SPRING GROVE AREA SCHOOL DISTRICT

PLANNED COURSE OVERVIEW

Course Title: Robotics 1	**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 and focus on human-controlled robots. The class will explore the structure, drivetrain, and functionality of robots. 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	Formal Assessments	Bell Ringers
Online Tutorials/Resources	Guided Practice	Class Discussion
Critical Thinking		Flexible Groups

Assessments

Final Exam	Unit Projects	Skills Mastery Checklists
Student Portfolio	Design/Lesson Rubrics	

Materials/Resources

Vex Robotic Kits – 1 for 2 students	SolidWorks Educational Package Installed on a Class Set of Computers	3D Printer Laser Cutter/Engraver

Adopted: 5/21/18
Revised: 12/9/20

Introduction to Engineering	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, the 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. A. Engineering B. Methodical C. Classical Mechanics D. Structural Design E. Manufacturing F. Design G. Innovation H. Quantitative I. Specifications J. Ideate K. Prototype L. Computer Aided Design (CAD) Models M. Assembly Drawings N. Manufacturing Plans O. Bill of Materials P. Maintenance Guide Q. User Manuals R. Design Presentations S. Proposals T. Design Review U. Iterate V. Engineering Notebook	The students will be able to: • Demonstrate how classical mechanics is used in the engineering process. • Produce a prototype of a design. **3.4.10.A1** ~ Illustrate how the development of technologies is often driven by profit and an economic market. **3.4.10.A2** ~ Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.10.B1** ~ Compare and contrast how the use of technology involves weighing the trade-offs between the positive and negative effects. **3.4.10.E7** ~ Evaluate structure design as related to function, considering such factors as style, convenience, safety, and efficiency. **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.

Introduction to Robotics	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, the students will learn about how the field of robotics operates and how robots work. The students will learn about the role of robots in society and how they are used in many aspects of modern life. A. Robot B. Robotics C. Subsystem D. Manipulators E. Control System F. Sensors G. Central Processing Unit (CPU) H. Drivetrain I. Actuators J. Servo K. Ultrasonic Range Finder L. Gyroscope M. Light Sensor N. Optical Encoders O. Microcontroller P. Autonomous	The students will be able to: • Provide examples of how 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. **3.4.10.A2** ~ Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.10.A3** ~ Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. **3.4.10.B4** ~ Recognize that technological development has been evolutionary, the result of a series of refinements to a basic invention. **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. **3.4.10.C3** ~ Illustrate the concept that not all problems are technological and not every problem can be solved using technology. **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. **3.4.10.E3** ~ Compare and contrast the major forms of energy: thermal, radiant, electrical, mechanical, chemical, nuclear and others. **3.4.10.E6** ~ Illustrate how manufacturing systems may be classified into types such as customized production, batch production, and continuous production. **3.4.10.E7** ~ Evaluate structure design as related to function, considering such factors as style, convenience, safety, and efficiency. **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..

Introduction to Controllers	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, the students will learn what the core components of robotic control systems are - the Microcontroller, the Joystick and Wireless controller links. They will also learn how they each function. A. Microcontroller B. Bi-directional Communication C. Debugging D. Downloading E. Interface F. Autonomously G. 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. • Set up their microcontroller to function in both autonomous and drive controlled modes. • Use control systems to successfully operate a robot while manipulating objects in a maze. **3.4.10.A1** ~ Illustrate how the development of technologies is often driven by profit and an economic market. **3.4.10.A2** ~ Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.10.A3** ~ Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. **3.4.10.B1** ~ Compare and contrast how the use of technology involves weighing the trade-offs between the positive and negative effects. **3.4.10.B4** ~ Recognize that technological development has been evolutionary, the result of a series of refinements to a basic invention. **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. **3.4.10.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. **3.4.10.E4** ~ Evaluate the purpose and effectiveness of information and communication systems. **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.B2** ~ Illustrate how, with the aid of technology, various aspects of the environment can be monitored to provide information for decision making. **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.

Introduction to Computer Aided Design	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, the students will get an introduction to Autodesk Inventor. They will get an overview of the different ways engineers use Autodesk Inventor and then learn specific ways they can use Inventor to help design and build VEX robots. A. Computer Aided Design (CAD) B. Assemblies C. Animate D. Rendering E. Browser Menu F. Constraints G. Degrees of Freedom H. Bottom Up Modeling I. Top Down Modeling J. Views	The students will be able to: • Create 3D models using design software. • Animate 3D models. • Render 3D models. **3.4.10.A2** ~ Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.10.A3** ~ Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. **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. **3.4.10.D1** ~ Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of a final product. **3.4.10.D3** ~ Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and the environment. **3.4.10.E4** ~ Evaluate the purpose and effectiveness of information and communication systems. **3.4.10.E7** ~ Evaluate structure design as related to function, considering such factors as style, convenience, safety, and efficiency. **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.

