Washington Office of Superintendent of
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CTE

Statewide Framework Document for:

150406 Robotics Foundations

Standards may be added to this document prior to submission but may not be removed from the framework to meet state credit equivalency requirements. Performance assessments and leadership alignment may be developed at the local level. In order to earn state approval, performance assessments must be submitted within this framework. **This course is eligible for 1 credit of third year lab science.** The Washington State Science Standards performance expectations for high school blend core ideas (Disciplinary Core Ideas, or DCIs) with scientific and engineering practices (SEPs) and crosscutting concepts (CCCs) to support students in developing usable knowledge that can be applied across the science disciplines. These courses are to be taught in a three-dimensional manner. The details about each performance expectation can be found at Next Generation Science Standards.

Enter Your School District Name		
Course Title: Robotics Foundations		**Total Framework Hours:** 180
CIP Code: 150406	☒ **Exploratory** ☐ **Preparatory**	**Date Last Modified:** December 30, 2020
Career Cluster: STEM		**Cluster Pathway:** Engineering and Technology
Course Summary: This course will introduce students to engineering concepts and technology design through a robotics system. Students learn and apply principles of Mechanical Engineering, Software Engineering, Electrical Engineering, Computer Science and Systems Design Engineering. Working in engineering teams, students use applied math and science along with their newfound technology and computer science skills to design, build and program a variety of robots to meet challenging specifications. No prior programming experience is required. After mastering the data logging capabilities of the robot platform, students will also learn to capture and analyze sensor data from a variety of probes/sensors to explore not only physical science, but also environmental science, chemistry, etc. Integrating this capability with their robotics skills, student will design interactive robots capable of autonomously gathering scientific data for subsequent analysis. Reminder: This CIP code is limited to 180 hours. After this course has been completed, a student would need to progress to the next course in the sequence.		
Eligible for Equivalent Credit in: 3rd year of lab science		**Total Number of Units:** 9

Unit 1: Safety, Community Engagement & STEM Career Awareness	**Total Learning Hours for Unit:** 10

Unit Summary: This unit will introduce STEM careers opportunities, safety protocols for lab and competition environments, and engage students in community outreach for STEM education.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

- *Demonstrate knowledge and skills of Robotics lab safety*
- *Develop and execute a plan for community engagement for STEM awareness/outreach, content experts and/or program support*
- *Present a plan to pursue a self-selected STEM career pathway*

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

EXAMPLE: *Students will develop a safety plan for the robotics classroom.*

1.B.1: Develop, implement and communicate new ideas to others effectively

3.B.2: Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal

Industry Standards and/or Competencies:

Example Competencies for this unit include:

- *Identify health and safety risks in a Robotics lab and at Robotics competitions*
- *Explain health and safety procedures which address risks in a Robotics lab and at Robotics competitions*
- *Identify and pursue local opportunities for STEM awareness/outreach, content experts and/or program support*
- *Describe the breadth of possible STEM careers*
- *Identify and explore a STEM career related to an area of student interest*
- *Explain the education pathway to a given STEM career*

Unit 2: Introduction to Robotics	**Total Learning Hours for Unit:** 10

Unit Summary: In this unit, students will be introduced to the field of robotics and the system used within the course. Students are expected to identify and understand the operations of the motor, sensors and other major components of the robotics system.

Performance Assessments:

Example assessments for this unit include:

1. *Research real and fictional robots and identify major components of the robotics system.*
2. *Demonstrate key attributes of robotic system used in the course.*
3. *Demonstrate and create a model of Faraday's Principle*
4. *Explain the sense and response systems of the robotics system*
5. *Document/describe key attributes of the robot system, including electrical, mechanical and structural components*

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

EXAMPLE: *Students will create a YouTube video that showcases the major components of the robotics system, including; operations of the motor, sensors and more.*
4.A.1: Access information efficiently (time) and effectively (sources)
5.A.3: Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of media

Industry Standards and/or Competencies:
Resource: International Technology and Engineering Educators Association:
https://www.iteea.org/File.aspx?id=67767&v=b26b7852

1. Students will develop an understanding of the characteristics and scope of technology.
   J. The nature and development of technological knowledge and processes are functions of the setting.
2. Students will develop an understanding of the core concepts of technology.
   X. Systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems.
3. Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
   J. Technological progress promotes the advancement of science and mathematics.
4. Students will develop an understanding of the cultural, social, economic, and political effects of technology.
   I. Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.
   J. Ethical considerations are important in the development, selection, and use of technologies.
5. Students will develop an understanding of the effects of technology on the environment
   I. With the aid of technology, various aspects of the environment can be monitored to provide information for decision making.
6. Students will develop an understanding of the role of society in the development and use of technology
   H. Different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values.

