Unit 4 - Drive Train Design and Lifting Mechanisms (Physical Science, Engineering Design)

Content Area: **Science**
Course(s): **Robotics**
Time Period:
Length: **28 Days**
Status: **Published**

Title Section

Department of Curriculum and Instruction

Belleville Public Schools

Curriculum Guide

Robotics Grade 12

Unit 4 - Drive Train Design and Lifting Mechanisms

Belleville Board of Education

102 Passaic Avenue

Belleville, NJ 07109

Prepared by: Joy Elaine Alfano, Ph.D

Dr. Richard Tomko, Ph.D., M.J., Superintendent of Schools

Ms. LucyAnn Demikoff, Director of Curriculum and Instruction K-12

Ms. Nicole Shanklin, Director of Elementary Education K-8, ESL Coordinator K-12

Mr. George Droste, Director of Secondary Education

Board Approved: September 23, 2019

Unit Overview

In this unit students will learn about the physical principles of friction and traction through the exploration of robot drivetrain design. In addition student will learn about the different types of lifting mechanisms and how they work. Engineering topics will include degrees of freedom, shock load, joint loading, joint speed, elevators, linkages, and passive assistance.

Enduring Understanding

- Friction is the force that opposes motion when two surfaces rub together. It is a reaction force only. It occurs when two surfaces are in contact and a force is applied such they slide along one another.
- Static Friction is the frictional force between two objects that are NOT moving relative to each other.
- Kinetic Friction is the frictional force between two surfaces that ARE moving relative to each other (sliding along each other).
- A degree of freedom refers to a something's ability to move in a single independent direction of motion.

- Linkages are designed to convert some input motion into a different output motion.

Essential Questions

- How does the coefficient of friction effect the interaction between two surfaces?
- How does the ability to work with unit analysis aid one in drivetrain design?
- What are the advantages and disadvantages to friction and how can friction be overcome?
- How is the concept of degrees of freedom related to the human body?
- What are the first three degrees of freedom?
- Where are linkages used in everyday life?

Exit Skills

1. Explain how the degrees of freedom will allow you to design a robot that is able to transfer motion as it manipulates objects.
2. Explain how a linkage system allows a robot to complete its objective.
3. Explain how passive assistance can provide a robot with a mechanical advantage

New Jersey Student Learning Standards (NJSLS-S)

NextGen Science Standards

HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs 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.

