



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](http://nextgenscience.org/three-dimensions). The details about each performance expectation can be found at [Next Generation Science Standards](http://nextgenscience.org/next-generation-science-standards), and the supporting evidence statements can be found under [Resources](http://nextgenscience.org/ngss-high-school-evidence-statements).

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| Olympia School District Framework: Introduction to STEM+CS Robo-Science (HS) | | |
| **CIP Code:** 150406 | **Exploratory  Preparatory** | **Date Last Modified:** 4/3/20 |
| **Career Cluster:** STEM | | **Cluster Pathway:** Engineering and Technology |
| **State Course Code:** | | **V-code(s):** |
| **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 |
| **Course Resources:**   * **Robo101**: [STEM Robotics 101 EV3](http://stemrobotics.cs.pdx.edu/node/2643?root=2643) curriculum hosted at Portland State University * **Optional:** [STEM Robotics 102 Software (Java for Robots)](http://stemrobotics.cs.pdx.edu/node/4196) curriculum hosted at Portland State University (Optional Java curriculum)   **Source of Standards**  Washington State Education Standards -[**https://www.k12.wa.us/student-success/learning-standards-instructional-materials**](https://www.k12.wa.us/student-success/learning-standards-instructional-materials), including adaptations of:  > [Next Generation Science Standards (NGSS)](https://www.nextgenscience.org/)  > [Common Core Math Standards](http://www.corestandards.org/Math/)  > [Common Core English Language Arts Standards](http://www.corestandards.org/ELA-Literacy/)  > [International Society for Technology Education Standards (ISTE)](https://www.iste.org/standards/for-educators) (for Educational Technology)  > [Computer Science Teachers Association Standards](https://drive.google.com/file/d/1-dPTAI1yk2HYPKUWZ6DqaM6aVUDa9iby/view)  21st Century Skills: [https://www.k12.wa.us/student-success/career-technical-education/career-technical-education-pathways/21st-century-skills](%20https:/www.k12.wa.us/student-success/career-technical-education/career-technical-education-pathways/21st-century-skills)  **Industry standard resources:**   * STL Standards and Benchmarks <https://www.iteea.org/42545.aspx> * ITEA Standards for Technological Literacy: <https://www.iteea.org/File.aspx?id=67767>   **Curriculum Alignment (EV3 & EV3-G)**  Unit 0 utilizes resources from ***FIRST*** Class Safety and Community Engagement.  Units 1 through 9 are aligned unit-by-unit with the [STEM Robotics 101 EV3](https://stemrobotics.cs.pdx.edu/node/2643?root=2643) (Robo EV3) curriculum below.   |  |  |  | | --- | --- | --- | | **Unit Number & Name** | **Hours** | **Curriculum Resources** | | **UNIT 1: Safety, Community Engagement & Career Awareness** | 10 | FC Units 1 & 8 | | **UNIT 2: Introduction to Robotics** | 10 | Robo101 EV3 Unit 1 | | **UNIT 3: Circuits & Computers: Hardware, Software, Firmware** | 15 | Robo101 EV3 Units 2 & 3 | | **UNIT 4: Get Moving** | 20 | Robo101 EV3 Unit 4 | | **UNIT 5: Precision Movement** | 20 | Robo101 EV3 Unit 5 | | **UNIT 6: Touch, See, Repeat** | 20 | Robo101 EV3 Unit 6 | | **UNIT 7: Decisions, Decisions** | 20 | Robo101 EV3 Unit 7 | | **UNIT 8: Wired for Data** | 25 | Robo101 EV3 Units 8 & 9 | | **UNIT 9: Advanced Sensor Use** | 40 | Robo101 EV3 Unit 10 | |  | **180** |  | |  |  |  | | | |

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| **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**:   * 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**:   * Students will develop a safety plan for the robotics classroom and competition venues.   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**:   1. Identify health and safety risks in a Robotics lab and at Robotics competitions 2. Explain health and safety procedures which address risks in a Robotics lab and at Robotics competitions 3. Identify and pursue local opportunities for STEM awareness/outreach, content experts and/or program support 4. Describe the breadth of possible STEM careers 5. Identify and explore a STEM career related to an area of student interest 6. Explain the education pathway to a given STEM career | | |
| **Aligned Washington State Academic Standards** | | |
| **Computer Science** | 3A-IC-24 Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices. (P. 1.2) | |
| **English Language Arts** | 9-10SL2: Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.  9-12WHST2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. | |