Aligned Washington State Academic Standards	
Science	HS-PS2-5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

	HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Ask questions and define problems	PS2A: Forces and Motion	Cause and Effect
Construct explanations and design solutions	PS3B: Conservation of Energy and Energy Transfer	Energy and Matter
Develop and Use Models	PS3C: Relationship Between Energy and Forces	Structure and Function
	ETS1A: Defining and Delimiting and Engineering Problem	Stability and change
	ETS1B: Developing Possible Solutions	

Unit 3: Circuits & Computers: Hardware, Software, Firmware	**Total Learning Hours for Unit:** 15

Unit Summary: This unit will delve into the technology underlying robots by exploring computers, circuits and hardware/software/firmware interaction through both direct instruction and creating models of these technologies. The robot system used in this course is then examined through this lens.

Performance Assessments:
Example assessments for this unit include:

- *Describe key concepts of computers, circuits, microprocessors and hardware/software/firmware interaction*
- *Create models of computers and microprocessors and analyze their performance*
- *Define Moore's Law and provide examples*
- *Explain sensor functionality and the data the sensors provide the robotics system*

Leadership Alignment: (Districts to complete for each unit)
Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

EXAMPLE: *Students will build and analyze robot circuits and create a storyboard that will be used to teach robot circuit to middle school students.*
6.A.1: Use technology as a tool to research, organize, evaluate and communicate information
7.A.2: Work effectively in a climate of ambiguity and changing priorities

Industry Standards and/or Competencies:
Resource: International Technology and Engineering Educators Association:
https://www.iteea.org/File.aspx?id=67767&v=b26b7852
3. Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
H. Technological innovation often results when ideas, knowledge, or skills are shared within a technology, among technologies, or across other fields.

8. Students will develop an understanding of the attributes of design.
H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.
12. Students will develop the abilities to use and maintain technological products and systems.
N. Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision.
O. Operate systems so that they function in the way they were designed.
13. Students will develop the abilities to assess the impact of products and systems.
J. Collect information and evaluate its quality.
16. Students will develop an understanding of and be able to select and use energy and power technologies.
J. Energy cannot be created nor destroyed; however, it can be converted from one form to another.
K. Energy can be grouped into major forms: thermal, radiant, electrical, mechanical, chemical, nuclear, and others.

Aligned Washington State Academic Standards	
Science	HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information. HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Use Mathematics and Computational Thinking	PS4A: Wave Properties	Structure and Function
Obtain, Evaluate, and Communicate Information	PS4C: Information Technologies and Instrumentation	Scale, proportion and quantity
Develop and Use Models	ETS1B: Developing Possible Solutions	Systems and system models
Plan and carry out investigations		Influence of Engineering, Technology, and Science on Society and the Natural World.
Use Mathematics and Computational Thinking		Stability and change

Unit 4: Get Moving	**Total Learning Hours for Unit:** 20

Unit Summary: This unit will introduce the NGSS Engineering Design process and develop the skills to design a robot which moves, responds to a wave-based sensor input, and optimizes performance for the task.

Performance Assessments:

Example assessments for this unit include:

- *Manipulate the movement of a robot through programming parameters*
- *Explain the physical science of sensor's operation*
- *Program a robot to respond to the sensor*
- *Calculate gears ratios and design a robot to trade off speed vs torque*
- *Use the NGSS Engineering Design to design/build/program a sensor activated robot which uses gears to trade off speed vs torque*
- *Compare and contrast motor performance to optimize components for the task*
- *Calculate program parameters based on the circumference of a circle*
- *Create a mathematical model to predict the motion of a robot*
- *Calculate, plot and interpolate speed vs power level data*
- *Calculate programming parameters for the sensor used*

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

EXAMPLE: *Students will design, build and program a sensor-based robot and create a challenge for other students to complete.*
8.C.1: Go beyond basic mastery of skills and/or curriculum to explore and expand one's own learning and opportunities to gain expertise
9.A.2: Conduct themselves in a respectable, professional manner

Industry Standards and/or Competencies:

Resource: International Technology and Engineering Educators Association:
https://www.iteea.org/File.aspx?id=67767&v=b26b7852

8. Students will develop an understanding of the attributes of design.

H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.

J. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.

K. Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.