Interdisciplinary Connections

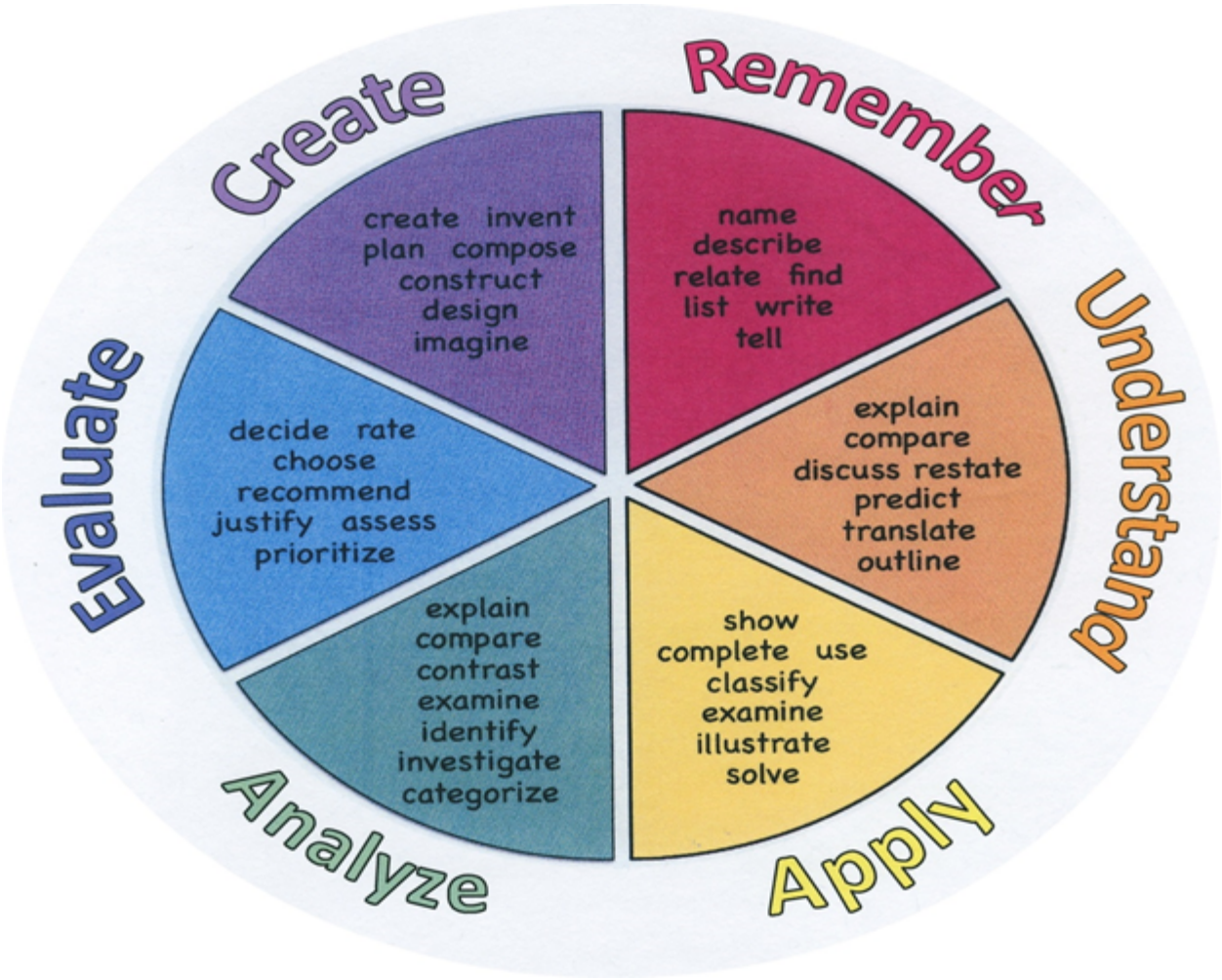
LA.RH.11-12.1	Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.), to support analysis of primary and secondary sources, connecting insights gained from specific details to develop an understanding of the text as a whole.
LA.RH.11-12.2	Determine the theme, central ideas, information and/or perspective(s) presented in a primary or secondary source; provide an accurate summary of how key events, ideas and/or author's perspective(s) develop over the course of the text.
LA.RH.11-12.3	Evaluate various perspectives for actions or events; determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain.
LA.RH.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, qualitatively, as well as in words) in order to address a question or solve a problem.
LA.RH.11-12.8	Evaluate an author's claims, reasoning, and evidence by corroborating or challenging them with other sources.
LA.RH.11-12.9	Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.
LA.RH.11-12.10	By the end of grade 12, read and comprehend history/social studies texts in the grades 11-CCR text complexity band independently and proficiently.
LA.RST.11-12.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.RST.11-12.2	Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Learning Objectives

1. Demonstrate how applied force and friction are related.
2. Distinguish between static and kinetic friction.
3. Calculate wheel speed.
4. Demonstrate how to calculate gear reduction.
5. Compare and contrast the different types of drivetrains, along with their benefits and drawbacks
6. Differentiate the three degrees of freedom.
7. Demonstrate the correct use of the calculations needed to choose a gear reduction.
8. Distinguish between the use of a linkage system and a multi-state elevator in manipulator design.
9. Explain how passive assistance can improve robot design.

Action Verbs: Below are examples of action verbs associated with each level of the Revised Bloom's Taxonomy.

