Course Name:	Robotics		
Credits:	1		
Prerequisites:	Engineering		
Description:	Students will walk through the design and build of a mobile robot. During this process, they will learn key STEM principles and robotics concepts. At the culmination of this class, they will compete head-to-head against their peers in the classroom, applying skills of technological design and analysis to robotic structures with varied task-oriented goals presented.		
Academic Standards:	**WI COMMON CAREER TECHNICAL STANDARDS (WCCTS)** Content Area: 4C/Creativity, Critical Thinking, Communication and Collaboration: 4C1 Content Area: CD/Career Development: CD1 **WI STANDARDS FOR TECHNOLOGY AND ENGINEERING (TE)** Content Area: BB/Broad-based: BB1 Content Area: EL/Electronics: EL6 Content Area: ENG/Engineering: ENG1, ENG3, ENG4, ENG5		
Units:	**Unit Length:**	**Unit Standards:**	**Unit Outcomes:**
Intro to Engineering	10 days	ENG1.a ENG3.b ENG4.b CD1	Students will learn about what engineering is and what engineers do. The concepts of classical mechanics, design and iteration will be defined and worked through.
Intro to Robotics	11 days	ENG3.a ENG5.a	Students will learn about how the field of robotics operates and how robots work. Students will learn about the role of robots in society and how they are used in all aspects of STEM education.
Intro to VEXnet	9 days	ENG5.b EL6	Students will learn what the core components of the VEX control system are - the Cortex Microcontroller, VEXnet Joystick and VEXnet Wireless link. They will also learn how they each function.
3D Modeling with Autodesk Inventor	20 days	ENG4.b	Students will get an introduction to Autodesk Inventor. They will get an overview of the different ways engineers use Autodesk Inventor and then learn specific ways they can use Inventor to help design and build VEX robots.

THE GAME!	14 days	ENG4.b CD1.b CD1.c	Students will learn the rules of the game, which will be necessary to design robots. The students will be able to analyze potential game strategies. Students will learn the effects of applying a cost benefit analysis to the design process.
Object Manipulation	8 days	ENG4.b BB1.c	Students will learn about the different types and categories of robot manipulators. Students will be presented with robot manipulators from the real world and shown the basic principles behind their operation. Students will then create their own object manipulator for use on their competition robot.
Speed, Power, Torque, & DC Motors	10 days	ENG5.b BB1.c	Students will learn about the physical principles of speed, power, and torque. Students will learn about DC motors and how these principles apply to them. Students will apply these concepts on a sample mechanical system to calculate key details of the design.
Mechanical Power Transmission	10 days	ENG4.b ENG5.b BB1.c BB1.f	Students will learn about the different types of mechanical power transmission. Topics include various gear types, and how to calculate gear ratios. These principles will then be applied to the types of motor - arm systems seen on competition robots.
Drivetrain Design	8 days	BB1.c BB1.f	Students will learn about the physical principles of friction and traction through the exploration of robot drivetrain design.
Lifting Mechanisms	11 days	ENG4.b ENG5.b BB1.c BB1.f	Students 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.
Systems Integration	7 days	BB1.a ENG4.b	Students will learn about the techniques that are used in engineering that allow for the successful integration of systems into a cohesive finished product. Students will learn how integration is an integral part of the initial design process.
Testing, Iteration, and Continuous Improvement	12 days	CD1d ENG4.b ENG4.c	Students will learn how important testing, iteration and continuous improvement are in the design process. The students will learn how to develop their final design.

Unit Name: **Intro to Engineering**	**Length:** 10 days
Standards: CD1.d.4.m: Apply decision-making strategies to personal and team interactions. ENG1.a.10.h: Identify key elements of the design process: define a problem, identify criteria, generate solutions, create a prototype, test and evaluate, refine, and communicate the results. ENG3.a.7.h: Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace. ENG4.b.5.h: Develop and produce a product or system using a design process.	**Outcomes:** This unit will teach students the answer to the question “What IS engineering?” Students will learn what engineers do, what different types of engineers there are, and what tools they use. This unit will get students started on their engineering notebook which they will use throughout the semester to document their progress.
Essential Questions: 1. What does an engineer do? 2. What is something that you have used today that was designed by an engineer? 3. Why is classical mechanics such an important part of engineering? 4. How does having constraints placed on a design change the engineering process? 5. Why is making a prototype so important in the design process? 6. What have you learned from the iterative process?	**Learning Targets:** 1. Students will be able to demonstrate how classical mechanics is used in the engineering process. 2. Students will be able to correctly produce entries into their engineering notebook. 3. Students will be able to produce a prototype of their design.
Topic 1: **What is Engineering?**	**Length:** 1 day
Standard(s): **ENG3.a.7.h: Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace.**	**Academic Vocabulary:** Engineering, Methodical, Classical Mechanics, Structural Design, Manufacturing, Design, Innovation
Lesson Frame: What is our world is engineered?	We will: brainstorm a definition for engineering, based on what we know.
	I will: identify what around me has been engineered.
Lesson Frame: Disciplines of Engineering	We will: list types of engineers.
	I will: explore the role of various types of engineers.
Performance Tasks: Students compare lists of engineered engineered products in small groups	Notes: Lesson: https://manawatech.com/courses/mod/page/view.php?id=122
Topic 2: **Engineering Design Teams**	**Length:** 1 day

