Wethersfield Public Schools

WHS Curriculum: Robotics Engineering

Grade(s)	9-12 - Unleveled
Unit Title and Purpose	**Unit 1: Introduction to Engineering & Robotics**
Timeframe	4 class sessions

Vision of the Graduate

Communicator: Students exchange ideas and information with others of diverse backgrounds and viewpoints.
Problem Solver: Students actively apply knowledge with empathy using the Engineering Design Process.
Collaborator: Students actively participate and share ideas while working hands-on toward a common goal.

Unit Priority Standards

Standards for Technological and Engineering Literacy
STEL-1Q. Conduct research to inform intentional innovations that address specific needs and wants.
STEL-1P. Analyze the rate of technological development and predict future diffusion and adoption of new technologies.
STEL-7AA. Illustrate principles, elements and factors of design.
STEL-7BB. Implement the best possible solution to a design.
STEL-7CC. Apply a broad range of design skills to their design process.
STEL-10. Assess how similarities and differences among scientific, mathematics, engineering, and technological knowledge and skills contributed to the design of a product or system.

Unit Supporting Standards

CCSS.ELA-LITERACY.RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context.
CCSS.ELA-LITERACY.RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

Essential Questions

What are the different careers in the field of Engineering and what does it take to get one?

How do engineers solve problems using the engineering design process?

How is creativity and innovation used in engineering design?

What are the elements of good engineering?

How do teams efficiently and effectively solve problems in an increasingly complex world?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
1. Illustrate principles, elements and factors of design. 2. Implement the best possible solution to a design. 3. Apply a broad range of design skills to the design process. 4. Optimize a design by addressing desired qualities within criteria and constraints. 5. Conduct research on technology topics.	1. Explain how the world around them guides technological development and engineering design. 2. Explain the history of robotic technology.. 3. Assess how similarities and differences among scientific, mathematics, engineering, and technological knowledge and skills contributed to the design of a product or system.

6. Identify steps of the engineering design process, and explain how this process can be used to solve a problem.	4. Explain the steps of the engineering design process, and explain how this process can be used to solve a problem. 5. Identify different fields of engineering and the post-secondary education requirements for each.
Student Learning Tasks & Resources	**Suggested Teacher Materials & Resources**
● Students work with a group to plan, delegate tasks and construct a straw tower using the Engineering Design process in a timed setting. The building component restricts users from verbally communicating through the process. ● Students research and explore the different types of engineering careers and complete the Investigate Engineering Careers task. ● Students apply the Engineering Design Process to decide which step in the process best fits given actions.	● Consumable supplies including tape, straws, pencils, paper, scissors, etc. ● Intro to Engineering - Google Slides ● 13 Types of Engineering Careers by Artur Meyster (video) ● Computers and coordinating software

Wethersfield Public Schools

WHS Curriculum: Robotics Engineering

Grade(s)	9-12 - Unleveled
Unit Title and Purpose	**Unit 2: Introduction to Robotics Engineering**
Timeframe	4 class sessions

Vision of the Graduate

Communicator: Students exchange ideas and information with others of diverse backgrounds and viewpoints.
Problem Solver: Students actively search for replacement parts and pricing for their robots.
Collaborator: Students actively participate and share ideas with a research presentation on a robot innovation.

Unit Priority Standards

STEL-1Q. Conduct research to inform intentional innovations that address specific needs and wants.
STEL-1N. Explain how the world around them guides technological development and engineering design.
STEL-2W. Select resources that involve tradeoffs between competing values, such as availability, cost, desirability, and waste, while problem-solving.
STEL-4P. Evaluate ways that technology can impact individuals, society, and the environment.
STEL-5H. Evaluate a technological innovation that arose from a specific society's unique need or want.
STEL-6D. Engage in a research and development process to simulate how inventions and innovations have evolved through systematic tests and re?nementsy.
STEL-7AA. Illustrate principles, elements and factors of design.

Unit Supporting Standards

CCSS ELA: ELA-Literacy.W.9-10.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
CCSS ELA: ELA-Literacy.W.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
CCSS.ELA-LITERACY.RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

Essential Questions

Why are robots used?

How have robots changed over time?

What makes a robot a robot?