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| **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 motors, sensors and other major components of the robotics system. | | | | |
| **Performance Assessments**:   * Research real and fictional robots and identify major components of the robotics system. * Demonstrate key attributes of the EV3 robotic system. * Demonstrate and create a model of Faraday’s Principle. * Document/describe key attributes of the robot system, including electrical, mechanical and structural components | | | | |
| **Leadership Alignment**:   * Create a video that showcases the major components of the robotics system, including operations of the motor, sensors and structural elements.   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** | | | | |
| **Educational Technology** | 1.d. Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.  4.a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.  4.c. Students develop, test and refine prototypes as part of a cyclical design process.  4.d. Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems*.* | | | |
| **English Language Arts** | 9-10SL1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.  9-10SL2: Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.  9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.  9-10RST7: 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.  9-12WHST2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. | | | |
| **Math** | N-Q2: Define appropriate quantities for the purpose of descriptive modeling. | | | |
| **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 |  | |

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| **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 EV3 system used in this course is then examined through this lens. | | | | |
| **Performance Assessments**:   * 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**:   * Build and analyze robot circuits and create a presentation explaining their functionality.   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** | | | | |
| **Computer Science** | 3A-CS-02 Compare levels of abstraction and interactions between application software, system software, and hardware layers. (P. 4.1)  3A-AP-18 Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs. (P. 5.2) | | | |
| **Educational Technology** | 1.d. Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.  3.a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits  4.d. Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.  6.b. Students create original works or responsibly repurpose or remix digital resources into new creations. | | | |
| **English Language Arts** | 9-10SL1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.  9-10SL2: Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.  9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.  9-10RST7: 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.  9-12WHST2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. | | | |
| **Math** | N-Q1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  N-Q3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  A-SSE1: Interpret expressions that represent a quantity in terms of its context. | | | |
| **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 | |

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| **Unit 4:** Get Moving | | | | **Total Learning Hours for Unit:** 20 |
| **Unit Summary**: This unit will introduce the [NGSS Engineering Design](https://www.nextgenscience.org/sites/default/files/Appendix%20I%20-%20Engineering%20Design%20in%20NGSS%20-%20FINAL_V2.pdf) 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**:   * 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](https://www.nextgenscience.org/sites/default/files/Appendix%20I%20-%20Engineering%20Design%20in%20NGSS%20-%20FINAL_V2.pdf) to design/build/program a sensor activated robot which uses gears to trade off speed vs torque * 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**:   * Design, build and program a sensor-based dragster-bot.   *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** | | | | |
| **Computer Science** | 3A-CS-03 Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors. (P. 6.2)  3A-AP-13 Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests. (P. 5.2)  3A-AP-16 Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions. (P. 5.2)  3A-AP-17 Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. (P. 3.2) | | | |
| **Educational Technology** | 1.d. Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.  3.a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits  3.c. Students curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.  4.a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.  4.b. Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.  4.c. Students develop, test and refine prototypes as part of a cyclical design process.  4.d. Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.  5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.  5.d. Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.  6.c. Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations. | | | |
| **English Language Arts** | 9-10SL1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.  9-10SL2: Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.  9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.  9-10RST7: 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.  9-12WHST2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. | | | |
| **Math** | N-Q2: Define appropriate quantities for the purpose of descriptive modeling.  N-Q3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  F-IF6: Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.  S-ID1: Represent data with plots on the real number line (dot plots, histograms, and box plots).  S-ID9: Distinguish between correlation and causation. | | | |
| **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 | |