Standard(s): CD1.d.4.m: Apply decision-making strategies to personal and team interactions.	**Academic Vocabulary:** N/A
Lesson Frame: The Design Team	We will: explore the different engineering tasks necessary to complete a project.
	I will: brainstorm a list of engineers identified in lesson one that would be involved in designing a car.
Lesson Frame: Roles	We will: identify characteristics of helpful work partners.
	I will: list characteristics necessary to be a productive member of a design team.
Performance Tasks: Answer "seed question": What does an engineer do?	Notes: Lesson: https://manawatech.com/courses/mod/page/view.php?id=484
Topic 3: **What is the Engineering Design Process?**	**Length:** 6 days
Standard(s): ENG1.a.10.h: Identify key elements of the design process: define a problem, identify criteria, generate solutions, create a prototype, test and evaluate, refine, and communicate the results.	**Academic Vocabulary:** Methodical, Classical Mechanics, Quantitative, Specifications, Ideate, Prototype, CAD Models, Assembly Drawings, Manufacturing Plans, Bill of Materials
Lesson Frame: Steps 1-3 of the Design Process: Understand, Explore, Define	We will: perform the task of identifying a problem to solve as an engineer.
	I will: identify faulty thinking in bids proposed to solve elevator problem (reading).
Lesson Frame: Steps 4-5 of the Design Process: Ideate, Prototype	We will: apply "specification ranking" to ideation and prototyping.
	I will: apply "Wish," "Preferred," or "Demand" to given project specifications.
Lesson Frame: Steps 6-8 of the Design Process: Choose, Refine, Present	We will: apply the use of "weighted objectives tables" to the decision making process
	I will: create a WOT table to apply weights for drivetrain, gripper, and lift comparison.
Lesson Frame: Steps 9-11 of the Design Process: Implement, Test, Iterate	We will: identify steps involved in the implementation and testing of a solution.
	I will: share group solutions determined best fit for the given scenario, and redefine from feedback.
Performance Tasks: Create a prototype, an iteration of the design, and document progress of a specified design challenge.	Notes: Lesson: https://manawatech.com/courses/mod/page/view.php?id=485
Topic 4: **Design Documentation**	**Length:** 1 day

Standard(s): ENG1.a.10.h: Identify key elements of the design process: define a problem, identify criteria, generate solutions, create a prototype, test and evaluate, refine, and communicate the results.	**Academic Vocabulary:** Maintenance Guide, User Manuals, Design Presentations, Proposals, Design Review
Lesson Frame: Engineering Notebooks	We will: identify, use, and organization of an engineer's notebook.
	I will: set up my engineering notebook to include an organized method of notetaking and design documentation.
Lesson Frame: Engineering Tools	We will: list common tools of all engineers.
	I will: record in my engineering notebook a list of tools necessary to complete the design process as an engineer.
Performance Tasks: Prepare Engineering Notebook for documentation/record-keeping.	Notes: Lesson: https://manawatech.com/courses/mod/page/view.php?id=486

Topic 5: **Design Challenge**	**Length:** 1 day
Standard(s): ENG4.b.5.h: Develop and produce a product or system using a design process.	**Academic Vocabulary:** Design Presentations, Proposals, Design Review
Lesson Frame: Engineer Freestanding Tower	We will: recognize that all steps in the design process are not always applicable or appropriate
	I will: create a freestanding tower in 30 minutes, applying appropriate steps in the process.
Performance Tasks: Using nothing but ten letter size sheets of paper, construct a freestanding tower as tall as possible, in 30 minutes.	Notes: Lesson: https://manawatech.com/courses/mod/page/view.php?id=487

Unit Name: Intro to Robotics	**Length:** 11 days
Standards: ENG3.a.7.h: Research and development is a specific problem solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace. ENG5.a.5.m: Demonstrate and use tools, materials, and machines safely to create, diagnose, adjust, and repair systems.	**Outcomes:** In this unit students will learn about robotics in our world, and how ALL the different aspects of STEM are all used in the field of robotics. This unit will also provide an introduction to VEX EDR; students will get an overview of the different subsystems within the VEX system and how they interact together. Students will then put this knowledge into practice as they follow step-by-step directions to build their first robot.
Essential Questions: 1. How do robots benefit society? 2. Explain how the different subsystems work together. 3. How does the installation of sensors improve the functioning of the robot?	**Learning Targets:** 1. Students will be able to discuss how robots are used today in industry, research and in education. 2. Students will be able to explain what the different basic components of a robot are and how they perform their function. 3. Students will be able to assemble the VEX Clawbot using the directions provided.

