2023 U06 iSTEM 2 - Intro to Robotics and Mechanical Engineering

Content Area: **CTE**
Course(s): **iSTEM**
Time Period: **November**
Length: **14 - 16 weeks**
Status: **Published**

Unit Overview:

The robotics unit will start with an introduction to coding and allow students to practice the use of different types of coding. Partnered students will then be assigned a robot, which will emphasize the the collaborative nature of computing and program writing. Partners will be given a basic robot template to build together, and then will advance to the physical application of robotics by programming the robot to at execute simple commands. Students will then add different input features and progress to more advanced problem solving tasks. After learning how to operate the robots effectively, students will begin acquainting themselves with applications of gear systems and gear ratios. The class will progress from calculating gear ratios and differentiating between power and torque to building gear trains, compound gears, and changing the angle of rotation assignments. Partners will then begin experimenting with the concept of worm gears, swinging mechanisms, and reciprocating mechanisms which will give the class a deeper understanding of how to integrate different types of motion into their EV3 Robots. The unit culminates with 2 Design Challenges, the first design challenge will take their understandings of gears and motion and apply them to the MudBot Project where students will be able to design, build, and improve their robots in order to climb an increasing sloped hill with only the parts with a EV3 Robot. The 2nd design challenge will be fabricating and operating a simple machine connected to the Ev3 Robot. Students will present both of these projects in a professional manner to the class, and communicate their data and steps of the design process via their engineering notebook.

Essential Questions:

- Why are robots used?
- How has public perception of robots changed over time?
- What are the limitations of using robots?
- In what ways can/will robots replace human abilities/capabilities?
- What are the safety considerations related to working with robots?
- How does the type of input impact the type of sensor to be used in the design of a robot?
- What are the limits of a robots capability with regard to the sensory data they collect?
- How does the purpose of a robot determine the type of locomotion necessary?
- How does the purpose of a robot determine the type of manipulators necessary?
- How does the purpose of a robot determine the type of sensors necessary?
- What processes should be incorporated to maximize the reliability of a robot?
- How are torque, speed, and power of a motor related?
- How do gear ratios affect speed and torque
- Why must the purpose of the robot be factored into the design of the locomotion system
- How do the size, alignment, and number of wheels or tracks affect the performance of a robot?
- What strategies can be used to minimize programming problems and errors when working with robots?
- What types of time management skills/ resources does an engineer/ designer use to manage a project?
- What types of personnel management skills/ resources does an engineer/ designer use to manage a

project?
- What types of planning skills/ resources does an engineer/ designer use to manage a project?
- What are the functions of gears
- What is the difference between a compound gear and a gear train?
- Apply gear ratio toward gear teeth, rpm, and pitch diameter.
- Generate methods of increasing and decreasing rpm though the compounding of gears.
- Identify: angle gear, bevel gear, center to center distance, chain & sprocket, circular pitch, clearance, gear ratio, idler gear, miter gear, outside diameter, pinion gear, pitch diameter, rack gear, ring gear, spur gear, worm gear.
- Develop a design hypothesis & predict the result of a mechanical system.
- Prepare drawings of gears and concept illustrations.
- Explain the use of linkages, pivots, and supports at they relate to gear driven systems.

Enduring Understandings:

- Analyze a given technological product, system, or environment to understand how the engineering design process and design specification limitations influenced the final solution.
- Evaluate the function, value, and appearance of technological products, systems, and environments from the perspective of the user and the producer.
- Develop methods for creating possible solutions, modeling and testing solutions, and modifying proposed design in the solution of a technological problem using hands-on activities
- Diagnose a malfunctioning product and system using appropriate critical thinking methods
- Create a technological product, system, or environment using given design specifications and constraints by applying design and engineering principles.
- The positive and negative effects technology can impart on a community, region, and society as a whole.
- Why mechanical, structural, power, and transportation systems are designed to work the way they do.
- The effects of maufacturing/production transportation technology on ecosystems, people, and our planet.
- Identify central tenents of design problems through research prior to the pursuit of solutions.
- Appreciate how the design process impacts both invention and innovation.
- Conduct on-going self-assessments and research in the face of evolving educational and workplace environments.

