate capacitive reactance in AC circuits.
        - Explain the behavior and applications of diodes.
    - Power Supplies and Filtering:
        - Understand the operation of rectifiers in converting AC to DC.
        - Describe the function of power supplies in electronic systems.
        - Explain the concept of filtering and its role in reducing noise in circuits.

Skills

- Basic Electrical Concepts:
    - Identify fundamental schematic symbols.
    - Describe resistors, conductors, and insulators.
    - Apply proper scientific and engineering notation to large and small numbers.
    - Identify sources of electricity, including renewable sources.
- Resistors and Ohm's Law:
    - Interpret color codes for resistors.

        - Apply knowledge using Ohm’s Law.
        - Apply knowledge and proper use of multimeters.
    - DC Circuits and Analysis:
        - Analyze and troubleshoot DC circuits.
        - Apply Kirchhoff’s Voltage Law.
        - Apply knowledge and proper use of multimeters.
        - Prototyping electronic circuits using schematics and breadboards.
    - Kirchhoff's Laws and DC Circuits:
        - Analyze and troubleshoot DC circuits.
        - Interpret color codes for resistors.
        - Apply Kirchhoff’s Current Law.
        - Apply knowledge and proper use of multimeters.
        - Prototyping electronic circuits using schematics and breadboards.
    - AC Circuits and Analysis:
        - Analyze and troubleshoot AC circuits and waveforms.
        - Explain current and voltage phase relationships.
        - Apply knowledge of capacitors.
        - Apply knowledge and proper use of function generators.
        - Apply knowledge and proper use of oscilloscopes.
        - Prototyping electronic circuits using schematics and breadboards.
    - Diodes and Advanced Analysis:
        - Apply knowledge of diodes.
        - Analyze and troubleshoot AC circuits and waveforms.
        - Apply knowledge and proper use of function generators.
        - Apply knowledge and proper use of oscilloscopes.
        - Prototyping electronic circuits using schematics and breadboards.

Assessments

- Self assessment

- Presentations
- Technical Reports
- Final Project

- Homework
- Lab
- Lab Report

Course: Intro to Computer Science I - C++ Programming	Length: Semester

Standards

- 9.3.IT.2 Use product or service design processes and guidelines to produce a quality information
- technology (IT) product or service.
- 9.3.IT.3 Demonstrate the use of cross-functional teams in achieving IT project goals.
- 9.3.IT.5 Explain the implications of IT on business development.
- 9.3.IT.6 Describe trends in emerging and evolving computer technologies and their influence on IT
- practices.
- 9.3.IT.7 Perform standard computer backup and restore procedures to protect IT information.
- 9.3.IT.9 Describe quality assurance practices and methods employed in producing and providing
- quality IT products and services.

- 9.3.IT.12 Demonstrate knowledge of the hardware components associated with information systems.
- 9.3.IT.13 Compare key functions and applications of software and determine maintenance strategies for
- computer systems.
- 9.3.IT-SUP.9 Employ technical writing and documentation skills in support of an information system.
- 9.3.IT-SUP.10 Apply quality assurance processes to maximize information system operation.

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Essential Question(s)

- What is software engineering?
- How does computer hardware process software?
- How is the software development process like the engineering design process?
- Explain why there may be more than one way to create a flowchart using a given algorithm.
- How are flowcharts useful when it comes to debugging a program?
- Why is a computer program designed to have a specific structure?
- Explain where there are instances when more than one data type can be used for a variable.
- Why does C++ have a set of Key Words embedded in its functionality?
- Explain the reason why loop variables are set to a specific value upon entering the loop.
- How can loops be used in programming a robot?
- How can loop structures be compared to video games or table top games?
- Why is it important to utilize functions in a complex software program?
- Describe when a program would want to return a value other than zero.
- Why would a programmer designate all of their Global Variables before the Main structure of the program?
- How are arrays and loops useful in gathering information in a computer program?
- Describe an example of a software program that uses multi-dimensional arrays.
- How are searching and sorting arrays used in a practical application?
- How can pointers be implemented in existing programs to reduce complexity?