Topic 1: **What is Robotics?**	**Length:** 2 days
Standard(s): ENG3.a.7.h: Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace	**Academic Vocabulary:** Robot, Robotics, Subsystem, Manipulators, Control System, Sensors
Lesson Frame: History of Robotics	We will: define Robotics and identify the basic components of a robot.
	I will: list and define components of a robot.
Lesson Frame: Robots and Society	We will: view a visual representation of robots in use in various environments.
	I will: list the types of tasks robots perform in different environments
Performance Tasks: Students will identify how robots are used today in industry, research and in education.	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=168

Topic 2: **VEX Robotics Design System**	**Length:** 2 days
Standard(s): ENG3.a.7.h: Research and development is a specific problem solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace.	**Academic Vocabulary:** The six subsystems: structure, motion, power, sensors, logic, control
Lesson Frame: Structure Subsystems	We will: identify the components within the six subsystems of the robot.
	I will: match pictures of robotic component to the subsystem in which it belongs.
Performance Tasks: Students will explain what the different basic components of a robot are and how they perform their function.	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=170

Topic 3: **Building the VEX Clawbot**	**Length:** 7 days
Standard(s): ENG5.a.5.m: Demonstrate and use tools, materials, and machines safely to create, diagnose, adjust, and repair systems. BB1.c.4.h: Build, test and troubleshoot simple linear, rotary, and compound mechanisms.	**Academic Vocabulary:** Autonomous, Drivetrain, Actuators, Servo, Ultrasonic Range Finder, Gyroscope, Light Sensor, Optical Encoders
Lesson Frame: Mechanical Build of Structure	We will: build the VEX Clawbot using the Clawbot Build Guide
	I will: demonstrate my ability to follow step-by-step instructions while building the Clawbot
Performance Tasks: Students will assemble the VEX Clawbot following the instructions, "Clawbot Build Guide".	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=171 Assembly Instructions: http://content.vexrobotics.com/docs/276-2600-Claw-Assembly.pdf (Stop at step #27)

Unit Name: **Introduction to VEXnet**	**Length:** 9 days
Standards: ENG5.b.8.h: Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate. EL6.a.5.h: Program a microcontroller to maneuver a robot. EL6.a.3.h: Program and test an autonomous robot.	**Outcomes:** In this unit students will learn about the core components of the VEX control system - the VEX ARM® Cortex®-based Microcontroller, VEXnet Joystick and VEXnet Wireless link. Students will then get the opportunity to use their previously built robots to compete in a head-to-head challenge against their classmates.
Essential Questions: 1. Explain how the microprocessor functions. 2. Explain how the VEXnet works. 3. Explain how you were able to use the joysticks in conjunction with the VEXnet system to pick up and score the bottles or cans in your classroom challenge. 4. Explain how you can improve you score in the classroom challenge using the control system of the robot.	**Learning Targets:** 1. Students will be able to explain what the specific components that make up the VEXnet System can do and how they are used to control the robot. 2. Students will be able to set up their microcontroller to function in both autonomous and drive controlled modes. 3. Students will be able to correctly produce entries into their engineering notebook. 4. Students will be able to use the VEXnet system to successfully control their robot in a classroom challenge.

Topic 1: **VEX ARM Cortex-based Microcontroller**	**Length:** 2 days
Standard(s): ENG5.b.8.h: Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate. EL6.a.5.h: Program a microcontroller to maneuver a robot	**Academic Vocabulary:** RobotC, Bi-directional communication, Debugging, Interface, Downloading
Lesson Frame: The Microcontroller	We will: identify the ports of the microcontroller as input/output and analog or digital
	I will: label the parts of the microcontroller as input/output and analog/digital
Lesson Frame: Default Code	We will: prepare the microcontroller with the default code
	I will: download the default program from the computer to the microcontroller
Performance Tasks: Students will explain what the specific components of the VEXnet System can do and how they are used to control the robot.	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=178

Topic 2: **VEXnet Joystick**	**Length:** 2 days

Standard(s): ENG5.b.8.h: Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.	**Academic Vocabulary:** Jumpers	
Lesson Frame: The VEX Joystick	We will: identify the ports and controls on the VEX joystick	
	I will: label a graphic of the joystick controls with appropriate assignments	
Lesson Frame: Assigning Controls	We will: understand the mapping procedure of the joystick controls	
	I will: map the controls of the joystick to the appropriate output motors	
Performance Tasks: Following step-by-step instructions, students will set up their microcontroller and joystick to function in a wired drive-controlled environment.	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=179	

Topic 3: **VEXnet Wireless Link**	**Length:** 1 day
Standard(s): ENG5.b.8.h: Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.	**Academic Vocabulary:** VEXnet Keys
Lesson Frame: Pairing the Joystick and Microcontroller	We will: learn the procedure for pairing the joystick to the microcontroller
	I will: pair the joystick to the microcontroller using RobotC and the USB A-to_A cable
Lesson Frame: Wireless Keys	We will: learn the method for pairing the joystick and microcontroller for wireless control
	I will: pair the joystick to the microcontroller wirelessly using the VEXnet keys
Performance Tasks: Following step-by-step instructions, students will pair a wireless connection between the joystick and microcontroller using VEXnet keys and RobotC.	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=183

Topic 4: **Wiring and Configuring a VEX Robot**	**Length:** 2 days
Standard(s): EL6.a.3.h: Program and test an autonomous robot.	**Academic Vocabulary:** Motor Port
Lesson Frame: Physical Configuration	We will: follow guided instructions for wiring a robots motors
	I will: wire the Clawbot as diagrammed in the handout.

Lesson Frame: Port Configuration in RobotC Software	We will: match the port configuration to the correct interface in RobotC
	I will: set up the port configuration in RobotC and download the new code to the microcontroller
Performance Tasks: Students will set up their microcontroller, joystick, and Clawbot to function remotely with joystick controls.	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=181 (Wiring instructions begin at step #27 of the Clawbot packet received in Unit 2.)

