SPRING GROVE AREA SCHOOL DISTRICT

PLANNED COURSE OVERVIEW

Course Title: Robotics 2	**Length of Course:** 15 cycles
Grade Level(s): 9-12	**Periods Per Cycle:** 6
Units of Credit: .5	**Length of Period:** 43 minutes
Classification: Elective	**Total Instructional Time:** 64.5 hours

Course Description

This class will introduce robotics to students with a focus on autonomous robots. The students will explore the structure, drivetrain, and functionality of robots operated both by manual manipulation and programming the robots using student written code. Course information will be aligned with lab experiments where students will work in groups to build and test increasingly more complex mobile robots.

Instructional Strategies, Learning Practices, Activities, and Experiences

Teacher Demonstration	Posted Objectives and Agenda	Bell Ringers
Online Tutorials/Resources	Formal Assessments	Class Discussion
Inquiry/Project Based Assignments	Guided Practice	Flexible Groups
Best Practice Instructional Strategies		

Assessments

Final Exam	Unit Projects	Directed Reading Packets
Quizzes & tests	Constructed Response Articles	Study Guides

Materials/Resources

Robotic kits – 1 set per 2 students	SolidWorks Educational Package Installed on a Class Set of Computers	3D Printer Laser Cutter/Engraver

Adopted: 5/20/2019
Revised: 12/9/20

Unit 1: Introduction to Engineering	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Students will learn about what engineering is and what engineers do. The concepts of classical mechanics, design and iteration will be defined and worked through the unit. Students will apply this knowledge to automatous robotic design. Key Terminology: • Engineering • Methodical • Classical mechanics • Structural design • Design • Innovation • Quantitative • Specifications • Ideate • Prototype • CAD models • User manuals • Design presentations • Design review • Iterate	The students will be able to: • Demonstrate how classical mechanics is used in the engineering process. • Produce a prototype of a design that uses automated reactions. • Have the ability to incorporate electronic sensors into a design. **3.4.12.A1** - Compare and contrast the rate of technological development over time. **3.4.12.A2** - Describe how management is the process of planning, organizing, and controlling work. **3.4.12.A3** - Demonstrate how technological progress promotes the advancement of science, technology, engineering and mathematics (STEM). **3.4.12.C2** - Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. **3.4.12.C3** - Apply the concept that many technological problems require a multi-disciplinary approach. **3.4.12.E6** - Compare and contrast the importance of science, technology, engineering, and math (STEM) as it pertains to the manufactured world.

Unit 2: Robotic Design	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Students will learn about how the field of robotics operates and how both manually operated and autonomous robots work. Key Terminology: • Robot • Robotics • Subsystem • Manipulators • Control system • Sensors • Central Processing Unit (CPU) • Drivetrain • Actuators • Servo • Ultrasonic Range Finder • Gyroscope • Light sensor • Optical encoders • Microcontroller • Autonomous	The students will be able to: • Provide examples of how automated robots are used today in industry, research and in education. • Explain what the different basic components of a robot are and how each part performs a function in a larger machine. • Build a robot with given design criteria that can react to and solve complex problems. • Learn about the role of robots in society and how they are used in many aspects of modern life. • Examine reactionary systems, systems that react to various inputs. **3.4.12.A2** - Describe how management is the process of planning, organizing, and controlling work. **3.4.12.A3** - Demonstrate how technological progress promotes the advancement of science, technology, engineering, and mathematics (STEM). **3.4.12.C2** - Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. **3.4.12.C3** - Apply the concept that many technological problems require a multi-disciplinary approach. **3.4.12.E6** - Compare and contrast the importance of science, technology, engineering, and math (STEM) as it pertains to the manufactured world.

Unit 3: Semi-Autonomous Coding

CONTENT/KEY CONCEPTS	OBJECTIVES/STANDARDS
Students will learn to write and test the code used for semi-autonomous robotic control. Key Terminology: • Semi-Autonomous • Degree of freedom • Design constraints • Prototype • Robotic choices • Control system • Sensors • Central Processing Unit (CPU) • Commands and sequences • Debugging • Functions and a bit of loops • Conditional code • While loops • Algorithms • Variables • Parameters • Arrays	The students will: • Have the ability to generate and send code to the robot to perform a given task. • Be able to explain what the specific components that make up the robotic control system can do and how they are used to control the robot. • Be able to set up their microcontroller to function in both autonomous and drive controlled modes. • Design code so that robots can operate with human interaction, but will complete some tasks without direct human control. **3B.AP.21** - Develop and use a series of test cases to verify that a program performs according to its design specifications. **B.AP.16** - Demonstrate code reuse by creating programming solutions using libraries and Application Programming Interface (API)s. **3B.AP.21** Develop and use a series of test cases to verify that a program performs according to its design specifications. **3B.AP.22** Modify an existing program to add additional functionality and discuss intended and unintended implications. **3B.AP.23** Evaluate key qualities of a program through a process such as a code review. **3B.AP.24** Compare multiple programming languages and discuss how their features make them suitable for solving different types of problems. **3B.IC.26** Evaluate the impact of equity, access, and influence on the distribution of computing resources in a global society.