Content

- Introduction to Programming and Concepts:
  - Understand computer components and their roles in program execution.
  - Define algorithms and their significance in problem-solving.
  - Differentiate between procedural and object-oriented programming paradigms.
- Programming Fundamentals:
  - Create flowcharts to visualize program logic.
  - Implement effective program debugging techniques.
  - Design well-structured program layouts for clarity and readability.
  - Understand and use various data types in programming.
  - Apply arithmetic operators for mathematical computations.
  - Implement decisions using If statements.
  - Recognize and utilize identifiers and keywords in programming.
  - Employ increment and decrement operators effectively.
- Control Structures and Loops:
  - Implement loops using While, Do-While, and For structures.
  - Work with nested loops for complex iterations.
  - Understand and define function processes in programming.
  - Use return statements to manage function output.
  - Manage local and global variables appropriately.
  - Implement exit functions for controlled program termination.
- Arrays and Data Structures:
  - Create and manipulate single arrays in programming.
  - Work with multiple arrays for diverse data handling.
  - Understand and implement multi-dimensional arrays.
  - Explore search and sort techniques for arrays.
- Pointers and Memory Management:
  - Explain the concept of pointers and their role in memory management.

- Declare pointers to variables and understand their usage.
- Use pointers for searching and sorting data.
- Understand the significance of pointers in programming.

Skills

- Introduction to Software Processing and Algorithm Design:
  - Understand how computers process software.
  - Develop algorithms for simple tasks.
- Programming Paradigms and Flowcharting:
  - Understand the difference between procedural and object-oriented programming.
  - Identify basic flowchart symbols.
  - Develop a flowchart for a given algorithm.
- Software Development Process and Debugging:
  - Develop a process to debug software programs using the Integrated Development Environment (IDE).
  - Identify structural components in a computer program.
- Data Types, Operators, and Identifiers:
  - Use proper data types for the variables in the program.
  - Understand the common and uncommon arithmetic operators and how they are used in the computer program.
  - Develop a program that makes proper use of identifiers and keywords.
- Loops and Decision Structures:
  - Use increments and decrements in various types of loops.
  - Implement appropriate loops for specific applications.
  - Utilize a nested loop for a series of embedded decisions in a computer program.
- Functions and Variables:
  - Implement the proper use of functions in a software program.
  - Understand the difference between using Return (0) and returning a value other than zero.
  - Develop a program that uses both local and global variables.

        - Understand how the Exit function is utilized in a software program.
    - Arrays and Pointers:
        - Implement a simple array in a computer program.
        - Develop a program that combines single arrays into multiple arrays.
        - Utilize a multi-dimensional array in a short program.
        - Implement searching and sorting arrays in a software program.
        - Implement pointers in existing programs to reduce complexity.
        - Correctly declare pointers for sorting and searching purposes.

Assessments

- Self assessment
- Presentations
- Technical Reports
- Final Project

- Homework
- Programming activities
- Quiz
- Programming project

Course: Computer Architecture Length: Semester

Standards

- 9.3.ST-SM.1 Apply science and mathematics to provide results, answers and algorithms for engineering and technological activities.

Essential Question(s)

- What is the engineering design process?
- How do you communicate effectively in teams?
- Explain practical examples of linear (analog) systems and digital systems.
- Why is hexadecimal commonly used in computer systems?
- Why do we consider basic logic gates as building blocks for digital design?
- How does knowledge of transistor characteristics help you learn how logic gates function?
- Describe at least two advantages of using Boolean Algebra to simplify logic circuits.
- Explain how a programmable logic chip will benefit from simplified circuits.
- Describe two applications of Decoders and Encoders used everyday.
- How does knowledge of number systems help understand the operation of multiplexers and demultiplexers?
- After looking up a schematic for a typical motherboard, explain how flip flops are used in the basic circuitry.
- Describe a unique application for a one-shot circuit.
- Describe two instances where we see up or down counters in daily life.
- How is knowledge of both analog and digital circuitry useful in building a large halogen bulb scoreboard with a timer?
- Look up the different types of memory found in computer systems, and explain why they are not compatible with each other.
- Why is it important to understand programming, electronics, and mechanics when building robots?
- When it comes to noise immunity in signal transmissions, what are the advantages and

disadvantages of using analog over digital?
- How is it decided that a data or signal bus should be parallel or serial in nature?