Strategic Design	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, the students will design a robot to complete a designed challenge. The students will be able to analyze potential design and operations strategies. The students will learn the effects of applying a cost-benefit analysis to the design process. Related Vocabulary: strategic design defining objectives cost benefit prioritization	The students will be able to: • Explain how the process of strategic design works. • Demonstrate the use of defining objectives to select game objectives. • List all of the ways to score the most points in the game. • Create a cost–benefit analysis to demonstrate the strengths of different tasks. **3.4.10.A2** ~ Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.10.A3** ~ Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. **3.4.10.B2** ~ Demonstrate how humans devise technologies to reduce the negative consequences of other technologies. **3.4.10.B4** ~ Recognize that technological development has been evolutionary, the result of a series of refinements to a basic invention. **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. **3.4.10.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. **3.4.10.E7** ~ Evaluate structure design as related to function, considering such factors as style, convenience, safety, and efficiency. **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.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.

Object Manipulation	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, the students will learn about the different types and categories of robot manipulators. The students will be presented with robot manipulators from the real-world and shown the basic principles behind their operation. The students will then create their own object manipulator for use on their competition robot. A. Manipulators B. Plow C. Scoops D. Traction E. Friction F. Claw G. Elasticity H. Accumulators I. Conveyor J. Magazine K. Indexing L. Hopper M. Conveyance	The students will be able to: • Demonstrate the basic concepts of manipulators and accumulators. • Design examples of each. **3.4.10.A2** ~ Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.10.A3** ~ Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. **3.4.10.B2** ~ Demonstrate how humans devise technologies to reduce the negative consequences of other technologies. **3.4.10.B4** ~ Recognize that technological development has been evolutionary, the result of a series of refinements to a basic invention. **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. **3.4.10.C3** ~ Illustrate the concept that not all problems are technological and not every problem can be solved using technology. **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. **3.4.10.E7** ~ Evaluate structure design as related to function, considering such factors as style, convenience, safety, and efficiency. **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.

Speed, Power, Torque and DC Motors	
CONTENT/KEY CONCEPT	**OBJECTIVES/STANDARDS**
In this unit, the students will learn about the physical principles of speed, power, and torque. The students will learn about Direct Current (DC) motors and how these principles apply to them. The students will apply these concepts on a sample mechanical system to calculate key details of the design. A. Methodical B. Engineering C. Mechanics D. Speed E. Rotational Speed F. Acceleration G. Force H. Work I. Power J. Torque K. Velocity L. Actuator M. DC Motor N. Voltage O. Current P. Stall Q. Load	The students will be able to: • Explain the difference between speed, power, and torque. • Apply the concept of speed, power, and torque, as related to robotic movements. **3.4.10.A2** ~ Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.10.A3** ~ Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. **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). **3.4.10.B1** ~ Compare and contrast how the use of technology involves weighing the trade-offs between the positive and negative effects. **3.4.10.B2** ~ Demonstrate how humans devise technologies to reduce the negative consequences of other technologies. **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.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.E3** ~ Compare and contrast the major forms of energy: thermal, radiant, electrical, mechanical, chemical, nuclear and others. **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.

Mechanical Power Transmission	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, the students will learn about the different types of mechanical power transmission. A. Gear B. Gear Ratio C. Mechanical Advantage D. Transmission E. Spur Gear F. Bevel Gear G. Crown Gear H. Worm Gear I. Helical Gear J. Idler Gear K. Epicyclical (Planetary) Gear L. Rack and Pinion Gear M. Gear Pitch N. Levers O. 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. • 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. **3.4.10.A2** ~ Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.10.A3** ~ Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. **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). **3.4.10.B1** ~ Compare and contrast how the use of technology involves weighing the trade-offs between the positive and negative effects. **3.4.10.B2** ~ Demonstrate how humans devise technologies to reduce the negative consequences of other technologies. **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.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.