What are the positive and negative impacts of robots on society and the environment?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
1. Evaluate ways that technology can impact individuals, society, and the environment. 2. Evaluate a technological innovation that arose from a specific society's unique need or want. 3. Illustrate principles, elements and factors of design. 4. Conduct research to inform intentional innovations that address specific needs and wants.	1. Explain how the world around them guides technological development and engineering design. 2. Identify what makes a robot a robot; identify the major parts of a robot. 3. Explain why the field of robotics is needed and areas they are used in. 4. Identify advantages and disadvantages of robots.

5. Select resources that involve tradeoffs between competing values, such as availability, cost, desirability, and waste, while problem-solving. 6. Use creativity to illustrate a new robot invention. 7. Work collaboratively to find and research a robotic invention and communicate their findings with classmates.	5. Identify and explain the different parts of the VEX robot system, identify parts and how systems work together. 6. Explain different sensors used in robotics/programming.
Student Learning Tasks & Resources	**Suggested Teacher Materials & Resources**
● Students conduct an inquiry to help them define a robot, the field of Robotics, the three laws of Robotics, why Robotics is needed, the five main parts of industrial robots, five areas robots are used, advantages and disadvantages of robots; they use this to illustrate a new, creative robot technology. ● Students research robots collaboratively and choose one to create a professional presentation to report their findings to the class. ● Students complete the Robot Google Presentation Collaborative Project ● Students assess and score classmates' presentations and complete the corresponding Robot Presentations peer assessment.	● Intro to Robotics - Google Slides ● Computers, internet and coordinating software ● Sensors - Google Slides

Grade(s)	9-12 - Unleveled
Unit Title and Purpose	**Unit 3: Robotics Systems Design & Build**
Timeframe	5 weeks

Vision of the Graduate

Communicator: Students will exchange ideas and information as they work in a team to build their robot and compete in multiple competitions.
Problem Solver: Students will actively apply knowledge with empathy while working in a team to solve problems with their robots and developing games.
Collaborator: Students will actively participate and share ideas with team members and classmates when working on robots and with game development.

Unit Priority Standards

STEL-2U. Diagnose a flawed system embedded within a larger technological, social, or environmental system.
STEL-2V. Analyze the stability of a technological system and how it is influenced by all of the components in the system, especially those in the feedback loop.
STEL-2Y. Implement quality control as a planned process to ensure that a product, service, or system meets established criteria.
STEL-2Z. Use management processes in planning, organizing, and controlling work.
STEL-7W. Determine the best approach by evaluating the purpose of the design.
STEL-7X. Document trade-offs in the technology and engineering design process to produce the optimal design.
STEL-7Y. Optimize a design by addressing desired qualities within criteria and constraints.
STEL-8P. Apply appropriate methods to diagnose, adjust and repair systems to ensure precise, safe and proper functionality.

Unit Supporting Standards

CCSS.ELA-LITERACY.RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
CCSS.ELA-LITERACY.RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

Essential Questions

How do the components within each system of a robot interact, relate and connect?

How do you troubleshoot and maintain a robot system?

What is the best design for a robot?

How do you achieve success while working in a group environment?

How can you use criteria and constraints to build an improved product?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
1. Diagnose a flawed system embedded within a larger technological, social, or environmental system.	1. Understand that robots are complex devices made up of systems that interact, relate and connect.

2. Analyze the stability of a technological system and how it is influenced by all of the components in the system, especially those in the feedback loop. 3. Implement quality control as a planned process to ensure that a product, service, or system meets established criteria. 4. Optimize a design by addressing desired qualities within criteria and constraints. 5. Apply appropriate methods to diagnose, adjust and repair systems to ensure precise, safe and proper functionality. 6. Read technical instructions. 7. Research part pricing and determine the most cost effective replacement parts to purchase. 8. Use management processes in planning, organizing, and controlling work. 9. Determine the best approach by evaluating the purpose of the design. 10. Document trade-offs in the technology and engineering design process to produce the optimal design. 11. Prepare and organize parts. 12. Create a functional control system with all expected behaviors. 13. Wire an electrical system safely, effectively with a result being completely functional. 14. Build a fully functional mechanical system. 15. Develop and improve criteria and constraints in individual, team and class game development. 16. Analyze strategies used in the LOR competition.	2. Gain knowledge of robot systems that require troubleshooting and maintenance to ensure safe and proper function and precision. 3. Identify the output ports, input ports, cables and the remote control.
Student Learning Tasks & Resources	**Suggested Teacher Materials & Resources**
● Research proper part names and pricing of individual parts to learn how to reorder parts in a cost-effective way (Parts - Vex V5 Clawbot Worksheet). ● Build robots in a team with the technical manual while using communication, problem solving and collaboration skills, and following the Robot Completion Rubric to evaluate their work and correct if needed. ● Analyze challenges faced while building robot and how they problem solved (Building Challenges Warm Up/Exit Tickets). ● Use the Vex V5 Robot Building kits in teams of 2-4 to construct a robot using the Robot Completion	● Robot Parts & Systems - Google slides ● Robot Completion Rubric ● Lord of the Rings - Original Worksheet ● Wheel of Names Picker ● Team Elimination Brackets ● LOR Flag Banner