Content

- Introduction to Analog and Digital Systems:
  - Understand the differences between analog and digital systems.
  - Define logic levels and their significance in digital circuits.
  - Recognize and analyze different waveforms in electronic signals.
- Number Systems and Conversion:
  - Understand different number systems: binary, octal, decimal, and hexadecimal.
  - Demonstrate proficiency in conversion techniques between number systems.
  - Work with signed numbers in various number systems.
- Binary Arithmetic and Logic:
  - Perform binary arithmetic operations.
  - Describe and analyze logic gates and their behavior.
  - Formulate Boolean expressions and construct truth tables.
- Digital Logic Components:
  - Understand the functions and applications of integrated circuits in digital systems.
  - Differentiate between TTL and CMOS logic families.
  - Analyze combinatorial logic circuits and their operation.
- Boolean Algebra and Simplification Techniques:
  - Apply the laws of Boolean algebra in simplifying expressions.
  - Utilize rules of Boolean algebra for logic manipulation.
  - Apply DeMorgan's Theorem to simplify complex expressions.
- Advanced Logic Design:
  - Understand Karnaugh maps and their role in logic simplification.
  - Explain the concept of universal gates and their applications.
  - Design and analyze half and full adders.
- Sequential Logic Components:

- Analyze comparators, decoders, encoders, multiplexers, and demultiplexers.
- Understand the purpose and operation of parity generators/checkers.
- Explain the functions of latches and flip flops in sequential circuits.

- Sequential Circuits and Applications:
  - Describe the applications of flip flops in various contexts.
  - Explain the functions and uses of one-shots and multivibrators.
  - Understand shift registers and their applications in serial data transmission.
- Counters and Finite State Machines:
  - Identify different types of counters and their applications.
  - Differentiate between asynchronous and synchronous counters.
  - Understand up and down counters and cascade counters.
  - Introduce the concept of finite state machines in digital design.
- Programmable Logic Devices and Microcontrollers:
  - Understand programmable logic devices and their role in digital circuit design.
  - Introduce the Microchip PICDEM Lab and its significance in practical applications.
- Memory and Data Transmission:
  - Understand memory basics and different types of memory.
  - Describe data transmission methods and protocols.
- Modulation and Data/Signal Busses:
  - Explain the modulation of analog signals.
  - Describe modulation techniques for digital signals.
  - Understand data and signal buses in communication systems.

Skills

- Analog and Digital Systems:
  - Identify and describe the difference between analog and digital systems.
- Scientific Notation and Engineering Units
  - Apply proper scientific and engineering notations.

        - Understand and use appropriate units for measurements.
    - Oscilloscope Usage:
        - Apply knowledge and proper use of oscilloscopes.
        - Use oscilloscopes to visualize and analyze electronic signals.
    - Number Systems and Conversion:
        - Converting values between number systems.
        - Understand and perform conversions between different number systems.
    - Fundamental Logic Gates and Digital Circuitry:
        - Apply knowledge of fundamental logic gates and functions.
        - Understand the operation of basic logic gates and their applications.
    - Digital Circuit Design:
        - Apply knowledge of digital circuitry.
        - Understand the principles of digital circuit design and implementation.

Assessments

- Self assessment
- Presentations
- Technical Reports
- Final Project

Course: Intro to Computer Science II - Python Length: Semester

Standards

- 9.3.IT-PRG.1 Analyze customer software needs and requirements.
- 9.3.IT-PRG.2 Demonstrate the use of industry standard strategies and project planning to meet customer specifications.
- 9.3.IT-PRG.3 Analyze system and software requirements to ensure maximum operating efficiency.
- 9.3.IT-PRG.4 Demonstrate the effective use of software development tools to develop software applications.
- 9.3.IT-PRG.5 Apply an appropriate software development process to design a software application.
- 9.3.IT-PRG.6 Program a computer application using the appropriate programming language.
- 9.3.IT-PRG.7 Demonstrate software testing procedures to ensure quality products.
- 9.3.IT-PRG.8 Perform quality assurance tasks as part of the software development cycle.
- 9.3.IT-PRG.9 Perform software maintenance and customer support functions.
- 9.3.IT-WD.3 Write product specifications that define the scope of work aligned to customer requirements.
- 9.3.IT-WD.4 Demonstrate the effective use of tools for digital communication production, development and project management.