Topic 5: **The Can Cleanup Challenge**	**Length:** 2 days
Standard(s): EL6.a.3.h: Program and test an autonomous robot.	**Academic Vocabulary:** N/A
Lesson Frame: Practice with Controls	We will: practice using the joystick to control the robot
	I will: control the Clawbot using wireless joystick controls
Lesson Frame: Challenge (Game)	We will: exercise our new skills controlling the robot in a competitive environment.
	I will: practice my skills by competing in the Can Cleanup Challenge
Performance Tasks: Students will use the VEXnet system to successfully control their robot in a classroom challenge Identified in the "Can Cleanup Challenge" game rules.	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=184

Unit Name: **3D Modeling With Autodesk Inventor**	**Length:** 20 days
Standards: ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.	**Outcomes:** In this unit students will get an introduction to Autodesk® Inventor®. They will get an overview of the different ways engineers use Autodesk® Inventor®, then learn specific ways they can use Inventor to help design and build VEX robots.
Essential Questions: 1. Which items in the classroom require 3D modeling software in order to be designed and manufactured? 2. Which types of engineers use CAD and how do they use it for their day to day job? 3. Why do designers create virtual models? 4. What is the benefit to designers of being able to animate an assembly? 5. What would a designer use a rendered image of a design for?	**Learning Targets:** 1. Students will be able to create 3D models using Autodesk Inventor 2. Students will be able to animate 3D models 3. Students will be able to render 3D models

Topic 1: **Basic Inventor Command Overview**	**Length:** 3 days
Standard(s): ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.	**Academic Vocabulary:** Computer Aided Design (CAD), Rendering, Browser Menu, Degrees of Freedom, Bottom Up Modeling, Top Down Modeling
Lesson Frame: Autodesk® Inventor®. Primary Environment	We will: become reacquainted with the 3D modeling software Autodesk Inventor's program interface I will understand the overall project tasks involved in assembling and animating the virtual Clawbot.
Lesson Frame: 3D Model the Claw Arm	We will: become reacquainted with the tools for creating 3D models in Autodesk Inventor. I will: create the Clawbot's claw arm in Autodesk® Inventor®.
Performance Tasks: Students will create 3D models and constrain components into a full assembly with appropriate movement of parts, using Autodesk® Inventor®.	Notes: Lesson (with video links): https://manawatech.com/courses/course/view.php?id=3&section=6

Topic 2: **Building the Virtual Clawbot**	**Length:** 15 days
Standard(s): ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.	**Academic Vocabulary:** Assemblies, Constraints, Views
Lesson Frame: Overview and Tutorial -Review of the Clawbot Model	We will: gain an understanding of the methods used for assembling the virtual Clawbot. I will: view "Intro" and "Video 1 to gain an understanding of the procedure for project assembly.
Lesson Frame: Video 2: Project Set up/Preparation	We will: understand the process for preparing your project library. I will: create my project library and prepare the folders with the downloaded part files.
Lesson Frame: Video 3: Start a New Assembly Video 4: Add Standard Parts to Assembly	We will: demonstrate the steps involved in assembling the Clawbot base. I will: place and assemble the base of the Clawbot parts in Autodesk Inventor.
Lesson Frame: Video 5: Assemble Bearing Flats and Rivets	We will: gain skill in assembling parts with the use of iMates.

	I will: assemble the bearing flats and rivets to the Clawbot base using Imate constraints.
Lesson Frame: Video 6: Assemble the Driveshaft and Collar	We will: demonstrate ongoing skill in virtual 3D model assembly.
	I will: assemble the driveshaft and collar of the Clawbot to its base.
Lesson Frame: Video 7: Assemble the Wheel; Video 8: Create a Wheel Subassembly	We will: demonstrate ongoing skill in virtual 3D model assembly.
	I will: prepare the claw arm joint as a separate subassembly.
Lesson Frame: Video 9: Align the Gears	We will: demonstrate ongoing skill in virtual 3D model assembly.
	I will: use work planes to align the teeth of the gears in the virtual assembly.
Lesson Frame: Video 10: Assemble the Claw Arm Drivetrain	We will: demonstrate ongoing skill in virtual 3D model assembly.
	I will: build the claw arm drivetrain using gears, shafts, and shaft collars.
Lesson Frame: Video 11: Assemble the Cortex Microcontroller	We will: demonstrate ongoing skill in virtual 3D model assembly.
	I will: assemble the microcontroller and battery straps to the base.
Lesson Frame: Video 12: Assemble the Claw Arm	We will: demonstrate ongoing skill in virtual 3D model assembly.
	I will: add the claw arm to the to the Clawbot assembly.
Lesson Frame: Video 13: Complete the Robot Assembly	We will: demonstrate ongoing skill in virtual 3D model assembly.
	I will: assemble the microcontroller and battery straps to the base.
Performance Tasks: Students will create 3D models and constrain components into a full assembly with appropriate movement of parts, using Autodesk® Inventor®.	Notes: Lesson (with video links): https://manawatech.com/courses/course/view.php?id=3&section=6

Topic 3: **Rendering and Animation**	**Length:** 2 days
Standard(s): ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.	**Academic Vocabulary:** Render, Animate
Lesson Frame: Video 14: Render and Animate the Robot	We will: learn to create an animation of the model assembly to prepare for a presentation.
	I will: create a rendered animation of my Clawbot assembly.
Performance Tasks: Students will animate and render the 3D Clawbot assembly using Autodesk® Inventor®.	Notes: Lesson (with video links): https://manawatech.com/courses/course/view.php?id=3&section=6