Rubric as a guide for the following criteria: Preparation; Control System; Electrical System; Mechanical Systems; Resources; and Teamwork. ● Evaluate team's strategies in the LOR Competition then complete the Lord of the Rings Robot Review (Google Form). ● Individually design a robot competition game with criteria and constraints (Invent a Clawbot Game Worksheet). ● Collaborate with a team to select and improve one member's game for the class competition as they problem-solve and improve it through effective communication and complete TEAM Invention of Game Worksheet. ● Self-assess group participation using the VoG in the TEAM Invention of a Game (Group Participation Rubric, Clawbot Game Worksheet). ● Evaluate the set up, rules, scoring, complexity and basic overall game play of each of their teammates games (Game Evaluation Worksheets).	

Grade(s)	9-12 - Unleveled
Unit Title and Purpose	**Unit 4: Robotics Control Systems & Programming**
Timeframe	3 weeks

Vision of the Graduate

Communicator: Students will exchange ideas and information with others as they work in a team to design a successful program for their robots to efficiently complete a task.
Problem Solver: Students actively apply knowledge with empathy while working in a team to solve problems while developing a program for the robots.
Collaborator: Students actively participate and share ideas with team members and classmates when working on the development of programs.

Unit Priority Standards

STEL-2T. Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making.
STEL-2U. Diagnose a flawed system embedded within a larger technological, social, or environmental system.
STEL-2V. Analyze the stability of a technological system and how it is influenced by all of the components in the system, especially those in the feedback loop.
STEL-2Y. Implement quality control as a planned process to ensure that a product, service, or system meets established criteria.
STEL-3J. Connect technological progress to the advancement of other areas of knowledge.
STEL-4R. Assess a technology that minimizes resource use and resulting waste to achieve a goal.
STEL-5H. Evaluate a technological innovation that arose from a specific society's unique need or want.
STEL-7W. Determine the best approach by evaluating the purpose of the design.
STEL-7X. Document trade-offs in the technology and engineering design process to produce the optimal design.
STEL-7AA. Illustrate principles, elements and factors of design.
STEL-7BB. Implement the best possible solution to a design.
STEL-8P. Apply appropriate methods to diagnose, adjust and repair systems to ensure precise, safe and proper functionality.

Unit Supporting Standards

CCSS.ELA-LITERACY.RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
CCSS.ELA-LITERACY.W.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Essential Questions

What new technologies are being developed and used currently?

In what ways can a robot be controlled?

How do the control components within a robot interact, relate and connect?

How do gears manipulate, manage or control a machine within the control system?

How do you write code to create a program for a robot?

How do you debug a program?

How do you download a program to a robot?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
1. Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making. 2. Diagnose a flawed system embedded within a larger technological, social, or environmental system. 3. Analyze the stability of a technological system and how it is influenced by all of the components in the system, especially those in the feedback loop. 4. Implement quality control as a planned process to ensure that a product, service, or system meets established criteria. 5. Design an appropriate technology for use in a different culture. 6. Illustrate principles, elements and factors of design. 7. Implement the best possible solution to a design. 8. Apply appropriate methods to diagnose, adjust and repair systems to ensure precise, safe and proper functionality. 9. Determine the best approach by evaluating the purpose of the design. 10. Assess a technology that minimizes resource use and resulting waste to achieve a goal. 11. Demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. 12. Demonstrate how to create and download programs to a robot to complete specific tasks while testing and problem-solving within a team. 13. Demonstrate professionalism in the CTE Classroom.	1. Understand the feedback loop. 2. Connect technological progress to the advancement of other areas of knowledge. Understand current and new technology. 3. Differentiate between operator control and autonomous control. 4. Understand that control systems are a group of technological parts used to manipulate, manage or control a machine or machine's features. 5. Understand that gears are part of a control system and provide specific functions. 6. Understand core computer science concepts of coding and programming as well as debugging techniques. 7. Evaluate a technological innovation that arose from a specific society's unique need or want. 8. Evaluate how technology enhances opportunities for new products and services through globalization.
Student Learning Tasks & Resources	**Suggested Teacher Materials & Resources**