Lesson Titles:

- Presentation of Information: EV3 Robotics Movement, Mechanical Advantage, Basic EV3 Robot Pictures

- Robotics

- Mini - Project: Race Track

- Mini - Project: Tile Maze

- Mini - Project: Reflective Light

- Simple Robot Movements

- Calculating Robot Movements

- Creating Algorithms

- Mechanical Advantage Terminology

- Simple Machine Problems

- Design Challenge #7: Mud Bot Project

- Design Challenge #8: EV3 Robot Simple Machine Project

- Project Presentations

Instructional Strategies, Learning Activities, and Levels of Blooms/DOK:

- Direct Instruction: Daily Overviews (Promethean Board, Chromebooks, White Board)
- Direct Instruction: Presentations - Presentations of Information (google slides)
- Instruction: Step by Step Videos / Example: Operating an EV3 Robot, Building of an EV3 Robot
- Independent Work: Simple Machine and Mechanical Advantage Simulations and Problems
- Indirect Instruction: Reflective Discussion, Evaluation of Data and Technical Writing - ENB Write Ups, Self Evaluations, Presentation of Projects
- Experiential: Project - Mud Bot Project
- Experiential: Project - EV3 Robot Simple Machine Project
- Experiential:- Mini - Project: Tile Maze
- Experiential: Mini - Project: Reflective Light
- Experiential: Mini - Project: Race Track
- Cooperative: Partner classwork, short projects, projects and ENB entries

Summative Assessment:

- Mini - Project: Race Track
- Mini - Project: Reflective Light
- Mini - Project: Tile Maze
- Project: EV3 Robot Simple Machine Packet and Presentation
- Project: Mud Bot Packet and Presentation
- Quiz: Ev3 Robot - Race Track ENB Write UP
- Quiz: Ev3 Robot - Reflective Light ENB Write-Up

- Quiz: EV3 Robot - Tile Maze ENB Write UP

Formative Assessment:

- Anticipatory Set - Overview of items for the day, future activities of the unit, and/or review of previous information from the unit
- Classroom / Student Observation - check in on student work during in-class activities / projects
- Closure of Projects - students provide results of their projects, self-evaluate projects for possible improvements that could be made, and evaluate instruction that could be improved
- Closure of Units - students complete a design project that pertains to the unit at hand as well as prior units
- Conferences between the instructor and student at various points in the semester.
- ENB (engineering notebooks) - reviewed periodically during the school year
- In-class activities where students informally present their results.
- Presentation Sample Slides - Students participate in classroom discussion on topic that is being introduced and reviewed
- Q & A session - Student led question and answer session at the start of class for project information as needed
- Question and answer sessions, formal, planned and informal, spontaneous.
- Warm-Up - review information from current topic or previous topics, preview time for current activity, and/or opportunity for clarity on the previous day's work

Benchmark Assessments

Skills-based assessment

Reading response

Writing prompt

Lab practical

Alternative Assessments

Performance tasks

Project-based assignments

Problem-based assignments

Presentations

Reflective pieces

Concept maps

Case-based scenarios

Portfolios

Standards/Indicators/Student Learning Objectives (SLOs):

9-12.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.
9-12.HS-ETS1-4.4.1	Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows— within and between systems at different scales.
9-12.HS-ETS1-4.5	Using Mathematics and Computational Thinking
9-12.HS-ETS1-3.6	Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.
9-12.HS-ETS1-3.6.1	Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
9-12.HS-ETS1-4.ETS1.B	Developing Possible Solutions
9-12.HS-ETS1-2.ETS1.C	Optimizing the Design Solution

Career Readiness, Life Literacies, & Key Skills:

WRK.K-12.P.1	Act as a responsible and contributing community members and employee.
WRK.K-12.P.3	Consider the environmental, social and economic impacts of decisions.
WRK.K-12.P.4	Demonstrate creativity and innovation.
WRK.K-12.P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
WRK.K-12.P.7	Plan education and career paths aligned to personal goals.
WRK.K-12.P.8	Use technology to enhance productivity increase collaboration and communicate effectively.
WRK.K-12.P.9	Work productively in teams while using cultural/global competence.

Inter-Disciplinary Connections:

MA.G-C.A	Understand and apply theorems about circles
MA.G-C.A.1	Prove that all circles are similar.
MA.G-C.A.4	Construct a tangent line from a point outside a given circle to the circle.
MA.G-C.B	Find arc lengths and areas of sectors of circles
LA.SL.11-12.4	Present information, findings and supporting evidence clearly, concisely, and logically. The

	content, organization, development, and style are appropriate to task, purpose, and audience.
LA.SL.11-12.5	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.
LA.SL.11-12.6	Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.
SCI.HS-PS2	Motion and Stability: Forces and Interactions
SCI.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.
SCI.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.