Remember	Understand	Apply	Analyze	Evaluate	Create
Choose	Classify	Choose	Categorize	Appraise	Combine
Describe	Defend	Dramatize	Classify	Judge	Compose
Define	Demonstrate	Explain	Compare	Criticize	Construct
Label	Distinguish	Generalize	Differentiate	Defend	Design
List	Explain	Judge	Distinguish	Compare	Develop
Locate	Express	Organize	Identify	Assess	Formulate
Match	Extend	Paint	Infer	Conclude	Hypothesize
Memorize	Give Examples	Prepare	Point out	Contrast	Invent
Name	Illustrate	Produce	Select	Critique	Make
Omit	Indicate	Select	Subdivide	Determine	Originate
Recite	Interrelate	Show	Survey	Grade	Organize
Select	Interpret	Sketch	Arrange	Justify	Plan
State	Infer	Solve	Breakdown	Measure	Produce
Count	Match	Use	Combine	Rank	Role Play
Draw	Paraphrase	Add	Detect	Rate	Drive
Outline	Represent	Calculate	Diagram	Support	Devise
Point	Restate	Change	Discriminate	Test	Generate
Quote	Rewrite	Classify	Illustrate		Integrate
Recall	Select	Complete	Outline		Prescribe
Recognize	Show	Compute	Point out		Propose
Repeat	Summarize	Discover	Separate		Reconstruct
Reproduce	Tell	Divide			Revise
	Translate	Examine			Rewrite
	Associate	Graph			Transform
	Compute	Interpolate			
	Convert	Manipulate			
	Discuss	Modify			
	Estimate	Operate			
	Extrapolate	Subtract			
	Generalize				
	Predict				



Suggested Activities & Best Practices

Assessment Evidence - Checking for Understanding (CFU)

Google Classroom Assignment (Formative)

QUIA Quiz (Summative)

Pear Deck (Alternate)

Common, Department Quarterly Benchmarks (Benchmark)

Oncourse Assessment Tools (Formative)

Unit Test/Quiz (Summative)

"Do Now/Exit Ticket" Activity (Formative)

- Admit Tickets
- Anticipation Guide
- Common Benchmarks
- Compare & Contrast
- Create a Multimedia Poster
- DBQ's
- Define
- Describe
- Evaluate
- Evaluation rubrics
- Exit Tickets
- Explaining
- Fist- to-Five or Thumb-Ometer
- Illustration
- Journals
- KWL Chart
- Learning Center Activities
- Multimedia Reports
- Newspaper Headline
- Outline
- Question Stems
- Quickwrite
- Quizzes
- Red Light, Green Light
- Self- assessments
- Socratic Seminar

- Study Guide
- Surveys
- Teacher Observation Checklist
- Think, Pair, Share
- Think, Write, Pair, Share
- Top 10 List
- Unit review/Test prep
- Unit tests
- Web-Based Assessments
- Written Reports

Primary Resources & Materials

http://curriculum.vexrobotics.com/

http://curriculum.vexrobotics.com/teacher-materials.html

Ancillary Resources

Upon completion of this section, please remove all remaining descriptions, notes, outlines, examples and/or illustrations that are not not needed or used.

Please list all additional resources that will be used to strengthen this unit's lessons.

Technology Infusion

Suggested Activities and Best Practices:

1. Google Classroom Assignment
2. QUIA Quiz
3. Pear Deck

4. VEXNET SOFTWARE

What **Technology Infusion** and/or strategies are integrated into this unit to enhance learning? Please list all hardware, software and strategies. Please find a technology pedagogy wheel for assistance while completing this section.



Alignment to 21st Century Skills & Technology

Upon completion of this section, please remove all remaining descriptions, notes, outlines, examples and/or illustrations that are not needed or used.

Mastery and infusion of **21st Century Skills & Technology** and their Alignment to the core content areas is essential to student learning. The core content areas include:

- English Language Arts;
- Mathematics;
- Science and Scientific Inquiry (Next Generation);
- Social Studies, including American History, World History, Geography, Government and Civics, and Economics;
- World languages;
- Technology;
- Visual and Performing Arts.

21st Century Skills/Interdisciplinary Themes

Upon completion of this section, please remove all remaining descriptions, notes, outlines, examples and/or illustrations that are not needed or used.

Please list only the **21st Century/Interdisciplinary Themes** that will be incorporated into this unit.

- Communication and Collaboration
- Creativity and Innovation
- Critical thinking and Problem Solving
- ICT (Information, Communications and Technology) Literacy
- Information Literacy

- Life and Career Skills
- Media Literacy

21st Century Skills

Upon completion of this section, please remove all remaining descriptions, notes, outlines, examples and/or illustrations that are not needed or used.