● Research a new or current technology (New/Current Technology Research Worksheet).
● Learn basic coding to complete and debug a program by completing 2 Hour of Code exercises individually: Flappy Bird, Star Wars
  ○ Worksheet: Flappy Bird and Star Wars Hour of Code with directions and place for students to post results.
● Use VexCode Blocks Desktop Program as a block programming platform in conjunction with the Vex Robots.
● Connect the robot to the computer, program each of their motors, create a basic program, save and download it to the robot (VexCode Getting Started Slides).
● Use VexCode Blocks to program robots as a team to use lines already marked on the classroom floor in three different levels and demonstrate it to the teacher:
  ○ Level 1 - Begin at the start line and drive forward to the first line and reverse back to start. Then proceed to the second line and reverse to start. Finally drive forward to the third line and back to start, autonomously.
  ○ Level 2 - Drive forward to the second line, stop, turn around, and return to start. Then drive forward to the third line, stop, turn around, and return to start.
  ■ *Extra Credit (for those who finish early)
  ○ Level 3 - Pick 2 of the 3 lines and push a cube to them and bring it back.The claw cannot fully grip the cube while recording the time it takes to complete.
● Package Dash Challenge: Students complete two challenges with their robots as a team both controlled and autonomously by learning what programming blocks work the best with one another. Students set up the playing field and then use their controllers to pick up a block with their robot claw and proceed to bring it to a loading area to drop it off. There are 3 boxes to unload in total. The second challenge is to do the same but programming the robot to work autonomously.
	● What Are Gears? What Do They Do? - Google Slides
	● Programming Assignment Videos
	● Flappy Bird
	● Star Wars
	● VEXCode Getting Started - Google Slides
	● Basketball Drills - Checklist
	● Package Dash - Checklist

Students will paste their code into the Package Dash Challenge Worksheet. ● Built robots and smart cable ● Self-assess using Professionalism Self-Assessment	

Grade(s)	9-12 - Unleveled
Unit Title and Purpose	**Unit 5: Electrical Circuits & Arduino Microcontroller Board**
Timeframe	4 weeks

Vision of the Graduate

Communicator: Students exchange ideas and information as they work with a partner to design, build and program electrical circuits to efficiently complete tasks.
Problem Solver: Students actively apply knowledge with empathy while working with a partner to solve problems with physical circuits and programming.
Collaborator: Students actively participate and share ideas with partners and classmates when building and programming electrical circuits.

Unit Priority Standards

STEL-1N. Explain how the world around them guides technological development and engineering design.
STEL-1Q. Conduct research to inform intentional inventions and innovations that address specific needs and wants.
STEL-1R. Develop a plan that incorporates knowledge from science, mathematics, and other disciplines to design or improve a technological product or system.
STEL-2T. Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making.
STEL-2U. Diagnose a flawed system embedded within a larger technological, social, or environmental system.
STEL-2V. Analyze the stability of a technological system and how it is influenced by all of the components in the system, especially those in the feedback loop.
STEL-2Z. Use management processes in planning, organizing, and controlling work.
STEL-3J. Connect technological progress to the advancement of other areas of knowledge.
STEL-5H. Evaluate a technological innovation that arose from a specific society's unique need or want.
STEL-7W. Determine the best approach by evaluating the purpose of the design.
STEL-7AA. Illustrate principles, elements and factors of design.
STEL-7BB. Implement the best possible solution to a design.
STEL-7CC. Apply a broad range of design skills to their design process.
STEL-7DD. Apply a broad range of making skills to their design process.
STEL-8P. Apply appropriate methods to diagnose, adjust and repair systems to ensure precise, safe and proper functionality.

Unit Supporting Standards

CCSS.ELA-LITERACY.RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
CCSS.ELA-LITERACY.RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
CCSS.ELA-LITERACY.RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
CCSS.ELA-LITERACY.RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Essential Questions

Where does electricity and how does it relate to energy?

How do robots use electricity?

What makes an electrical circuit?

What is the relationship between voltage, resistance and current?