9. Students will develop an understanding of engineering design.

I. Established design principles are used to evaluate existing designs, to collect data, and to guide the design process.

J. Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

L. The process of engineering design takes into account a number of factors.

11. Students will develop abilities to apply the design process.

N. Identify criteria and constraints and determine how these will affect the design process.

O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.

P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.

Q. Develop and produce a product or system using a design process.

R. Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.

12. Students will develop the abilities to use and maintain technological products and systems.

O. Operate systems so that they function in the way they were designed.

13. Students will develop the abilities to assess the impact of products and systems.

J. Collect information and evaluate its quality.

Aligned Washington State Academic Standards

Science	HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Use Mathematics and Computational Thinking	PS2A: Forces and Motion	Structure and Function
Obtain, Evaluate, and Communicate Information	PS3B: Conservation of Energy and Energy Transfer	Scale, proportion and quantity

Develop and Use Models	PS4A: Wave Properties	Systems and system models
Plan and carry out investigations	ETS1A: Defining and Delimiting and Engineering Problem	Energy and Matter
Construct explanations and design solutions	ETS1B: Developing Possible Solutions	Cause and Effect
	ETS1C: Optimizing the Design Solution	Interdependence of science, engineering and technology
		Stability and change

Unit 5: Precision Movement	**Total Learning Hours for Unit:** 20

Unit Summary: This unit will explore making precision maneuvers by comparing and contrasting dead reckoning (time and heading) odometry (rotations) and motion-based sensor. Students will use the NGSS Engineering Design to design and program a robot that requires precision movement and use of a mission-specific manipulator. This unit will provide an opportunity to introduce software planning strategies.

Performance Assessments:
Example assessments for this unit include:

- *Manipulate the movement of a robot through programming parameters*
- *Explain the physical science of the motion-based (example: gyro sensor's operation)*
- *Program a robot to respond to a gyro sensor*
- *Use software planning tools and incremental design to breakdown a large programming task into manageable sub-tasks, e.g. pseudocode, flow charts, etc.*
- *Use the Engineering Process to design/build/program a motion-based sensor-controlled robot with an articulated manipulator*

Leadership Alignment: (Districts to complete for each unit)
Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

EXAMPLE: *Students will listen to a guest speaker from local industry partner. They will develop a plan that incorporates industry standards to create a robot that functions only on motion-based sensors.*
10.A.1: Set and meet goals, even in the face of obstacles and competing pressures
11.A.3: Inspire others to reach their very best via example and selflessness

Industry Standards and/or Competencies:
Resource: International Technology and Engineering Educators Association:
https://www.iteea.org/File.aspx?id=67767&v=b26b7852
2. Students will develop an understanding of the core concepts of technology.
BB. Optimization is an ongoing process or methodology of designing or making a product and is dependent on criteria and constraints.

8. Students will develop an understanding of the attributes of design.

H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.

J. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.

K. Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.

9. Students will develop an understanding of engineering design.

I. Established design principles are used to evaluate existing designs, to collect data, and to guide the design process.

K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

L. The process of engineering design takes into account a number of factors.

11. Students will develop abilities to apply the design process.

N. Identify criteria and constraints and determine how these will affect the design process.

O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.

P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.

Q. Develop and produce a product or system using a design process.

Aligned Washington State Academic Standards	
Science	HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Analyzing and Interpreting Data	PS2.A: Forces and Motion	Cause and Effect

Using Mathematics and Computational Thinking	PS3.A: Definitions of Energy	Systems and System Models
Constructing Explanations and Designing Solutions	PS3.D: Energy in Chemical Processes	Energy and Matter
	ETS1.a: Defining and Delimiting an Engineering Problem	
	ETS1.C: Optimizing the Design Solution	
	ETS1.B: Developing Possible Solutions	

Unit 6: See, Touch, Repeat	**Total Learning Hours for Unit:** 20

Unit Summary: Use the NGSS Engineering Design process to create a robot with repetitious behavior utilizing multiple sensors.

Performance Assessments:

Example assessments for this unit include:

- Program a proximity-sensing robot to respond using multiple sensors (e.g. touch, ultrasonic, limit switch, etc.)
- Explain the physical science behind the proximity sensors
- Optimize repetitive or perpetual autonomous behavior
- Program a robot for repeating behavior controlled by timers, counters and sensors

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

EXAMPLE: *Students will research 3 different robot companies that utilize robots with repetitious behavior utilizing multiple sensors.*
3.A.1: Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts
5.B.1: Understand and utilize the most appropriate media creation tools, characteristics and conventions

Industry Standards and/or Competencies:

Resource: International Technology and Engineering Educators Association:
https://www.iteea.org/File.aspx?id=67767&v=b26b7852

2. Students will develop an understanding of the core concepts of technology.
   BB. Optimization is an ongoing process or methodology of designing or making a product and is dependent on criteria and constraints.
8. Students will develop an understanding of the attributes of design.
   H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.
   J. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.
   K. Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.