Unit 4: Autonomous Coding	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Students will learn to write and test the code used for autonomous robotic control. Key Terminology: • Semi-Autonomous • Degree of freedom • Design constraints • Prototype • Robotic choices • Control system • Sensors • Central Processing Unit (CPU) • Commands and sequences • Debugging • Functions and a bit of loops • Conditional code • While loops • Algorithms • Variables • Parameters • Arrays • Touch events	The students will: • Have the ability to generate and send code to the robot to perform a given task. • Be able to explain what the specific components that make up the robotic control system can do and how they are used to control the robot. • Be able to set up their microcontroller to function in autonomous modes. • Design code so that robots can operate without human interaction. **3B.AP.21** - Develop and use a series of test cases to verify that a program performs according to its design specifications. **B.AP.16** - Demonstrate code reuse by creating programming solutions using libraries and APIs. **3B.AP.21** - Develop and use a series of test cases to verify that a program performs according to its design specifications. **3B.AP.22** - Modify an existing program to add additional functionality and discuss intended and unintended implications. **3B.AP.23** - Evaluate key qualities of a program through a process such as a code review. **3B.AP.24** - Compare multiple programming languages and discuss how their features make them suitable for solving different types of problems. **3B.IC.26** - Evaluate the impact of equity, access, and influence on the distribution of computing resources in a global society.

Unit 5: Functions	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Students will learn how to use the functions that are used to shorten robotic programing. Key Terminology: • Function • Loop • If / And / Or statements • While • Nesting functions	The students will: • Have the ability to generate and send code to the robot to perform a given task. • Be able to explain what the specific components that make up the robotic control system can do and how they are used to control the robot. • Be able to set up their microcontroller to function in autonomous modes. • Use functions in advanced code where a repeatable set of events are simplified. **3B.AP.21** - Develop and use a series of test cases to verify that a program performs according to its design specifications. **B.AP.16** - Demonstrate code reuse by creating programming solutions using libraries and APIs. **3B.AP.21** Develop and use a series of test cases to verify that a program performs according to its design specifications. **3B.AP.22** - Modify an existing program to add additional functionality and discuss intended and unintended implications. **3B.AP.23** - Evaluate key qualities of a program through a process such as a code review. **3B.AP.24** - Compare multiple programming languages and discuss how their features make them suitable for solving different types of problems. **3B.IC.26** - Evaluate the impact of equity, access, and influence on the distribution of computing resources in a global society.

Unit 6: Object Manipulation

CONTENT/KEY CONCEPTS	OBJECTIVES/STANDARDS
Students will learn about the different types and categories of robot manipulators, both simple and manipulators that automatically react to inputs (e.g. an arm that senses an item and closes around that item). Students will be presented with robot manipulators from the real world, and shown the basic principles behind their operation. Students will then create their own object manipulator for use on student-designed robots. <u>Key Terminology:</u> • Manipulators • Plow • Scoops • Traction • Friction • Claw • Elasticity • Accumulators • Conveyor • Magazine • Indexing • Hopper • Conveyance	The students will be able to: • Demonstrate the basic concepts of manipulators and accumulators incorporating advanced sensors. • Design examples of robotic manipulators that use sensors to complete given tasks. **3.4.12.A2** - Describe how management is the process of planning, organizing, and controlling work. **3.4.12.A3** - Demonstrate how technological progress promotes the advancement of science, technology, engineering, and mathematics (STEM). **3.4.12.C2** - Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. **3.4.12.C3** - Apply the concept that many technological problems require a multi-disciplinary approach. **3.4.12.D2** - Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. **3.4.12.E5** - Explain how the design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques. **3.4.12.E6** - Compare and contrast the importance of science, technology, engineering, and math (STEM) as it pertains to the manufactured world. **3.4.12.E7** - Analyze the technologies of prefabrication and new structural materials and processes as they pertain to constructing the modern world.