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| **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](https://www.nextgenscience.org/sites/default/files/Appendix%20I%20-%20Engineering%20Design%20in%20NGSS%20-%20FINAL_V2.pdf) 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**:   * 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 (Robo-Tagger). | | | | |
| **Leadership Alignment**:   * Design, build and program a robot using a gyro sensor for precision turns and a manipulator to control a dry erase marker:   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** | | | | |
| **Computer Science** | 3A-CS-02 Compare levels of abstraction and interactions between application software, system software, and hardware layers. (P. 4.1)  3A-CS-03 Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors. (P. 6.2)  3A-AP-13 Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests. (P. 5.2)  3A-AP-16 Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions. (P. 5.2)  3A-AP-17 Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. (P. 3.2)  3A-AP-18 Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs. (P. 5.2)  3B-AP-21 Develop and use a series of test cases to verify that a program performs according to its design specifications. (P. 6.1) | | | |
| **Educational Technology** | 1.d. Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.  3.a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits  4.a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.  4.b. Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.  4.c. Students develop, test and refine prototypes as part of a cyclical design process.  4.d. Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.  5.c. Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.  5.d. Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.  6.b. Students create original works or responsibly repurpose or remix digital resources into new creations. | | | |
| **English Language Arts** | 9-10SL1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.  9-10SL2: Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.  9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.  9-10RST7: 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.  9-12WHST2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. | | | |
| **Math** | F-BF1: Write a function that describes a relationship between two quantities.  G-CO1: Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.  G-MG1: Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).  G-MG3: Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).  S-ID9: Distinguish between correlation and causation. | | | |
| **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](https://www.nextgenscience.org/sites/default/files/Appendix%20I%20-%20Engineering%20Design%20in%20NGSS%20-%20FINAL_V2.pdf) process to create a robot with repetitious behavior utilizing multiple sensors. | | | | |
| **Performance Assessments**:   * Program a proximity-sensing robot to respond using multiple sensors (e.g. touch & ultrasonic) * 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 (Robo-Zoo animatronic animal) | | | | |
| **Leadership Alignment**:   * Research different companies that utilize robots with repetitious behavior and multiple sensors and create an autonomous Robo-Zoo animal   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** | | | | |
| **Computer Science** | 3A-CS-02 Compare levels of abstraction and interactions between application software, system software, and hardware layers. (P. 4.1)  3A-CS-03 Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors. (P. 6.2)  3A-AP-13 Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests. (P. 5.2)  3B-AP-14 Construct solutions to problems using student-created components, such as procedures, modules and/or objects. (P. 5.2)  3A-AP-16 Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions. (P. 5.2)  3A-AP-17 Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. (P. 3.2)  3A-AP-18 Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs. (P. 5.2)  3B-AP-21 Develop and use a series of test cases to verify that a program performs according to its design specifications. (P. 6.1) | | | |
| **Educational Technology** | 3.a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits  4.a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.  4.b. Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.  4.c. Students develop, test and refine prototypes as part of a cyclical design process.  4.d. Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.  5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.  5.c. Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.  5.d. Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.  6.b. Students create original works or responsibly repurpose or remix digital resources into new creations.  6.c. Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations. | | | |
| **English Language Arts** | 9-10SL1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.  9-10SL2: Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.  9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.  9-10RST7: 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.  9-12WHST2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. | | | |
| **Math** | S-ID9: Distinguish between correlation and causation. | | | |
| **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**:   * 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. switches, switch-loops, 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](https://www.nextgenscience.org/sites/default/files/Appendix%20I%20-%20Engineering%20Design%20in%20NGSS%20-%20FINAL_V2.pdf) to design/build/program a robot for complex autonomous behavior (the Sumo-Bot) * Complex coding structures such as hierarchical code, sub-routines, My Blocks, etc. | | | | |
| **Leadership Alignment**:   * 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** | | | | |
| **Computer Science** | 3A-CS-02 Compare levels of abstraction and interactions between application software, system software, and hardware layers. (P. 4.1)  3A-CS-03 Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors. (P. 6.2)  3A-AP-13 Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests. (P. 5.2)  3B-AP-14 Construct solutions to problems using student-created components, such as procedures, modules and/or objects. (P. 5.2)  3A-AP-16 Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions. (P. 5.2)  3A-AP-17 Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. (P. 3.2)  3A-AP-18 Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs. (P. 5.2)  3B-AP-21 Develop and use a series of test cases to verify that a program performs according to its design specifications. (P. 6.1) | | | |
| **Educational Technology** | 3.a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits  4.a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.  4.b. Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.  4.c. Students develop, test and refine prototypes as part of a cyclical design process.  4.d. Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.  5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.  5.c. Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.  5.d. Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.  6.b. Students create original works or responsibly repurpose or remix digital resources into new creations.  6.c. Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations. | | | |
| **English Language Arts** | 9-10SL1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.  9-10SL2: Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.  9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.  9-10RST7: 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.  9-12WHST2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. | | | |
| **Math** | S-ID9: Distinguish between correlation and causation. | | | |
| **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 | |

