SCHOOL DISTRICT OF THE CHATHAMS

Robotics & Controls
Grades 9 - 12
Semester

Course Overview

In this course, students will explore the field of robotics and control systems through a variety of hands-on, experiential learning experiences. Students will work individually and in teams to design, build, program, and test digital controls and robotics systems, as well as microprocessors and electromechanical components, such as sensors, actuators, motors, and servos. Students will utilize the Engineering Design Process to design and build real-world robotic systems that solve problems present in our day-to-day lives.

New Jersey Student Learning Standards
The New Jersey Student Learning Standards (NJSLS) can be located at www.nj.gov/education/cccs/2020/.

Algorithm & Programming
8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.
8.1.12.AP.9: Collaboratively document and present design decisions in the development of complex programs.

Nature of Technology
8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Technology Standards
9.4.12.DC.6: Select information to post online that positively impacts personal image and future college and career opportunities.

21st Century Integration | NJSLS 9
9.4.12.CI.1: Demonstrate the ability to reflect, analyze and use creative skills and ideas.
9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving.
9.3.ST.3 Describe and follow safety, health and environmental standards related to science, technology, engineering and mathematics (STEM) workplaces.
9.3.ST-ET.1 Use STEM concepts and processes to solve problems involving design and/or production.
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.
9.3.12.AC-CST.9 Safely use and maintain appropriate tools, machinery, equipment and resources to accomplish construction project goals.
9.3.12.AC-DES.1 Justify design solutions through the use of research documentation and analysis of data.
9.3.12.AC-DES.7 Employ appropriate representational media to communicate concepts and project design.
9.3.12.AC-DES.8 Apply standards, applications and restrictions pertaining to the selection and use of construction materials, components and assemblies in the project design.

Career Ready Practices

CRP2. Apply appropriate academic and technical skills.
CRP4. Communicate clearly and effectively and with reason.
CRP6. Demonstrate creativity and innovation
CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP11. Use technology to enhance productivity.
CRP12. Work productively in teams while using cultural global competence.

Interdisciplinary Connections

Science

HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Units of Study

Unit 1: Introduction to Electronics (~ 12 days)

- What is a circuit?
- How are parallel and series circuits different?
- What are the main components of a circuit?
- What is soldering?
- What is Ohm's law and how is it applied when building circuits?

Unit 2: Introduction to Programming Electronics (~20 days)

- What are methods?
- What are comments?
- How do you initialize a program?
- What are the parts of a simple program and correct syntax?
- How does the Arduino software communicate with the boards?
- How can you make an LED blink or a speaker make a note?

Unit 3: Using Motors and Servos to Create Movement (~10 days)

- How can a motor be connected to the breadboard?
- How do you define a motor in Arduino?
- How can a shield be used with the Arduino board?

Unit 4: Robotic Design Challenges (~12 days)

- How can materials be joined together to allow movement?
- What are different types of power?
- How can hydraulic power be used in robotics?
- How can you create a robot using hydraulic power?

Unit 5: Research & Design a Robotic Design Challenge (~15 days)

- What problems can robots solve?
- How can robotics and controls be used in the real world?

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- Can you determine, design and prototype a solution?

Learning Objectives/Discipline Standards of Practice

Learning Objectives:

- Apply workshop rules and safety regulations inside a materials processing lab.
- Applying measurement and geometry to calculate robot navigation
- Identify, utilize, and maintain appropriate materials in the design of a robotic system.
- Identify use and application of robotics with manufacturing systems.
- Build, test and evaluate electronics and programming.
- Test, verify, and maintain robotic inventions.
- Measure torque with various gear ratios.
- Students are challenged to develop solutions through a systematic process that identifies the problem and refines ideas for solutions within the stated requirements
- Students use critical thinking skills to plan and conduct research, manage projects, solve problems and make informed decisions using appropriate technology tools.
- Students use digital media and environments to communicate and work collaboratively to support individual learning and contribute to the learning of others

Discipline Standards of Practice:

- Computing Systems
    - People interact with a wide variety of computing devices that collect, store, analyze, and act upon information in ways that can affect human capabilities both positively and negatively. The physical components (hardware) and instructions (software) that make up a computing system communicate and process information in digital form.
- Networks and the Internet
    - Computing devices typically do not operate in isolation. Networks connect computing devices to share information and resources and are an increasingly integral part of computing. Networks and communication systems provide greater connectivity in the computing world.
- Impacts of Computing
    - Computing affects many aspects of the world in both positive and negative ways at local, national, and global levels. Individuals and communities influence computing through their behaviors and cultural and social interactions, and, in turn, computing influences new cultural practices.
- Data & Analysis
    - Computing systems exist to process data. The amount of digital data generated in the world is rapidly expanding, so the need to process data effectively is increasingly important. Data is collected and stored so that it can be analyzed to better understand the world and make more accurate predictions.
- Algorithms & Programming
    - An algorithm is a sequence of steps designed to accomplish a specific task. Algorithms are translated into programs, or code, to provide instructions for computing devices. Algorithms and programming control all computing systems, empowering people to communicate with the world in new ways and solve compelling problems.
- Engineering Design
    - People design for enjoyment and to solve problems, extend human capabilities, satisfy needs and wants, and improve the human condition. Engineering Design, a systematic approach to creating solutions to technological problems and finding ways to meet people's

needs and desires, allows for the effective and efficient development of products and systems.

- Interaction of Technology and Humans
    - Societies influence technological development. Societies are characterized by common elements such as shared values, differentiated roles, and cultural norms, as well as by entities such as community institutions, organizations, and businesses. Interaction of Technology and Humans concerns the ways society drives the improvement and creation of new technologies, and how technologies both serve and change society.
- Nature of Technology
    - Human population, patterns and movement focus on the size, composition, distribution, and movement of human populations and how they are fundamental and active features on Earth's surface. This includes understanding that the expansion and redistribution of the human population affects patterns of settlement, environmental changes, and resource use. Patterns and movements of population also relate to physical phenomena including climate variability, landforms, and locations of various natural hazards and their effects on population size, composition, and distribution.
- Effects of Technology on the Natural World
    - Many of engineering and technology's impacts on society and the environment are widely regarded as desirable. However, other impacts are regarded as less desirable. Effects of Technology on the Natural World concerns the positive and negative ways that technologies affect the natural world.
- Ethics & Culture
    - Ethics and Culture concerns the profound effects that technologies have on people, how those effects can widen or narrow disparities, and the responsibility that people have for the societal consequences of their technological decisions.

Instructional Resources and Materials
Whole class resources have been identified with an asterisk.

Resources

- Arduino Project Hub
- Arduino Starter Kits
- Breadboards
- Electronic components
- Parallax BOE Shield Bot
- Soldering Irons
- Building materials, such as foam core

Materials

- Desktop Computing Devices

Assessment Strategies
Assessment is designed to measure a student's mastery of a course standard and learning objective. Assessment can be used for both instructional purposes (formative assessment) and for evaluative purposes (summative assessment).

The following is a general list of the many forms assessment may take in learning.

- Tests
- Design Projects

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    - Design & Rationale
    - Performance
    - Rubrics
- Digital Portfolio

Course Specific Assessments Include:

- Engineering Design Notebook