Essential Question(s)

- What is software engineering?
- Introduction to the python programming language
- How is python different and similar to C++?
- What is object oriented programming?
- What are data structures?
- Why use different sorting and search techniques?
- How can I analyze algorithms?

Content

- Python Programming
  - Develop proficiency in using the Python programming language.
  - Write Python code to solve various programming challenges.
  - Understand the syntax, data types, and control structures of Python.
- Object-Oriented Programming:
  - Understand the principles and concepts of object-oriented programming (OOP).
  - Implement classes, objects, methods, and inheritance in Python.
  - Design and create Python programs using an object-oriented approach.
- Data Structures:
  - Define and explain the characteristics of queues, stacks, linked lists, hash tables, trees, and graphs.
  - Implement and manipulate different data structures in Python.
  - Understand the applications and use cases for each data structure.
- Sorting and Searching:
  - Learn various sorting algorithms (e.g., bubble sort, insertion sort, merge sort, quicksort).
  - Implement sorting algorithms to organize data efficiently.
  - Understand different searching techniques (e.g., linear search, binary search).
- Algorithm Complexity Analysis:
  - Understand the concept of Big O notation and its role in analyzing algorithm efficiency.
  - Analyze the time and space complexity of algorithms using Big O notation.
  - Compare and contrast the efficiency of different algorithms.

Skills

- Soft Skills and Teamwork:
  - Communication
  - Collaborating in teams

        - Technical documentation
        - Analyzing solutions
        - Developing and testing prototypes
        - Applying the design process to a problem
    - Python Programming and Object-Oriented Concepts:
        - Having the ability to read and write code in Python
        - Creating objects and classes
        - Demonstrating inheritance, abstraction, and polymorphism
    - Data Structures and Algorithms:
        - Creating queues, stacks, linked lists, hash tables, trees, and graphs
        - Using sorting and searching techniques to solve problems
        - Using Big O notation to analyze algorithms

Assessments

- Self assessment
- Presentations
- Technical Reports
- Final Project
- Homework
- Programming activities
- Quiz
- Programming project

Course: Intro to Embedded systems	Length: Semester

Standards

- 9.3.IT-WD.1 Analyze customer requirements to design and develop a Web or digital communication
- product.
- 9.3.IT-WD.2 Apply the design and development process to produce user-focused Web and digital
- communications solutions.

Essential Question(s)

- What is an embedded system?
- How can embedded systems help the engineer?

Content

- Arduino Microcontrollers:
  - Understand the fundamental concepts of microcontrollers.
  - Develop proficiency in programming Arduino microcontrollers.
  - Interface sensors, actuators, and other components with Arduino.
  - Create projects that demonstrate practical applications of Arduino microcontrollers.
- Raspberry Pi:
  - Understand the capabilities and features of Raspberry Pi.
  - Set up and configure Raspberry Pi for various projects.
  - Develop programming skills for Raspberry Pi applications.

        - Utilize Raspberry Pi to create projects with networking and multimedia capabilities.
    - Embedded Systems in Engineering and Design:
        - Understand the role of embedded systems in engineering and design.
        - Identify suitable scenarios for incorporating embedded systems.
        - Design and implement embedded systems to address specific engineering challenges.
        - Utilize sensors, actuators, and data processing in embedded systems projects.