Unit Name: **The Game!**	**Length:** 14 days
Standards: 4C1.a.7.h: Develop original ways to solve a problem. ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. ENG4.b.5.h: Develop and produce a product or system using a design process.	**Outcomes:** In this unit students will be presented with a game (typically the VRC game of the current competition season). They will split into teams and spend the rest of the semester designing a robot which can play this game head-to-head against the robots built by their classmates. This robot build will follow the engineering design process discussed in Unit 1. The first step in this process is analyzing the design challenge placed in front of them and deciding what they want their robot to do.
Essential Questions: 1. How can you maximize the number of points you can score during the game? 2. How can you keep your opponent from scoring efficiently during the game? 3. How do you choose what features of the robot are needed to play the game?	**Learning Targets:** 1. Students will be able to explain how the process of strategic design works. 2. Students will be able to demonstrate the use of defining objectives to select game objectives. 3. Students will be able to list all of the ways to score the most points in the game. 4. Students will be able to create a cost – benefit analysis to demonstrate the strengths of different tasks.

Topic 1: **Strategic Design**	**Length:** 1 day
Standard(s): ENG4.b.5.h: Develop and produce a product or system using a design process.	**Academic Vocabulary:** Strategic Design
Lesson Frame: Understand, Define, Explore	We will: understand the task by identifying the rules, constraints, and goals.
	I will: create a chart of information helpful and necessary in creating a successful design
Performance Tasks: Students will list all of the ways to score the most points in the "Swept Away" game.	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=418

Topic 2: **Defining Objectives**	**Length:** 2 days
Standard(s): 4C1.a.7.h: Develop original ways to solve a problem.	**Academic Vocabulary:** cost-benefit analysis, prioritization of tasks
Lesson Frame: Cost-Benefit Analysis	We will: understand the process of creating a cost-benefit analysis to engineering desigr
	I will: create a cost-benefit analysis chart as it applies to "The Game!"
Lesson Frame: Prioritization of Tasks	We will: learn to prioritize strategically when problem solving a solution.
	I will: create a chart of our group's evolution through the prioritization process.

Performance Tasks: Students will apply the methodical process to determining best strategies and design to win the game.	Notes: Lesson: https://manawatech.com/courses/mod/page/view.php?id=475

Topic 3: **Analyzing the Game**	**Length:** 3 days
Standard(s): ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.	**Academic Vocabulary:** None
Lesson Frame: Prototype	We will: create the first prototype of our design idea.
	I will: create a model of our team's robot design.
Lesson Frame: Create/Test/Refine	We will: test our design ideas for efficiency.
	I will: test our finished prototype, searching critically for possible improvements based on movement and basic design.
Performance Tasks: Create a 3D model of your team's robot design.	Notes: Lesson: https://manawatech.com/courses/mod/page/view.php?id=476

Topic 4: **Performance**	**Length:** 8 days
Standard(s): ENG4.b.5.h: Develop and produce a product or system using a design process.	**Academic Vocabulary:** None
Lesson Frame: Build	We will: construct our robot models for competition
	I will: work with my team toward completion of our physical model.
Lesson Frame: Competition	We will: compete in the Swept Away competition
	I will: assist my team in successful performance during the competition.
Lesson Frame: Reflection	We will: reflect on our performance.
	I will: create a list of design alternations that would improve performance.
Performance Tasks: Robot team build Swept Away - game performance and reflection	Notes: Lesson: https://manawatech.com/courses/mod/page/view.php?id=478

Unit Name: **Object Manipulation**	**Length:** 8 days
Standards: BB1.c.5.h: Given a linear, rotary, and/or compound motion mechanism, students will measure and calculate units such as work, power, torque, gear ratios, and mechanical advantage. ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. ENG4.b.5.h: Develop and produce a product or system using a design process.	**Outcomes:** In this unit, students will learn about the different types and categories of robot manipulators. Students will be presented with robot manipulators from the real world, and shown the basic principles behind their operation. Students will then create their own object manipulator for use on their competition robot.
Essential Questions: 1. Why would you choose one type of a manipulator over another type? 2. How can your data from your test improve your redesign?	**Learning Targets:** 1. Students will be able to demonstrate the basic concepts of manipulators, and accumulators. 2. Students will be able to design examples of manipulators, and accumulators.

Topic 1: **Manipulators**	**Length:** 2 days
Standard(s): BB1.c.5.h: Given a linear, rotary, and/or compound motion mechanism, students will measure and calculate units such as work, power, torque, gear ratios, and mechanical advantage.	**Academic Vocabulary:** Manipulators, Elasticity, Plow, Accumulators, Scoops, Conveyor, Traction, Magazine, Friction, Indexing, Claw, Hopper, Conveyance
Lesson Frame: Plows, Scoops, and Friction Grabbers	We will: Identify different types of manipulators and their advantages I will: identify a manipulator by its name and state a reason for its prefered use.
Lesson Frame: Roller Manipulator	We will: develop an understanding of the advantages of a roller manipulator in competition I will: list advantages of the roller manipulator in competition
Performance Tasks: Match the manipulator name to its graphic and state its preferred use.	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1029