9. Students will develop an understanding of engineering design.

I. Established design principles are used to evaluate existing designs, to collect data, and to guide the design process.

K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

L. The process of engineering design takes into account a number of factors.

11. Students will develop abilities to apply the design process.

N. Identify criteria and constraints and determine how these will affect the design process.

O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.

P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.

Q. Develop and produce a product or system using a design process.

Aligned Washington State Academic Standards	
Science	HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Use Mathematics and Computational Thinking	PS2A: Forces and Motion	Structure and Function
Obtain, Evaluate, and Communicate Information	PS3C: Relationship Between Energy and Forces	Scale, proportion and quantity
Develop and Use Models	PS4A: Wave Properties	Systems and system models
Ask questions and define problems	ETS1A: Defining and Delimiting and Engineering Problem	Energy and Matter
Plan and carry out investigations	ETS1B: Developing Possible Solutions	Cause and Effect
Construct explanations and design solutions	ETS1C: Optimizing the Design Solution	Interdependence of science, engineering and technology
		Stability and change

Unit 7: Decisions, Decisions	**Total Learning Hours for Unit:** 20
Unit Summary: This unit will explore robots that make decisions based on sensory input using hierarchical code and multitasking, and then use the Engineering Process to design a robot for complex autonomous behavior (using switches, multitasking and hierarchy).	
Performance Assessments: *Example assessments for this unit include:* • *Manipulate the behavior of a robot through decision making based on sensory input* • *Program a robot to make real-time decisions using sensor and conditional statements (e.g. if-then-else, switched, etc.)* • *Use software planning tools and incremental design to breakdown a large programming task into manageable pre-designed sub-tasks* • *Program robots to perform simultaneous tasks through multitasking* • *Use the NGSS Engineering Design to design/build/program a robot for complex autonomous behavior* • *Complex coding structures such as hierarchical code, sub-routines, etc.*	
Leadership Alignment: (Districts to complete for each unit) *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.* *EXAMPLE: Students will compare robots with autonomous behavior to animals that have similar behavior patterns.* *8.C.1: Go beyond basic mastery of skills and/or curriculum to explore and expand one's own learning and opportunities to gain expertise* *2.A.1: Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation*	
Industry Standards and/or Competencies: **Resource:** International Technology and Engineering Educators Association: https://www.iteea.org/File.aspx?id=67767&v=b26b7852 4. Students will develop an understanding of the cultural, social, economic, and political effects of technology. I. The decision whether to develop a technology is influenced by societal opinions and demands, in addition to corporate cultures. 8. Students will develop an understanding of the attributes of design. H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results. J. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved. 9. Students will develop an understanding of engineering design. K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments. 11. Students will develop abilities to apply the design process. O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.	

Q. Develop and produce a product or system using a design process.

Aligned Washington State Academic Standards	
Science	HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concept**
Use Mathematics and Computational Thinking	PS2A: Forces and Motion	Structure and Function
Obtain, Evaluate, and Communicate Information	PS3C: Relationship Between Energy and Forces	Scale, proportion and quantity
Develop and Use Models	PS4A: Wave Properties	Systems and system models
Ask questions and define problems	ETS1A: Defining and Delimiting and Engineering Problem	In Energy and Matter
Plan and carry out investigations	ETS1B: Developing Possible Solutions	Cause and Effect
Construct explanations and design solutions	ETS1C: Optimizing the Design Solution	Interdependence of science, engineering and technology
		Stability and change

Unit 8: Wired for Data	**Total Learning Hours for Unit:** 20

Unit Summary: This unit will explore manipulating sensor data in real-time and using Boolean logic, variables, and/or math functions to control robot behavior and then use these skills to demonstrate Newtonian Physics.