Skills

- Communication and Teamwork:
    - Develop effective communication skills for conveying technical concepts.
    - Collaborate effectively within interdisciplinary teams.
    - Foster open and respectful team dynamics.
    - Document and present project progress and findings.
- Technical Documentation and Analysis:
    - Create clear and organized technical documentation.
    - Analyze solutions using appropriate methodologies.
    - Apply safe work procedures and practices in technical projects.
- Prototyping and Design Process:
    - Develop and test prototypes for electrical circuits.
    - Apply the design process to solve engineering challenges.
    - Apply circuit analysis and design principles to practical applications.
- Electrical and Electronics Proficiency:
    - Apply principles of analog and digital electronics in projects.
    - Utilize microcomputers for building, testing, and operating systems.
    - Apply engineering standards in the development of electrical/electronics systems.
- Programming and Software Skills:
    - Develop code using the Arduino IDE.
    - Implement loops, both in programming and circuit design.

        - Understand the basics of Linux and text editors.
        - Compile and execute programs effectively.
    - Networking and Embedded Systems:
        - Connect and configure inputs and outputs in electrical systems.
        - Understand and work with analog and digital signals.
        - Connect systems to the internet and utilize networking principles.
        - Utilize embedded systems in engineering and design projects.

Assessments

- Self assessment
- Presentations
- Technical Reports
- Final Project

- Homework
- Programming activities
- Quiz
- Embedded systems project

Course: Machine learning with Python Length: Semester

Standards

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- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw
- conclusions about the data

Essential Question(s)

- What is machine learning?
- What is statistics?
- How can trends in data be established?
- How can machine learning algorithms be used to classify data?

Content

- Introduction to Statistics:
  - Understand the fundamental concepts of statistics.
  - Define key statistical terms and measures (mean, median, mode, standard deviation, etc.).
  - Learn how to organize and summarize data using descriptive statistics.
  - Interpret graphical representations of data (histograms, scatter plots, etc.).
  - Apply basic probability concepts in statistical analysis.
- Linear Regression:

        - Understand the principles of linear regression analysis.
        - Learn to identify the relationship between variables using scatter plots.
        - Develop skills to calculate and interpret the regression equation.
        - Utilize regression analysis to make predictions and understand correlations.
        - Apply linear regression in real-world scenarios.
    - Classification:
        - Learn the basics of classification in machine learning.
        - Understand different classification algorithms (e.g., decision trees, support vector machines).
        - Develop skills to train and evaluate classification models.
        - Apply classification techniques to solve practical problems.
        - Understand the concept of accuracy, precision, recall, and F1-score in classification.

Skills

- Statistics with Python:
    - Conduct basic statistics on a data set using the Python programming language.
- Linear Regression with Python:
    - Create a linear regression model for a data set using the Python programming language.
- Image Classification with Python:
    - Create an image classification model using the Python programming language.

Assessments

- Self assessment
- Presentations
- Technical Reports
- Final Project

- Homework
- Programming activities
- Quiz
- Image classification project

Course: Green engineering	Length: Semester

Standards

- 9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1,•9.4.12.IML.5: Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a,7.1.AL.PRSNT.2).
- •9.4.12.IML.6: Use various types of media to produce and store information on climate change for different purposes.
- 9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).
- 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specific task (e.g., W.11-12.6.).
- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw
- conclusions about the data.
- 9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.

- 9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).

Essential Question(s)

- What is the engineering design process?
- How do you communicate effectively in teams?
- What is green engineering?
- How can humans have a positive impact on the environment?
- How can I help my local community?

Content

- Green Engineering and Environmental Awareness:
  - Understand the principles and goals of green engineering.
  - Recognize the importance of sustainable practices in engineering.
  - Explore different alternative energy sources and their potential benefits.
- Research and Problem Identification:
  - Develop skills in researching local environmental issues/problems.
  - Identify key factors contributing to the identified problem.
  - Analyze data and information related to the environmental issue.
- Engineering Solutions:
  - Apply engineering principles to design viable solutions for local environmental issues/problems.
  - Utilize innovative thinking to create effective solutions.
  - Incorporate sustainable practices and consider long-term impacts in solution design.
- Project Presentation and Communication:
  - Develop effective presentation skills for communicating technical solutions.
  - Create clear and engaging presentations for the local community.