Drivetrain Design	
CONTENT/KEY CONCEPTS	OBJECTIVES/STANDARDS
In this unit, the students will learn about the physical principles of friction and traction through the exploration of robot drivetrain design. A. Friction B. Traction C. Drivetrain D. Static Friction E. Kinetic Friction F. Maximum Static Friction G. Magnitude H. Force of Friction I. Normal Force J. Tractive Force K. Drive Wheel L. Turning Point M. Turning Scrub N. Zero Radius Turn O. Ackermann Steering P. Skid Steer Q. Omni Directional	The students will be able to: • Demonstrate how applied force and friction are related. • Distinguish between static and kinetic friction. • Calculate wheel speed. • Demonstrate how to calculate a gear reduction. • Compare and contrast the different types of drivetrains, along with their benefits and drawbacks. **3.4.10.A2** ~ Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.10.A3** ~ Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. **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). **3.4.10.B1** ~ Compare and contrast how the use of technology involves weighing the trade-offs between the positive and negative effects. **3.4.10.B2** ~ Demonstrate how humans devise technologies to reduce t negative consequences of other technologies. **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.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.

Lifting Mechanisms	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, the 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. A. Object Manipulators B. Lifting Mechanisms C. Degrees of Freedom D. First Degree of Freedom E. Second Degree of Freedom F. Third Degree of Freedom G. Shock Load H. Joint Loading I. Joint Speed J. Mechanical Advantage K. Factor of Safety L. Elevator M. Actuation N. Linkages O. 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. **3.4.10.A2** ~ Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.10.A3** ~ Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. **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). **3.4.10.B1** ~ Compare and contrast how the use of technology involves weighing the trade-offs between the positive and negative effects. **3.4.10.B2** ~ Demonstrate how humans devise technologies to reduce the negative consequences of other technologies. **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.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.

Systems Integration	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, the students will learn about the techniques that are used in engineering that allow for the successful integration of systems into a cohesive finished product. The students will learn how integration is an integral part of the initial design process. A. System Integration B. Power C. Control D. Pneumatics E. Drivetrain F. Lifting Mechanisms G. Object Manipulators	The students will be able to: • Demonstrate how system integration works. • Demonstrate how they can use the six tips of for integration in their design. **3.4.10.A2** ~ Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.10.A3** ~ Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. **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). **3.4.10.B1** ~ Compare and contrast how the use of technology involves weighing the trade-offs between the positive and negative effects. **3.4.10.B2** ~ Demonstrate how humans devise technologies to reduce the negative consequences of other technologies. **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.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.E3** ~ Compare and contrast the major forms of energy: thermal, radiant, electrical, mechanical, chemical, nuclear and others. **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.

Testing and the Iteration Process	
CONTENT/KEY CONCEPTS	**OBJECTIVES/STANDARDS**
In this unit, the students will learn how important testing, iteration and continuous improvement are in the design process. The students will learn how to develop their final design. A. Iteration B. Fail Point C. Testing D. Troubleshooting	The students will be able to: • Demonstrate the role that testing plays in the 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 from the data collected from their testing. **3.4.10.A2** ~ Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.10.A3** ~ Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. **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). **3.4.10.B2** ~ Demonstrate how humans devise technologies to reduce the negative consequences of other technologies. **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.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.E3** ~ Compare and contrast the major forms of energy: thermal, radiant, electrical, mechanical, chemical, nuclear and others. **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.

Design your Own Part	
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 through the use of 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. A. CAD B. Computer Numerical Control (CNC) C. Degree of Freedom D. Design Constraints E. Prototype F. Rapid Prototyping G. Tolerances H. 3D Printer I. Laser Cutter	The students will be able to: • Analyze an existing product (VEX robot) to identify potential areas for innovation that might include improvements relative to performance or cost, among other factors. • Explain how physical sketch models, 2D sketches, and 3D digital models can be used as visualization tools for design ideation. • Use Computer Aided Design software to create, render and animate custom 3D models. • Describe the importance of documenting and annotating a design in the design software. • Create physically a custom part from a virtual prototype using Computer Aided Design software. **3.4.10.A2** ~ Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.10.A3** ~ Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. **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. **3.4.10.D1** ~ Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of a final product. **3.4.10.D3** ~ Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and the environment. **3.4.10.E4** ~ Evaluate the purpose and effectiveness of information and communication systems. **3.4.10.E7** ~ Evaluate structure design as related to function, considering such factors as style, convenience, safety, and efficiency. **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.B1** ~ Analyze ethical, social, economic, and cultural considerations as related to the development, selection, and use of technologies. **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.