What is the relationship between magnetism and electricity?

How can an Arduino be created and programmed to control output based on input received?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
1. Conduct research to inform intentional inventions and innovations that address specific needs and wants. 2. Develop a plan that incorporates knowledge from science, mathematics, and other disciplines to design or improve a technological product or system. 3. Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making. 4. Diagnose a flawed system embedded within a larger technological, social, or environmental system. 5. Analyze the stability of a technological system and how it is influenced by all of the components in the system, especially those in the feedback loop. 6. Determine the best approach by evaluating the purpose of the design. 7. Illustrate principles, elements and factors of design. 8. Implement the best possible solution to a design. 9. Apply a broad range of design skills to their design process. 10. Apply a broad range of making skills to their design process. 11. Apply appropriate methods to diagnose, adjust and repair systems to ensure precise, safe and proper functionality. 12. Combine hardware and software by creating interactive objects or environments. 13. Design and implement various smart system applications and upload code to an Arduino. 14. Build an electrical circuit using a breadboard. 15. Debug (troubleshoot) a circuit. 16. Use Arduino functions for digital input and output.	1. Understand that there is a close relationship between electricity and magnetism. 2. Explain how electricity and magnetism are used to control motors. 3. Explain how to create electrical circuits that are able to read inputs and turn them into outputs. 4. Explain how to send the board a set of programming instructions. 5. Explain how the world around them guides technological development and engineering design. 6. Understand the basics of an Arduino board and components. 7. Evaluate a technological innovation that arose from a specific society's unique need or want. 8. Connect technological progress to the advancement of other areas of knowledge.

17. Use Arduino functions for analog input and output. 18. Use management processes in planning, organizing, and controlling work.	
Student Learning Tasks & Resources	**Suggested Teacher Materials & Resources**
● Practice reading a technical manual using SparkFun Inventor's Guide for Arduino. ● Read resistors color coding and identify their resistor values and percentage of tolerance with the physical size of the resistor indicating its wattage rating (Resistor Values Worksheet). ● Build a circuit and program an Arduino to control it; read schematic drawings. ● Apply LEDs to a circuit board and use programming to create an output (Blink LEDs Worksheet). ○ Apply learning about the LEDs to a physical circuit and use the Arduino IDE to download a program to control the input/outputs ● Learn what a potentiometer is and how it acts as a voltage divider with varying resistance value; learn how the analogRead() command is used within the TinkerCAD application (TinkerCAD Potentiometer Worksheet). ○ Apply learning about the potentiometer to a physical circuit and use the Arduino IDE to download a program to control the input/outputs. ● Learn how a RGB LED can create a unique color combination depending on how bright each diode is, how to wire it with a common cathode and properly use resistors in TinkerCAD with programming (TinkerCAD RGB LED Worksheet). ● Learn how button switches function as an input and how to wire it in an electrical system (TinkerCAD - Pushbutton with LEDs Worksheet). ○ Apply learning about buttons to a physical circuit along with LEDS and use the Arduino IDE to download a program to control the input/outputs. ● Learn how to use a photoresistor and a voltage divider to output voltage depending on the input of light being read (TinkerCAD Photoresistor Worksheet).	● TinkerCAD classroom ● Video - Resistor Color Codes by electronicinstructor ● SparkFun Inventor's Guide for Arduino ● Arduino and Breadboard - Google slides ● Video - Everything You Need To Know About Arduino by Element14

○ Apply learning about photoresistors to a physical circuit along with LEDS and use the Arduino IDE to download a program to control the input/outputs. ● Learn how to wire and use a piezo buzzer to create sound and bridge the gap between the analog and digital worlds (TinkerCAD Piezo Buzzer Worksheet). ○ Apply learning about piezo buzzers to a physical circuit and use the Arduino IDE to download a program to control the output of tones. ● Learn how to wire and use a temperature sensor to measure ambient temperature along with the serial monitor window to read the output voltage (TinkerCAD Temperature Sensor Worksheet). ● Learn how to wire and use a servo motor and where they are found in real life electronics along with button switches (TinkerCAD Servo Motor with 2 Buttons Worksheet). ● Learn how to wire and use a DC Motor, how it differs from a servo motor, and where they are found in real life electronics (TinkerCAD DC Motor Worksheet). ○ Apply learning about DC motors to a physical circuit and use the Arduino IDE to download a program to control the output of the motor.	