        - Tailor presentations to different audience types and levels of understanding.
    - Community Engagement and Outreach:
        - Identify opportunities for community engagement and involvement.
        - Plan and implement outreach initiatives to raise awareness about the solution.
        - Explore ways to continue and sustain the project beyond its initial implementation.

Skills

- Communication:
    - Develop effective verbal and written communication skills.
    - Present technical concepts clearly and concisely.
    - Adapt communication style for different audiences and situations.
    - Active listening and understanding feedback.
- Collaborating in Teams:
    - Work effectively within diverse teams.
    - Share ideas and contribute constructively.
    - Resolve conflicts and promote team cohesion.
    - Delegate tasks based on team members' strengths.
- Technical Documentation:
    - Create organized and comprehensive technical documentation.
    - Convey complex information in a clear and structured manner.
    - Use appropriate diagrams, charts, and visuals to enhance documentation.
- Analyzing Solutions:
    - Apply critical thinking to evaluate and compare potential solutions.
    - Consider advantages, disadvantages, and feasibility of solutions.
    - Utilize data and evidence to support solution analysis.
- Developing and Testing Prototypes:
    - Design and develop prototypes to demonstrate concepts.
    - Utilize appropriate tools and materials for prototyping.

        - Iteratively test and refine prototypes based on feedback and results.
    - Applying the Design Process:
        - Understand and apply the stages of the design process.
        - Identify problems, generate ideas, and select solutions.
        - Plan, implement, and evaluate designs systematically.

Assessments

- Self assessment
- Presentations
- Technical Reports
- Final Project

Course: Robotic vehicles | Length: Semester

Standards

- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
- 9.3.ST.6 Demonstrate technical skills needed in a chosen STEM field.

Essential Question(s)

- What is the engineering design process?
- How do you communicate effectively in teams?

- How can forces be transferred?
- How do gears work?
- How can electricity be produced and stored?
- How can electrical signals be transmitted?
- How can simple and complex behaviors be modeled using computer programming?
- How can a robot be used to complete a task?

Content

- Mechanisms and Gear Trains:
  - Understand the principles of gear trains and mechanisms.
  - Design and create gear trains for specific applications.
  - Demonstrate proficiency in assembling and testing mechanisms.
- Robot Power Systems:
  - Understand the role of batteries in robot power systems.
  - Select and integrate appropriate batteries for a robot's power needs.
  - Explore battery technologies and considerations for efficient power supply.
- Circuits and Electrical Wiring:
  - Understand fundamental circuit concepts for robots.
  - Design and create electrical wiring layouts for robots.
  - Ensure proper connections, safety measures, and efficient power distribution.
- Robot Programming and IDE:
  - Familiarize yourself with the RobotC IDE.
  - Develop programming skills to control and coordinate robot movements.
  - Utilize the RobotC IDE for coding, debugging, and testing.

- Engineering Robotic Solutions:
    - Identify real-world problems that can be addressed using robotic vehicles.
    - Engineer creative and effective solutions using robotic vehicles.
    - Plan, design, build, and test the robotic vehicle to solve the identified problem.

Skills

- Communication:
    - Develop clear and effective verbal and written communication skills.
    - Convey complex technical concepts in a understandable manner.
    - Adapt communication style for different audiences and contexts.
    - Listen actively and provide constructive feedback.
- Collaborating in Teams:
    - Work effectively within multidisciplinary teams.
    - Share ideas, insights, and expertise to contribute to team goals.
    - Foster a positive team environment by respecting diverse perspectives.
    - Resolve conflicts and challenges through open communication.
- Technical Documentation:
    - Create comprehensive and organized technical documentation.
    - Present information clearly using diagrams, charts, and visuals.
    - Document design decisions, processes, and outcomes thoroughly.
    - Ensure documentation is accessible and understandable for stakeholders.
- Analyzing Solutions:
    - Apply critical thinking to evaluate and compare potential solutions.
    - Consider technical, economic, and ethical factors in solution analysis.
    - Utilize data and evidence to support decision-making.
    - Identify strengths and weaknesses of different solution options.
- Developing and Testing Prototypes:

        - Design and develop prototypes to validate concepts and ideas.
        - Utilize appropriate materials and tools for prototyping.
        - Rigorously test and refine prototypes to optimize performance.
        - Incorporate user feedback to improve prototype iterations.
    - Applying the Design Process:
        - Understand and apply the stages of the design process.
        - Define problems, generate ideas, and select viable solutions.
        - Develop and implement design solutions systematically.
        - Continuously iterate and improve solutions based on feedback.