Unit 7: Mechanical Power Transmission	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Students will learn about the different types of mechanical power transmission. <u>Key Terminology:</u> • Gear • Gear ratio • Mechanical advantage • Transmission • Spur gear • Bevel gear • Crown gear • Worm gear • Helical gear • Idler gear • Epicyclical (Planetary) gear • Rack and pinion gear • Gear pitch • Levers • Compound gear reduction	The students will be able to: • Demonstrate how mechanical power transmission systems are very important in the design and construction of student designed robots. • Vary the gear ratio (and the mechanical advantage) in a system, which gives them the versatility necessary to accomplish whatever work needs to be done. • Determine gear inputs and outputs by calculating the difference between them, and determine their gear ratio accordingly. **3.4.12.D2** - Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. **3.4.10.E5** - Analyze the development of transportation services and methods and their impact on society. **3.4.12.E4** - Synthesize the effects of information and communication systems and subsystems as an integral part of the development of the Information Age. **3.4.12.E5** - Explain how the design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques. **3.4.12.E6** - Compare and contrast the importance of science, technology, engineering, and math (STEM) as it pertains to the manufactured world.

Unit 8: Lifting Mechanisms

CONTENT/KEY CONCEPTS	OBJECTIVES/STANDARDS
Students will learn about the different types of lifting mechanisms and how they work. Engineering topics will include degrees of freedom, shock load, joint loading, joint speed, elevators, linkages, and passive assistance. Key Terminology: • Object manipulators • Lifting mechanisms • Degrees of freedom • First degree of freedom • Second degree of freedom • Third degree of freedom • Shock load • Joint loading • Joint speed • Mechanical advantage • Factor of safety • Elevator • Actuation • Linkages • Passive assistance	The students will be able to: • Differentiate the three degrees of freedom that are presented in the beginning of the unit. • Demonstrate the correct use of the calculations needed to choose a gear reduction. • Distinguish between the use of a linkage system and a multi-state elevator in manipulator design. • Explain how passive assistance can improve a robot design. **3.4.12.C2** - Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. **3.4.12.C3** - Apply the concept that many technological problems require a multi-disciplinary approach. **3.4.12.D2** - Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. **3.4.12.E4** - Synthesize the effects of information and communication systems and subsystems as an integral part of the development of the Information Age. **3.4.12.E5** - Explain how the design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques. **3.4.12.E6** - Compare and contrast the importance of science, technology, engineering, and math (STEM) as it pertains to the manufactured world.

Unit 9: Systems Integration

CONTENT/KEY CONCEPTS	OBJECTIVES/STANDARDS
Students will learn about the techniques that are used in engineering that allow for the successful integration of systems into a cohesive finished product. Students will learn how integration is an integral part of the initial design process. Key Terminology: • System integration • Power • Control • Pneumatics • Drivetrain • Lifting mechanisms • Object manipulators	The students will be able to: • Demonstrate how system integration works. • Demonstrate how they can use the six tips of integration in their design. **3.4.12.C2** - Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. **3.4.12.C3** - Apply the concept that many technological problems require a multi-disciplinary approach. **3.4.12.D2** - Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. **3.4.12.E4** - Synthesize the effects of information and communication systems and subsystems as an integral part of the development of the Information Age. **3.4.12.E5** - Explain how the design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques. **3.4.12.E6** - Compare and contrast the importance of science, technology, engineering, and math (STEM) as it pertains to the manufactured world.

Unit 10: Testing and the Iteration Process	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Students will learn how important testing, iteration and continuous improvement are in the design process. The students will learn how to develop their final automated robot design. Students will need to fully incorporate both mechanical design and the design of the automated code. <u>Key Terminology:</u> • Diagnose • Testing • Investigate • Symptoms • Iteration	The students will be able to: • Demonstrate the role that testing plays in the programing and design process. • Demonstrate how the information collected in the testing process is used in the different iterations of their robot design. • Demonstrate a systematic process to prioritize the improvements dictated to both mechanics and code from the data collected from their testing. **3.4.12.A1** - Compare and contrast the rate of technological development over time. **3.4.12.A3** - Demonstrate how technological progress promotes the advancement of science, technology, engineering, and mathematics (STEM). **3.4.12.C2** - Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. **3.4.12.C3** - Apply the concept that many technological problems require a multi-disciplinary approach. **3.4.12.D2** - Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. **3.4.12.E4** - Synthesize the effects of information and communication systems and subsystems as an integral part of the development of the Information Age. **3.4.12.E5** - Explain how the design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques. **3.4.12.E6** - Compare and contrast the importance of science, technology, engineering, and math (STEM) as it pertains to the manufactured world.