SPRING GROVE AREA SCHOOL DISTRICT

PLANNED COURSE OVERVIEW

Course Title: Electronics and Robotics I	**Length of Course:** Semester
Grade Level(s): 10-12	**Periods Per Cycle:** 6
Units of Credit: .5	**Length of Period:** 40 Minutes
Classification: Elective	**Total Instructional Time:** 60 Hours

Course Description

This is the first class of two at the high school that is intended for students to utilize the Design Process for authentic learning experiences in Electronics and Robotics. Practical applications of electronics will include, but are not limited to bread boarding, use of test equipment, and assembly of printed circuit boards and electronic projects. Emphasis will be placed on electronic components and their functions, operations, specifications, and circuit applications as it relates to human-controlled robots. The course will explore the structure, drivetrain, and functionality of robots. The students will pay a lab fee for this course.

Instructional Strategies, Learning Practices, Activities, and Experiences

Build Upon and Develop Minimum Competency Skills (MICS) Develop Advanced Competency Skills Design and Self-Reflect for Action Steps	Independent Research Project Construction Posted Objectives and Agendas	Bell Ringers Design, Build, Practice, Assess Process Journal Logs Constructive Responses

Assessments

Journals Weekly Checkpoints Small Group Discussions	Independent Projects Group Projects Panels of Experts	Competition Judges Competition Results Interviews with Local Businesses and Organizations

Materials/Resources

Technology Procedures and Equipment Instructor Provided Rubrics	Daily, Weekly, and Monthly Student Created Objectives	Competition Guidelines Various Materials Determined by Student(s') Needs

Adopted: 5/21/18
Revised: 12/9/20, 5/22/23

Unit 1: Introduction to Electronics	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Design Process Energy Concepts and Safety Ohm's Law Magnetism and Motors Speakers and Voice Coils	**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). **3.4.10.C1** ~ Apply the components of the technological design process. **3.4.10.C2** ~ Analyze a prototype and/or create a working model to test a design concept by making actual observations and necessary adjustments. **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. **3.4.10.D1** ~ Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of a final product. **3.4.10.D2** ~ Diagnose a malfunctioning system and use tools, materials, and knowledge to repair it. **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: Wire and Circuits	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Design Process Wire Gage Outlets and Switches Static Electricity Heat Sink Soldering Techniques and Troubleshooting Resistor Color Code Series and Parallel Circuits Digital Logic Circuits	**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). **3.4.10.C1** ~ Apply the components of the technological design process. **3.4.10.C2** ~ Analyze a prototype and/or create a working model to test a design concept by making actual observations and necessary adjustments. **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. **3.4.10.D1** ~ Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of a final product. **3.4.10.D2** ~ Diagnose a malfunctioning system and use tools, materials, and knowledge to repair it. **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: Microcontroller Platforms	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Students will learn about the microcontroller platform. i.e., Arduino, Raspberry Pie, or other similar platforms **Key Terminology:** • Resistor • Capacitor • Switch • Diode • LED (Light Emitting Diodes) • Breadboard • Circuitry • Breadboard	The students will be able to: • Demonstrate how a microcontroller works by building circuits and programing the microcontroller with coding. • Demonstrate how they can use a microcontroller to implement a design that reacts to outside stimuli. **Minimum Competency Skills:** The student will have the ability to learn the hardware components of a basic computer system. The student will have the ability to learn to code by writing commands. The student will have the ability to use functions to program small useful task that can be repeated. The student will have the ability to write code using for loops. The student will have the ability to use conditional code to write useful code. The student will have the ability to use logical operators to compare conditions in programming. The student will have the ability to repeat code until a condition is met using while loops. The student will have the ability to learn to write algorithms to solve complex coding problems. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to make design changes and modifications to a robot to complete a given task. The student will have the ability to program a robot to make decisions based on sensor inputs. The student will have the ability to program a robot to make multiple moves using coding. The student will have the ability to program a robot to make decisions based on sensor multiple inputs. The student will have the ability to follow a wiring diagram to correctly wire a robot for autonomously controlled operations. **Next Generation Science Standards (NGSS):** 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 account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Unit 4: Introduction to Robotics	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, students will learn about how the field of robotics operates and how robots work. Students will learn about the role of robots in society and how they are used in many aspects of modern life. **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 robots are used today in industry, research and in education. The students will be able to explain what the different basic components of a robot are and how each part performs a function in a larger machine. The students will be able to build a robot with given design criteria that mimics commercial robots. **Minimum Competency Skills:** The student will have the ability to follow a set of plans to build a robotic chassis with a given set of components. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to make design changes and modifications to a robot to complete a given task. The student will have the ability to use a remote control to correctly operate a robot through a given set of obstacles. The student will have the ability to design & operate a robot that uses four channels of control. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. **Next Generation Science Standards (NGSS):** HS-ETS1-1 - Analyze a major global or District 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 account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Unit 5: Introduction to Controllers	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, students will learn what the core components of robotic control system are - the Microcontroller, the Joystick and Wireless controller links. They will also learn how they each function. **Key Terminology:** • Microcontroller • Bi-Directional Communication • Debugging • Downloading • Interface • Autonomously • Jumpers	The students will 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. The students will be able to set up their microcontroller to function in both autonomous and drive controlled modes. The students will be able to use control systems to successfully operate a robot while manipulating objects in a maze. **Minimum Competency Skills:** The student will have the ability to follow a set of plans to build a robotic chassis with a given set of components. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to make design changes and modifications to a robot to complete a given task. The student will have the ability to use a remote control to correctly operate a robot through a given set of obstacles. The student will have the ability to design & operate a robot that uses four channels of control. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to learn to code by writing commands. The student will have the ability to use functions to program small useful task that can be repeated. The student will have the ability to write code using for loops. The student will have the ability to use conditional code to write useful code. **Next Generation Science Standards (NGSS):** HS-ETS1-1 - Analyze a major global or District 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 account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Unit 6: Object Manipulation