Assessments

- Self assessment
- Presentations
- Technical Reports
- Final Project

Course: Senior clinic Length: Semester

Standards

- 9.3.ST.1 Apply engineering skills in a project that requires project management, process control and
- quality assurance.
- 9.3.ST.2 Use technology to acquire, manipulate, analyze and report data.
- 9.3.ST.3 Describe and follow safety, health and environmental standards related to science,
- technology, engineering and mathematics (STEM) workplaces.

- 9.3.ST.4 Understand the nature and scope of the Science, Technology, Engineering & Mathematics
- Career Cluster and the role of STEM in society and the economy.
- 9.3.ST.5 Demonstrate an understanding of the breadth of career opportunities and means to those
- opportunities in each of the Science, Technology, Engineering & Mathematics Career
- Pathways.
- 9.3.IT.1 Demonstrate effective professional communication skills and practices that enable positive
- customer relationships

Career Readiness, Life Literacies, and Key Skills Practices

- Act as a responsible and contributing community member and employee.
- Attend to financial well-being.
- Consider the environmental, social and economic impacts of decisions.
- Demonstrate creativity and innovation.
- Utilize critical thinking to make sense of problems and persevere in solving them.
- Model integrity, ethical leadership and effective management.
- Plan education and career paths aligned to personal goals.
- Use technology to enhance productivity, increase collaboration and communicate effectively.
- Work productively in teams while using cultural/global competence.

Essential Question(s)

- What is the engineering design process?
- How do you communicate effectively in teams?
- Why is it important to understand expectations when undergoing a project?
- What does it mean to act professionally when communicating with others?
- Explain why it is important to plan projects of any size.

- How is one qualified to be called an expert in any subject?
- Why is it important to produce a clear problem statement before moving on?
- How is the brainstorming step effectively accomplished?
- When do you know that your problem is justified enough to move on with the project?
- What defines a credible source?
- In what way does market research support your problem justification?
- Why is it important to look at current and past solutions, which include patents?
- How do we know something is an invention versus an innovation?
- How does a trend analysis influence your ideas in solving your problem?
- Why is it important to develop subjective criteria for analyzing your design alternatives?
- Why is it important to have detailed technical drawings for your solution?
- Why do we rely on subject matter experts in helping us develop solutions?
- How do design parameters support the development of the design solution?
- Why is it important to think ahead to possible problems when building the prototype?
- How will the types of materials affect your build process and schedule?
- How will the types of tools and equipment needed affect your build process and schedule?
- Why is it not important that the prototype look exactly like the planned finished product?
- Why is it important to develop a robust set of testing procedures?
- How is safety addressed in a test plan and procedure?
- What type of permissions might be needed to allow testing of a prototype?
- How does your testing support the solution to your problem statement?
- Why is it important to plan a presentation for the final design solution?
- How does one anticipate questions when preparing for a major presentation?
- Why is there a specific dress code when presenting to industry professionals?
- Why is it important to research the company for which you are seeking employment?
- How does one prepare for a job interview?