Technology Materials and Standards

- SmartBoard Presentations
- Chromebooks, Google Drive, Google Applications
- MS Office Software as needed
- Smartphones
- Construction Hand Tools and Safety Equipment
- Lego Mindstorms EV3 Software

TECH.8.1.12.A.2	Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review.
TECH.8.1.12.A.CS1	Understand and use technology systems.
TECH.8.1.12.A.CS2	Select and use applications effectively and productively.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.1.12.B.CS1	Apply existing knowledge to generate new ideas, products, or processes.
TECH.8.1.12.B.CS2	Create original works as a means of personal or group expression.
TECH.8.1.12.D.CS2	Demonstrate personal responsibility for lifelong learning.

Computer Science and Design Thinking Standards

CS.K-12.2.a	Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities.
CS.K-12.2.b	Create team norms, expectations, and equitable workloads to increase efficiency and effectiveness.
CS.K-12.2.c	Solicit and incorporate feedback from, and provide constructive feedback to, team members and other stakeholders.
CS.K-12.3.a	Identify complex, interdisciplinary, real-world problems that can be solved computationally.
CS.K-12.3.c	Evaluate whether it is appropriate and feasible to solve a problem computationally.
CS.K-12.4.a	Extract common features from a set of interrelated processes or complex phenomena.

CS.K-12.4.c	Create modules and develop points of interaction that can apply to multiple situations and reduce complexity.
CS.K-12.6.a	Systematically test computational artifacts by considering all scenarios and using test cases.
CS.K-12.6.b	Identify and fix errors using a systematic process.
CS.K-12.6.c	Evaluate and refine a computational artifact, multiple times, to enhance its performance, reliability, usability, and accessibility.
CS.K-12.7.b	Describe, justify, and document computational and/or design processes and solutions using appropriate terminology consistent with the intended audience and purpose.

Equity Considerations

LGBTQ and Disabilities Mandate

Topic: What topics can have an impact on individuals in LGBTQ

Materials Used: https://prideinstem.org/lgbtstemday/

Topic: What topics can have an impact on individuals with Disabilities

Materials Used: https://alexandertutoring.com/supporting-stem-education-students-disabilities/

Addresses the Following Component of the Mandate:

- Economic
- Political
- Social

Modifications

G&T Modifications:

- Alternate assignments/enrichment assignments
- Enrichment projects
- Extension activities
- Higher-level cooperative learning activities
- Pairing direct instruction with coaching to promote self-directed learning
- Provide higher-order questioning and discussion opportunities
- Provide texts at a higher reading level
- Tiered assignments
- Tiered centers

ELL Modifications:

- Choice of test format (multiple-choice, essay, true-false)
- Continue practicing vocabulary
- Provide study guides prior to tests
- Read directions to the student
- Read test passages aloud (for comprehension assessment)
- Vary test formats

At Risk Modifications

The possible list of modifications/accommodations identified for Special Education students can be utilized for At-Risk students. Teachers should utilize ongoing methods to provide instruction, assess student needs, and utilize modifications specific to the needs of individual students. In addition, the following may be considered:

- Additional time for assignments
- Adjusted assignment timelines
- Agenda book and checklists
- Answers to be dictated
- Assistance in maintaining uncluttered space
- Books on tape
- Concrete examples
- Extra visual and verbal cues and prompts
- Follow a routine/schedule
- Graphic organizers
- Have students restate information
- No penalty for spelling errors or sloppy handwriting
- Peer or scribe note-taking
- Personalized examples

- Preferential seating
- Provision of notes or outlines
- Reduction of distractions
- Review of directions
- Review sessions
- Space for movement or breaks
- Support auditory presentations with visuals
- Teach time management skills
- Use of a study carrel
- Use of mnemonics
- Varied reinforcement procedures
- Work in progress check

IEP & 504 Modifications:

*All teachers of students with special needs must review each student's IEP. Teachers must then select the appropriate modifications and/or accommodations necessary to enable the student to appropriately progress in the general curriculum.

Possible Modifications/Accommodations: (See listed items below):

- Allow for redos/retakes
- Assign fewer problems at one time (e.g., assign only odds or evens)
- Differentiated center-based small group instruction
- Extra time on assessments
- Highlight key directions
- If a manipulative is used during instruction, allow its use on a test
- Opportunities for cooperative partner work
- Provide reteach pages if necessary
- Provide several ways to solve a problem if possible
- Provide visual aids and anchor charts
- Test in alternative site
- Tiered lessons and assignments
- Use of a graphic organizer
- Use of concrete materials and objects (manipulatives)
- Use of word processor

Resources & Materials:

- Project Lead the Way, Introduction to Engineering Design Information
- Walker, Exploring Drafting, II: Goodhart-Wilcox, 1996
- Gradwell & Wekch. Technology, Engineering Our World, IL: Goodhart-Wilcox, 2012

- Lego Mindstorms EV3 Software