Topic 2: **Accumulators**	**Length:** 2 days
Standard(s): BB1.c.5.h: Given a linear, rotary, and/or compound motion mechanism, students will measure and calculate units such as work, power, torque, gear ratios, and mechanical advantage.	**Academic Vocabulary:** magazine, conveyor, conveyance
Lesson Frame: Magazines, Conveyor Belts, and Hoppers	We will: Identify the different styles of accumulators along with reasons for preferred use. I will: recognize a type of accumulator by its components within the design
Lesson Frame: Accumulator Design	We will: recognize the trade-offs in choosing one style of accumulator over another I will: identify the advantages and disadvantages of each style of accumulator

Performance Tasks: Teams brainstorm sketches of manipulator or accumulator designs.	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1030

Topic 4: **Create Object Manipulator**	**Length:** 4 days
Standard(s): ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. ENG4.b.5.h: Develop and produce a product or system using a design process.	**Academic Vocabulary:** N/A
Lesson Frame: Virtual Model	We will: create a prototype of our design in Autodesk® Inventor®.
	I will: 3D model our team's chosen design.
Lesson Frame: Design Activity: Physical Model	We will: create the physical model of the object manipulator
	I will: produce a physical copy of our chosen object manipulator
Performance Tasks: 3D model of manipulator in Autodesk® Inventor®. Physical model, upon instructor approval of design	Notes: Lesson: https://manawatech.com/courses/course/view.php?id=3&section=8

Unit Name: **Speed, Power, Torque & DC Motors**	**Length:** 10 days
Standards: BB1.c.5.h: Given a linear, rotary, and/or compound motion mechanism, students will measure and calculate untis such as work, power, torque, gear ratios, and mechanical advantage. ENG5.b.7.h: Operate systems so that they function in the way they were designed.	**Outcomes:** In this unit, students will learn about the physical principles of speed, power, and torque. They will also learn about DC motors and how these principles apply to them. Students will apply these concepts on a sample mechanical system to calculate key details of the design.
Essential Questions: 1. Why would you want to increase your speed and lower your power? 2. Why would you want to increase your power and lower your speed? 3. How does the change in the load affect your current draw?	**Learning Targets:** 1. Students will be able to demonstrate the concept of speed. 2. Students will be able to demonstrate the concept of power. 3. Students will be able to demonstrate the concept of torque. 4. Students will be able to describe the 4 primary characteristics of a DC Motor, and how they relate to each other. 5. Students will be able to calculate motor loading for a mechanical DC Motor system, and describe how changes in the system would affect the loading.

Topic 1: **Classical Mechanics**	**Length:** 1 day
Standard(s): BB1.c.5.h: Given a linear, rotary, and/or compound motion mechanism, students will measure and calculate units such as work, power, torque, gear ratios, and mechanical advantage.	**Academic Vocabulary:** Mechanics, Torque, Speed, Velocity, Rotational Speed, Actuator, Acceleration, DC Motor, Force, Voltage, Work, Current, Power, Stall, Load
Lesson Frame: Speed, Acceleration, Force, and Torque	We will: define speed, rotational speed, acceleration, force, and torque
	I will: provide examples of differentiation in speed, acceleration, force, and torque.
Performance Tasks: Study packet with calculations and exercises	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1034

Topic 2: **DC Motors**	**Length:** 3 days
Standard(s): BB1.c.5.h: Given a linear, rotary, and/or compound motion mechanism, students will measure and calculate untis such as work, power, torque, gear ratios, and mechanical advantage.	**Academic Vocabulary:** voltage, speed, torque, load, current, rotational speed,
Lesson Frame: Motor Loading, Current Draw, Key Motor Characteristics	We will: understand the load acting on a motor.
	I will: define the relationship between torque, load, and rotational speed.
Lesson Frame: Varying Power with Voltage	We will: recognize that power output varies with voltage
	I will: determine motor limits and calculations.

Performance Tasks Arm Design Calculations - voltage and motor limits	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1035

Topic 3: **Simulate and Size a DC Motor**	**Length:** 6 days
Standard(s): BB1.c.5.h: Given a linear, rotary, and/or compound motion mechanism, students will measure and calculate untis such as work, power, torque, gear ratios, and mechanical advantage. ENG5.b.7.h: Operate systems so that they function in the way they were designed.	**Academic Vocabulary:** Dynamic Simulation
Lesson Frame: Video 1: Review of Robot Assembly	We will: review the existing robot assembly and create a simplified model.
	I will: create a simplified model.
Lesson Frame: Video 2: Run the Simulation and Calculate the Torque	We will: learn how to determine calculations from within the 3D virtual environment.
	I will: determine the torque on the driveshaft by running a simulation.
Lesson Frame: Evaluation of Arm Structures	We will: evaluate workflow required to calculate maximum torque
	I will: determine maximum torque using the Dynamic Simulation environment
Performance Tasks: Testing of arm designs. Data collection. Redesign.	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1037

Unit Name: **Mechanical Power Transmission**	**Length:** 10 days
Standards: BB1.c.5.h: Given a linear, rotary, and/or compound motion mechanism, students will measure and calculate units such as work, power, torque, gear ratios, and mechanical advantage. ENG5.b.8.h: Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate. ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.	**Outcomes:** In this lesson students will learn about the different types of mechanical power transmission. They will learn about different gear types, and how to calculate gear ratios. These principles will then be applied to the types of motor - arm systems seen in Unit 7.
Essential Questions: 1. How do the different types of gears provide an advantage in your arm design? 2. How do the mathematical calculations help you to determine what type of gear ratio is needed in your design?	**Learning Targets:** 1. Students will be able to demonstrate how mechanical power transmission systems are very important in the design and construction of competition robots. 2. Students will be able to vary the gear ratio (and the mechanical advantage) in a system giving them the versatility necessary to accomplish whatever work needs to be done. 3. Students will be able to determine gear inputs & outputs by calculating the difference between them, and determine their gear ratio accordingly.