Please list only the **21st Century Skills** that will be incorporated into this unit.

- Civic Literacy
- Environmental Literacy
- Financial, Economic, Business and Entrepreneurial Literacy
- Global Awareness
- Health Literacy

Differentiation

Content:

- Providing audio/visual supports for taking in text or other information
- Posing situations, problems, or dilemmas that vary by complexity, skill mastery, or background knowledge required
- Modeling or demonstrating
- Working with content/skills that are pre-requisite to targeted content/skills
- Varying the time allotted to take in/learn content

Process:

- Giving tiered questions/organizers (same idea, different phrasing or emphasis, more/less support)
- Increasing/decreasing the facets of a task Increasing/decreasing the degree of scaffolding for a task
- Working more/less like an expert, practitioner, or professional
- Providing models of work at different levels of complexity
- Asking students to see content through a certain focus or lens

Product:

- Varying the audience for the product (from closer to student experience/more familiar to further from student experience/less familiar)
- Varying the demands or sophistication of the product
- Having varied arrangements for working on a product
- Giving more or fewer check-in dates and chunks in progress of completing task
- Providing more or fewer givens or knowns (models/examples, resources, guidelines)

Differentiations:

- Small group instruction
- Small group assignments
- Extra time to complete assignments
- Pairing oral instruction with visuals
- Repeat directions
- Use manipulatives
- Center-based instruction
- Token economy
- Study guides
- Teacher reads assessments allowed
- Scheduled breaks
- Rephrase written directions
- Multisensory approaches
- Additional time
- Preview vocabulary
- Preview content & concepts
- Story guides
- Behavior management plan
- Highlight text
- Student(s) work with assigned partner
- Visual presentation
- Assistive technology
- Auditory presentations
- Large print edition
- Dictation to scribe
- Small group setting

Hi-Prep Differentiations:

- Alternative formative and summative assessments
- Choice boards

- Games and tournaments
- Group investigations
- Guided Reading
- Independent research and projects
- Interest groups
- Learning contracts
- Leveled rubrics
- Literature circles
- Multiple intelligence options
- Multiple texts
- Personal agendas
- Project-based learning
- Problem-based learning
- Stations/centers
- Think-Tac-Toes
- Tiered activities/assignments
- Tiered products
- Varying organizers for instructions

Lo-Prep Differentiations

- Choice of books or activities
- Cubing activities
- Exploration by interest
- Flexible grouping
- Goal setting with students
- Jigsaw
- Mini workshops to re-teach or extend skills
- Open-ended activities
- Think-Pair-Share
- Reading buddies
- Varied journal prompts
- Varied supplemental materials

Special Education Learning (IEP's & 504's)

Content:

- Providing audio/visual supports for taking in text or other information
- Posing situations, problems, or dilemmas that vary by complexity, skill mastery, or background knowledge required
- Modeling or demonstrating

- Working with content/skills that are pre-requisite to targeted content/skills
- Varying the time allotted to take in/learn content

Process:

- Giving tiered questions/organizers (same idea, different phrasing or emphasis, more/less support)
- Increasing/decreasing the facets of a task Increasing/decreasing the degree of scaffolding for a task
- Working more/less like an expert, practitioner, or professional
- Providing models of work at different levels of complexity
- Asking students to see content through a certain focus or lens

Product:

- Varying the audience for the product (from closer to student experience/more familiar to further from student experience/less familiar)
- Varying the demands or sophistication of the product
- Having varied arrangements for working on a product
- Giving more or fewer check-in dates and chunks in progress of completing task
- Providing more or fewer givens or knowns (models/examples, resources, guidelines)

- printed copy of board work/notes provided
- additional time for skill mastery
- assistive technology
- behavior management plan
- Center-Based Instruction
- check work frequently for understanding
- computer or electronic device utilizes
- extended time on tests/ quizzes
- have student repeat directions to check for understanding
- highlighted text visual presentation
- modified assignment format
- modified test content
- modified test format

- modified test length
- multi-sensory presentation
- multiple test sessions
- preferential seating
- preview of content, concepts, and vocabulary
- Provide modifications as dictated in the student's IEP/504 plan
- reduced/shortened reading assignments
- Reduced/shortened written assignments
- secure attention before giving instruction/directions
- shortened assignments
- student working with an assigned partner
- teacher initiated weekly assignment sheet
- Use open book, study guides, test prototypes

English Language Learning (ELL)

Please identify the **English Language Learning** adaptations that will be employed in the unit, using the ones identified below.