Content

- Project Management and Professionalism:
  - Learn project management principles and schedule planning techniques.
  - Demonstrate professionalism in communication, collaboration, and work ethics.
  - Understand the importance of adhering to project schedules and deadlines.
- Expert Involvement and Problem Definition:
  - Explore the role of experts in engineering projects.
  - Formulate clear and concise problem statements.
  - Identify and justify the significance of the defined problem.
- Brainstorming and Problem Solving:
  - Practice brainstorming techniques to generate creative solutions.
  - Engage with subject matter experts to gain insights and perspectives.
  - Verify and validate the identified problem through research and analysis.
- Research and Analysis:
  - Conduct market research to understand user needs and trends.
  - Perform patent searches and analyze existing solutions.
  - Evaluate current and past solutions to identify gaps and opportunities.
- Innovation and Decision Analysis:
  - Explore inventions, innovations, and trend analysis in engineering.
  - Apply decision analysis tools and techniques to make informed choices.
  - Utilize decision matrices to compare and evaluate potential solutions.
- Design and Technical Drawings:
  - Create technical drawings that communicate design specifications.
  - Define design parameters and constraints for projects.
  - Seek feedback from experts to refine and improve designs.
- Prototyping and Testing:
  - Develop assembly manuals for prototype construction.
  - Research appropriate tools and materials for prototyping.
  - Develop a detailed build schedule to ensure efficient execution.
  - Define test methods, plans, and procedures for evaluating prototypes.
- Project Documentation and Presentation:

        - Keep thorough project documentation for reference and accountability.
        - Prepare a final presentation to showcase the project's process and outcomes.
    - Career Development:
        - Develop and update a high school portfolio highlighting achievements.
        - Create or refine a resume, cover letter, and prepare for mock interviews.

Skills

- Communication Skills:
    - Effective verbal and written communication.
    - Tailoring communication for different audiences.
    - Active listening and understanding.
- Team Collaboration Skills
    - Collaborating effectively within diverse teams.
    - Sharing ideas and insights constructively.
    - Resolving conflicts and promoting a positive team environment.
- Technical Documentation Skills:
    - Creating clear and organized technical documentation.
    - Presenting information through diagrams and visuals.
    - Documenting sources and references accurately.
- Analytical Skills:
    - Evaluating and comparing potential solutions critically.
    - Utilizing data analysis to inform decision-making.
    - Identifying correlations and trends in data.
- Prototyping and Testing Skills:
    - Developing and testing prototypes.
    - Planning for contingencies and safety.
    - Creating clear and detailed assembly manuals.
- Design and Project Management Skills:

        - Applying the design process to solve problems.
        - Setting realistic expectations and goals.
        - Utilizing management skills to plan and execute projects.
    - Professionalism and Career Development:
        - Demonstrating professional behavior and demeanor.
        - Developing a high school portfolio and a professional resume.
        - Preparing for interviews and effectively answering questions.
    - Research and Innovation Skills:
        - Conducting thorough research and analysis.
        - Identifying subject matter experts and credible sources.
        - Recognizing innovations and inventions in the field.
    - Decision-Making and Problem-Solving Skills:
        - Developing clear problem statements.
        - Generating feasible ideas and solutions.
        - Creating decision matrices and criteria analysis.
    - Presentation and Communication Skills:
        - Presenting projects to panels of industry peers.
        - Creating brochures and materials for effective communication.
        - Conveying understanding through effective communication.

Assessments

- Self assessment
- Presentations
- Technical Reports
- Final Project
- Activities
- Notebook Evaluations
- Weekly assessments
- Status Presentations
- Final Project Presentation

Resources

➔ Course Resources

- https://www.epa.gov/green-engineering/about-green-engineering
- https://www.arduino.cc/
- https://cplusplus.com/reference/
- https://www.raspberrypi.com/
- https://www.teachengineering.org/
- https://www.abet.org/
- https://www.rcbc.edu/academics/engineering-technology
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➔ Textbooks:

- Buchla, D. M., & Floyd, T. L. (2004). *Electronics Fundamentals*(8th ed.). Pearson/Prentice Hall.
  - ISBN-10: 0-13-507295-6
- Floyd, T. L. (n.d.). *Digital Fundamentals*(11th ed.). 2014: Pearson.
  - ISBN-10: 978-0132737968
- Gaddis, T. (n.d.). *Starting Out with C*(8th ed.). Pearson.
  - ISBN 978-013376939-5
- Petruzella, F. D. (2001). *Essentials of Electronics*(2nd ed.). Glencoe/McGraw Hill.
  - ISBN 0-07821048-8