Topic 1: **Power Transmission**	**Length:** 5 days
Standard(s): BB1.c.5.h: Given a linear, rotary, and/or compound motion mechanism, students will measure and calculate units such as work, power, torque, gear ratios, and mechanical advantage.	**Academic Vocabulary:** Gear, Gear Ratio, Mechanical Advantage, Transmission, Spur Gear, Bevel Gear, Crown Gear, Worm Gear, Helical Gear, Idler Gear, Epicyclical (Planetary) Gear, Rack and Pinion Gear, Gear Pitch,
Lesson Frame: Overview of transmission process	We will: gain an understanding of the transmission process.
	I will: reiterate the transmission process.
Lesson Frame: Gear teeth and pitch; Gear ratios	We will: identify different gear types and how they work
	I will: prepare a template for presenting different gear types through research
Lesson Frame: Motion Reversal & Idler Gears	We will: understand the cause and effect of motion reversal
	I will: determine direction of motion by identifying a pattern.
Lesson Frame: Compound Gear Reduction	We will: view a presentation on how the gear reduction process works.
	I will: illustrate the mathematical calculations involved in gear reduction.
Lesson Frame: Formulas & Calculations	We will: understand the procedure for calculating gear reduction.
	I will: calculate gear reduction of my arm configuration

Performance Tasks: Revisit arm design from Unit 7 - apply Adaptation Activity	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1049

Topic 2: **Arm Design**	**Length:** 1 day
Standard(s): ENG5.b.8.h: Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.	**Academic Vocabulary:** N/A
Lesson Frame: Design Adaptation Activity	We will: apply design adaptations to the arm activity from Unit 7.
	I will: produce the changes identified in the packet to my arm design.
Performance Tasks: Revisit arm design from Unit 7 - apply Adaptation Activity	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1049

Topic 3: **Modeling an Articulating Scoop**	**Length:** 4 days
Standard(s): ENG5.b.8.h: Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.	**Academic Vocabulary:** N/A
Lesson Frame: Videos 1 and 2: Spur Gear Assembly	We will:
	I will:
Lesson Frame: Video 3: Assemble the Gears	We will: gain an understanding of the overall process involved in assembling the
	I will: begin assembling the gears, following the video tutorial instructions provide
Lesson Frame: Video 4: Complete the Gear Assembly	We will: finalize the mechanical assembly of parts in our gear assembly.
	I will: begin assembling the gears, following the video tutorial instructions provide
Lesson Frame: Video 5: Add the Motor and Animate Assembly	We will: learn how to add the motors to the assembly and finalize the animation.
	I will: add the motors, and animate the assembly
Performance Tasks: Assembly Project	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1050

Unit Name: **Drivetrain Design**	**Length:** 8 days
Standards: BB1.c.4.h: Build, test, and troubleshoot simple linear, rotary, and compound mechanisms. BB1.c.5.h: Given a linear, rotary and/or compound motion mechanism, students will measure and calculate units such as work, power, torque, gear ratios, and mechanical advantage. B1.f.5.h: Calculate and define the different loads acting on structures (i.e. static, dynamic, stress, strain, compression, tension)	**Outcomes:** In this unit students will be exposed to the physical principles of friction & traction while exploring the implications these principles have on robot drivetrain design. Students will be shown a variety of different robot drive system types and will learn the differences between them. Students will then apply the lessons they've previously learned about DC motors & gear ratios to design the powertrain of their robot's drive system.
Essential Questions: 1. How can you use friction to your advantage when you create your robot drivetrain? 2. How can you use geometry to help select the most efficient drivetrain for your robot?	**Learning Targets:** 1. Students will be able to demonstrate how applied force and friction are related. 2. Students will be able to distinguish between static and kinetic friction. 3. Students will be able to calculate wheel speed. 4. Students will be able to demonstrate how to calculate a gear reduction. 5. Students will be able to compare and contrast the different types of drivetrains, along with their benefits and drawbacks.

Topic 1: **Terminology**	**Length:** 2 days
Standard(s): B1.f.5.h: Calculate and define the different loads acting on structures (i.e. static, dynamic, stress, strain, compression, tension)	**Academic Vocabulary:** Friction, Traction, Drivetrain, Static Friction, Kinetic Friction, Maximum Static Friction, Magnitude, Force of Friction, Normal Force, Tractive Force, Drive Wheel, Turning Point, Turning Scrub, Zero Radius Turn
Lesson Frame: Friction and Traction (terms)	We will: review basic principles of friction.
	I will: identify examples of friction, traction, static friction, coefficient of friction, and no
Lesson Frame: Drivetrain (terms)	We will: identify types of drivetrains.
	I will: locate and identify types of drivetrains around school and home.
Performance Tasks: Engineering Notebook Sketches	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1052