- teaching key aspects of a topic. Eliminate nonessential information
- using videos, illustrations, pictures, and drawings to explain or clarif
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning;
- allowing students to correct errors (looking for understanding)
- allowing the use of note cards or open-book during testing
- decreasing the amount of workpresented or required
- having peers take notes or providing a copy of the teacher's notes
- modifying tests to reflect selected objectives
- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test
- tutoring by peers
- using computer word processing spell check and grammar check features
- using true/false, matching, or fill in the blank tests in lieu of essay tests

At Risk

Content:

- Providing audio/visual supports for taking in text or other information
- Posing situations, problems, or dilemmas that vary by complexity, skill mastery, or background knowledge required
- Modeling or demonstrating
- Working with content/skills that are pre-requisite to targeted content/skills
- Varying the time allotted to take in/learn content

Process:

- Giving tiered questions/organizers (same idea, different phrasing or emphasis, more/less support)
- Increasing/decreasing the facets of a task Increasing/decreasing the degree of scaffolding for a task
- Working more/less like an expert, practitioner, or professional
- Providing models of work at different levels of complexity
- Asking students to see content through a certain focus or lens

Product:

- Varying the audience for the product (from closer to student experience/more familiar to further from student experience/less familiar)
- Varying the demands or sophistication of the product
- Having varied arrangements for working on a product
- Giving more or fewer check-in dates and chunks in progress of completing task
- Providing more or fewer givens or knowns (models/examples, resources, guidelines)

- allowing students to correct errors (looking for understanding)
- teaching key aspects of a topic. Eliminate nonessential information
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning
- allowing students to select from given choices
- allowing the use of note cards or open-book during testing
- collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test.
- decreasing the amount of workpresented or required

- having peers take notes or providing a copy of the teacher's notes
- marking students' correct and acceptable work, not the mistakes
- modifying tests to reflect selected objectives
- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test
- tutoring by peers
- using authentic assessments with real-life problem-solving
- using true/false, matching, or fill in the blank tests in lieu of essay tests
- using videos, illustrations, pictures, and drawings to explain or clarify

Talented and Gifted Learning (T&G)

Content:

- Providing audio/visual supports for taking in text or other information
- Posing situations, problems, or dilemmas that vary by complexity, skill mastery, or background knowledge required
- Modeling or demonstrating
- Working with content/skills that are pre-requisite to targeted content/skills
- Varying the time allotted to take in/learn content

Process:

- Giving tiered questions/organizers (same idea, different phrasing or emphasis, more/less support)
- Increasing/decreasing the facets of a task Increasing/decreasing the degree of scaffolding for a task
- Working more/less like an expert, practitioner, or professional
- Providing models of work at different levels of complexity
- Asking students to see content through a certain focus or lens

Product:

- Varying the audience for the product (from closer to student experience/more familiar to further from student experience/less familiar)

- Varying the demands or sophistication of the product
- Having varied arrangements for working on a product
- Giving more or fewer check-in dates and chunks in progress of completing task
- Providing more or fewer givens or knowns (models/examples, resources, guidelines)

- Above grade level placement option for qualified students
- Advanced problem-solving
- Allow students to work at a faster pace
- Cluster grouping
- Complete activities aligned with above grade level text using Benchmark results
- Create a blog or social media page about their unit
- Create a plan to solve an issue presented in the class or in a text
- Debate issues with research to support arguments
- Flexible skill grouping within a class or across grade level for rigor
- Higher order, critical & creative thinking skills, and discovery
- Multi-disciplinary unit and/or project
- Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities
- Utilize exploratory connections to higher-grade concepts
- Utilize project-based learning for greater depth of knowledge

Sample Lesson