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| **Unit 8:** Wired for Data | | | | **Total Learning Hours for Unit:** 25 |
| **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**:   * 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 | | | | |
| **Leadership Alignment**:   * Work in a group to design, build and program a robot which is controlled by the manipulation of real-time sensor data.   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** | | | | |
| **Computer Science** | 3A-CS-02 Compare levels of abstraction and interactions between application software, system software, and hardware layers. (P. 4.1)  3A-CS-03 Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors. (P. 6.2)  3A-AP-13 Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests. (P. 5.2)  3B-AP-14 Construct solutions to problems using student-created components, such as procedures, modules and/or objects. (P. 5.2)  3A-AP-16 Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions. (P. 5.2)  3A-AP-17 Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. (P. 3.2)  3A-AP-18 Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs. (P. 5.2)  3B-AP-21 Develop and use a series of test cases to verify that a program performs according to its design specifications. (P. 6.1) | | | |
| **Educational Technology** | 3.a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits  4.a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.  4.b. Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.  4.c. Students develop, test and refine prototypes as part of a cyclical design process.  4.d. Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.  5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.  5.c. Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.  5.d. Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.  6.b. Students create original works or responsibly repurpose or remix digital resources into new creations.  6.c. Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations. | | | |
| **English Language Arts** | 9-10SL1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.  9-10SL2: Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.  9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.  9-10SL5: Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.  9-10RI4: Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the cumulative impact of specific word choices on meaning and tone.  9-10RST4: 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.  9-10RST7: 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.  9-10RST10: By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.  9-12WHST2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.  9-12WHST4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. | | | |
| **Math** | N-Q1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  N-Q2: Define appropriate quantities for the purpose of descriptive modeling.  N-Q3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  S-ID9: Distinguish between correlation and causation.  F-BF1: Write a function that describes a relationship between two quantities.  S-ID9: Distinguish between correlation and causation.  S-IC2: Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. | | | |
| **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 | |

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| **Unit 9:** Advanced Sensor Use | | | | **Total Learning Hours for Unit:** 40 |
| **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**:   * 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**   * Design, build and program a robotics system to collect scientific data and analyze the results.   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** | | | | |
| **Computer Science** | 3A-CS-02 Compare levels of abstraction and interactions between application software, system software, and hardware layers. (P. 4.1)  3A-CS-03 Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors. (P. 6.2)  3A-DA-09 Translate between different bit representations of real-world phenomena, such as characters, numbers, and images. (P. 4.1)  3A-AP-13 Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests. (P. 5.2)  3B-AP-14 Construct solutions to problems using student-created components, such as procedures, modules and/or objects. (P. 5.2)  3A-AP-16 Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions. (P. 5.2)  3A-AP-17 Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. (P. 3.2)  3A-AP-18 Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs. (P. 5.2)  3B-AP-21 Develop and use a series of test cases to verify that a program performs according to its design specifications. (P. 6.1) | | | |
| **Educational Technology** | 1.d. Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.  3.a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits  3.c. Students curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.  4.a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.  4.b. Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.  4.c. Students develop, test and refine prototypes as part of a cyclical design process.  4.d. Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.  5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.  5.b. Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.  5.c. Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.  5.d. Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.  6.b. Students create original works or responsibly repurpose or remix digital resources into new creations.  6.c. Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations. | | | |
| **English Language Arts** | 9-10SL1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.  9-10SL2: Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.  9-10SL4: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.  9-10SL5: Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.  9-10RI4: Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the cumulative impact of specific word choices on meaning and tone.  9-10RST4: 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.  9-10RST7: 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.  9-10RST10: By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.  9-12WHST2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.  9-12WHST4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. | | | |
| **Math** | N-Q1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  N-Q2: Define appropriate quantities for the purpose of descriptive modeling.  N-Q3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  S-ID9: Distinguish between correlation and causation.  F-BF1: Write a function that describes a relationship between two quantities.  S-ID1: Represent data with plots on the real number line (dot plots, histograms, and box plots).  S-ID7: Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.  S-ID9: Distinguish between correlation and causation.  S-IC2: Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. | | | |
| **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 | |  |  | |