CONTENT/KEY CONCEPTS	OBJECTIVES/STANDARDS
In this unit, students will learn about the different types and categories of robot manipulators. 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 their competition robot. **Key Terminology:** • 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. The students will be able to design examples of each. **Minimum Competency Skills:** The student will have the ability to follow a set of plans to build a robotic chassis with a given set of components. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to make design changes and modifications to a robot to complete a given task. The student will have the ability to use a remote control to correctly operate a robot through a given set of obstacles. The student will have the ability to design & operate a robot that uses four channels of control. The student will have the ability to design and make an end effector with the CAD/CAM process that accomplished a given goal. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to program a robot to make decisions based on sensor inputs. **Next Generation Science Standards (NGSS):** HS-ETS1-1 - Analyze a major global or District 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 account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Unit 7: Speed, Power, Torque & DC Motors

CONTENT/KEY CONCEPTS	OBJECTIVES/STANDARDS
In this unit, students will learn about the physical principles of speed, power, and torque. Students will learn about DC motors and how these principles apply to them. Students will apply these concepts on a sample mechanical system to calculate key details of the design. **Key Terminology:** • Methodical • Engineering • Mechanics • Speed • Rotational Speed • Acceleration • Force • Work • Power • Torque • Velocity • Actuator • DC Motor • Voltage • Current • Stall • Load	The students will be able to explain the difference between speed, power, and torque. The students will be able to apply the concept of speed as related to robotic movements. The students will be able to apply the concept of power as related to robotic movements. The students will be able to apply the concept of torque as related to robotic movements. **Minimum Competency Skills:** The student will have the ability to follow a set of plans to build a robotic chassis with a given set of components. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to make design changes and modifications to a robot to complete a given task. The student will have the ability to use a remote control to correctly operate a robot through a given set of obstacles. The student will have the ability to design & operate a robot that uses four channels of control. The student will have the ability to design and make an end effector with the CAD/CAM process that accomplished a given goal. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to program a robot to make decisions based on sensor inputs. **Next Generation Science Standards (NGSS):** HS-ETS1-1 - Analyze a major global or District 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 account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Unit 8: Mechanical Power Transmission	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, students will learn about the different types of mechanical power transmission. **Key Terminology:** • 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 competition robots. The students will be able to 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. The students will be able to determine gear inputs & outputs by calculating the difference between them and determine their gear ratio accordingly. **Minimum Competency Skills:** The student will have the ability to follow a set of plans to build a robotic chassis with a given set of components. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to make design changes and modifications to a robot to complete a given task. The student will have the ability to use a remote control to correctly operate a robot through a given set of obstacles. The student will have the ability to design & operate a robot that uses four channels of control. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to program a robot to make decisions based on sensor inputs. **Next Generation Science Standards (NGSS):** HS-ETS1-1 - Analyze a major global or District 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 account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Unit 9: Drivetrain Design	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, students will learn about the physical principles of friction and traction through the exploration of robot drivetrain design. **Key Terminology:** • Friction • Traction • Drivetrain • Static Friction • Kinetic Friction • Maximum Static Friction • Magnitude • Force of Friction • Normal Force • Tractive Force • Drive Wheel • Turning Point • Turning Scrub • Zero Radius Turn	The students will be able to demonstrate how applied force and friction are related. The students will be able to distinguish between static and kinetic friction. The students will be able to calculate wheel speed. The students will be able to demonstrate how to calculate a gear reduction. The students will be able to compare and contrast the different types of drivetrains, along with their benefits and drawbacks. **Minimum Competency Skills:** The student will have the ability to follow a set of plans to build a robotic chassis with a given set of components. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to make design changes and modifications to a robot to complete a given task. The student will have the ability to use a remote control to correctly operate a robot through a given set of obstacles. The student will have the ability to design & operate a robot that uses four channels of control. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to program a robot to make decisions based on sensor inputs. **Next Generation Science Standards (NGSS):** HS-ETS1-1 - Analyze a major global or District 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 account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Unit 10: Lifting Mechanisms

CONTENT/KEY CONCEPTS	OBJECTIVES/STANDARDS
In this unit, 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. The students will be able to demonstrate the correct use of the calculations needed to choose a gear reduction. The students will be able to distinguish between the use of a linkage system and a multi-state elevator in manipulator design. The students will be able to explain how passive assistance can improve a robot design. **Minimum Competency Skills:** The student will have the ability to follow a set of plans to build a robotic chassis with a given set of components. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to make design changes and modifications to a robot to complete a given task. The student will have the ability to use a remote control to correctly operate a robot through a given set of obstacles. The student will have the ability to design & operate a robot that uses four channels of control. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to program a robot to make decisions based on sensor inputs. **Next Generation Science Standards (NGSS):** HS-ETS1-1 - Analyze a major global or District 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 account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Unit 11: End Effector Design	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
Engineers and designers use a variety of tools and techniques, ranging from freehand pencil sketches to sophisticated digital modeling, to explore ideas and communicate concepts and technical directions to others. The design development process can be expedited using virtual prototypes and rapid prototyping. The development of a custom product feature for a robot requires careful consideration for how it will be integrated into the entire robotic system. Design Process **Key Terminology:** • CAD • CNC • Degree Of Freedom • Design Constraints • Prototype • Rapid Prototyping • Tolerances • 3D Printer • Laser Cutter	The students will be able to analyze an existing product to identify potential areas for innovation that might include improvements relative to performance or cost, among other factors. The students will be able to explain how physical sketch models, 2D sketches, and 3D digital models can be used as visualization tools for design ideation. The students will be able to use Computer Aided Design software to create, render and animate custom 3D models. The students will be able to describe the importance of documenting and annotating a design in the design software. The students will be able to physically create a custom part from a virtual prototype using Computer Aided Design software. **Minimum Competency Skills:** The student will have the ability to follow a set of plans to build a robotic chassis with a given set of components. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to make design changes and modifications to a robot to complete a given task. The student will have the ability to use a remote control to correctly operate a robot through a given set of obstacles. The student will have the ability to design & operate a robot that uses four channels of control. The student will have the ability to follow a wiring diagram to correctly wire a robot for remote controlled operations. The student will have the ability to program a robot to make decisions based on sensor inputs. **Next Generation Science Standards (NGSS):** 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 account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.