Performance Assessments:

Example assessments for this unit include:

- *Model a collision to gather and analyze evidence to support traffic recommendations*
- *Use the Engineering Process to design/build/program a robot for more complex autonomous behavior and semi-autonomous interactive robots*
- *Program a robot to write and read variables*
- *Program with math functions using real-time sensor data*
- *Use PID control for precision movement with real-time feedback*

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

EXAMPLE: *Students will work in a group and solve problems to complete a challenge.*
1.B.4: View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small successes and frequent mistakes
2.B.1: Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems

Industry Standards and/or Competencies:
Resource: International Technology and Engineering Educators Association:
https://www.iteea.org/File.aspx?id=67767&v=b26b7852

2. Students will develop an understanding of the core concepts of technology.
Y. The stability of a technological system is influenced by all of the components in the system, especially those in the feedback loop.
AA. Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development.
8. Students will develop an understanding of the attributes of design.
H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.
J. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.
9. Students will develop an understanding of engineering design.
K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.
11. Students will develop abilities to apply the design process.
O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.
Q. Develop and produce a product or system using a design process.

Aligned Washington State Academic Standards	
Science	HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

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

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Use Mathematics and Computational Thinking	PS2A: Forces and Motion	Structure and Function
Obtain, Evaluate, and Communicate Information	PS3B: Conservation of Energy and Energy Transfer	Scale, proportion and quantity
Develop and Use Models	PS3C: Relationship Between Energy and Forces	Systems and system models
Plan and carry out investigations	PS4A: Wave Properties	Energy and Matter
Construct explanations and design solutions	ETS1A: Defining and Delimiting and Engineering Problem	Cause and Effect
Engage in Argument from Evidence	ETS1B: Developing Possible Solutions	Interdependence of science, engineering and technology
Analyze and Interpret Data	ETS1C: Optimizing the Design Solution	Influence of Engineering, Technology, and Science on Society and the Natural World
		Stability and change

Unit 9: Advanced Sensor Use	**Total Learning Hours for Unit:** 45
Unit Summary: In this unit, students will explore the use of robotics for advanced scientific modeling, data gathering and analysis using the sensors and/or analysis tools.	
Performance Assessments: *Example assessments for this unit include:* • *Design, build and program a robot using advanced sensors* • *Perform scientific data logging and analysis of sensor readings (tethered, remote and embedded/autonomous)* • *Design experiments and data-gathering robots to perform data logging/analysis of sensors for Physical, Life and/or Earth Sciences* • *Design, build and program a remote-control robot through Bluetooth communication* • *Design, build and program a robot that provides real-time data telemetry for remote analysis*	

- *Multiple robots communicating in real-time to perform a larger coordinated task*
- *Develop a model of a complex real world problem, that relies on real-time data manipulation*

Leadership Alignment: (Districts to complete for each unit)
Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

EXAMPLE: *Students will collect data and create a campaign to sell their robot to shark tank investors.*
3.A.2: Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions
4.A.2: Evaluate information critically and competently

Industry Standards and/or Competencies:
Resource: International Technology and Engineering Educators Association:
https://www.iteea.org/File.aspx?id=67767&v=b26b7852

2. Students will develop an understanding of the core concepts of technology.
   W. Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems.
5. Students will develop an understanding of the effects of technology on the environment.
   I. With the aid of technology, various aspects of the environment can be monitored to provide information for decision making.
8. Students will develop an understanding of the attributes of design.
   H. The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.
   J. The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.
9. Students will develop an understanding of engineering design.
   K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.
10. Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
   J. Technological problems must be researched before they can be solved.
11. Students will develop abilities to apply the design process.
   N. Identify criteria and constraints and determine how these will affect the design process.
   O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.
   P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.
   Q. Develop and produce a product or system using a design process.
   R. Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.

12. Students will develop the abilities to use and maintain technological products and systems.
P. Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.
13. Students will develop the abilities to assess the impact of products and systems.
J. Collect information and evaluate its quality.

Aligned Washington State Academic Standards	
Science	HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. 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. HS-XXX-X**. Note**: other PE's may be addressed depending upon which Physical/Life/Earth Science topics are explored by the available sensors/probes.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Use Mathematics and Computational Thinking	PS2A: Forces and Motion	Structure and Function
Obtain, Evaluate, and Communicate Information	ETS1A: Defining and Delimiting and Engineering Problem	Scale, proportion and quantity
Develop and Use Models	ETS1B: Developing Possible Solutions	Systems and system models
Ask questions and define problems	ETS1C: Optimizing the Design Solution	In Energy and Matter
Plan and carry out investigations	Note: other DCI's may be addressed depending upon which Physical/Life/Earth Science topics are explored by the available sensors/probes	Cause and Effect
Construct explanations and design solutions		Interdependence of science, engineering and technology
Engage in Argument from Evidence		Stability and change
Analyze and Interpret Data		