Topic 2: **Drivetrain Geometry and Turning**	**Length:** 6 days
Standard(s): BB1.c.5.h: Given a linear, rotary and/or compound motion mechanism, students will measure and calculate units such as work, power, torque, gear ratios, and mechanical advantage.	**Academic Vocabulary:** Ackermann Steering, Skid Steer, Omni Directional, turning point
Lesson Frame: Geometry of a turning drivetrain	We will: identify types of drivetrains

	I will: sketch and label examples of different types of drivetrains.
Lesson Frame: Gear Train Design	We will: determine calculations of gear reduction on a gear train.
	I will: calculate the gear reduction of a turning drivetrain
Performance Tasks: Apply concepts to design activity.	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1054

Unit Name: **Lifting Mechanisms**	**Length:** 11 days
Standards: ENG4.b.5.h: Develop and produce a product or system using a design process. BB1.c.5.h: Given a linear, rotary and/or compound motion mechanism, students will measure and calculate units such as work, power, torque, gear ratios, and mechanical advantage. BB1.c.4.h: Build, test, and troubleshoot simple linear, rotary, and compound mechanisms. BB1.f.5.h: Calculate and define the different loads acting on structures (i.e. static, dynamic, stress, strain, compression, tension).	**Outcomes:** In this unit students will learn about different types of lifting mechanisms which are useful on competition robots. Students will then do preliminary design work on a mechanism for their robots.
Essential Questions: 1. Explain how the degrees of freedom will allow you to design a robot that is able to transfer motion as it manipulates game objects. 2. Explain how a linkage system allows a robot to score on a high goal in a game situation. 3. Explain how passive assistance can provide your robot with a mechanical advantage.	**Learning Targets:** 1. Students will be able to differentiate the three degrees of freedom that are presented in the beginning of the unit. 2. Students will be able to demonstrate the correct use of the calculations needed to choose a gear reduction. 3. Students will be able to distinguish between the use of a linkage system and a multi-state elevator in manipulator design. 4. Students will be able to explain how passive assistance can improve a robot design.

Topic 1: **Degrees of Freedom**	**Length:** 2 days
Standard(s): BB1.c.5.h: Given a linear, rotary and/or compound motion mechanism, students will measure and calculate units such as work, power, torque, gear ratios, and mechanical advantage	**Academic Vocabulary:** Object manipulators, Lifting mechanisms, Degrees of freedom, First degree of freedom, Second degree of freedom, Third degree of freedom, Mechanical advantage, Factor of Safety, Elevator, Actuation, Passive assistance
Lesson Frame: Types of Movement	We will: define three degrees of freedom: rotational, linear, and rotation around a p
	I will: provide examples of the three different degrees of freedom.
Lesson Frame: Calculating Degree of Freedom	We will: identify the method of determining the degrees of freedom of a human arm
	I will: calculate the degrees of freedom on my arm.
Performance Tasks: Degrees of Freedom on a human arm - Activity	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1055

Topic 2: **Rotating Joints**	**Length:** 2 days

Standard(s): BB1.c.5.h: Given a linear, rotary and/or compound motion mechanism, students will measure and calculate units such as work, power, torque, gear ratios, and mechanical advantage.	**Academic Vocabulary:** Shock load, joint loading, joint speed, mechanical advantage
Lesson Frame: Joint Loading/Joint Speed	We will: become aware of methods to adjust joint loading and speed.
	I will: apply methods of methods to adjust joint loading and speed.
Lesson Frame: Approach 1	We will: practice methods of gear reduction starting with loading.
	I will: apply Approach 1 to gear reduction of my rotating joint.
Lesson Frame: Approach 2	We will: practice methods of gear reduction starting with speed.
	I will: apply Approach 2 to gear reduction of my rotating joint.
Performance Tasks: Practice Approaches 1 & 2 of calculating gear reduction on a rotating joint. (Review calculations 2nd day)	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1056

Topic 3: **Elevators**	**Length:** 1 day
Standard(s): BB1.f.5.h: Calculate and define the different loads acting on structures (i.e. static, dynamic, stress, strain, compression, tension).	**Academic Vocabulary:** actuation
Lesson Frame: Comparison as a Lifting Mechanism	We will: gain an understanding of how an elevator differs from other lifting mechani
	I will: identify characteristics of an elevator arm.
Performance Tasks: Engineering Notebook Sketches	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1057

Topic 4: **Linkages, Passive Assistance, and Design Application**	**Length:** 6 days
Standard(s): ENG4.b.5.h: Develop and produce a product or system using a design process.	**Academic Vocabulary:** linkages, passive assistance
Lesson Frame: Types of Linkages	We will: define and provide examples of types of linkages.
	I will: list types of linkages and define advantages of each.
Lesson Frame: Passive Assistance	We will define and list examples of passive assistance.
	I will: determine a method of passive assistance to apply to my design.
Lesson Frame: Application of Design to Lifting Mechanisms	We will: identify key considerations in design of lifting mechanisms

	I will: determine appropriate design for my robot's lifting mechanism
Performance Tasks: Engineering Notebook: Sketches and notes Application of design to Design Activity	Notes: Lesson: https://manawatech.com/courses/mod/resource/view.php?id=1058 Design Activity: https://manawatech.com/courses/mod/resource/view.php?id=1059

Unit Name: **Systems Integration**	**Length:** 7 days
Standards: BB1.a.6.h: Describe how the outputs of one subsystem are the inputs of another subsystem given a prominent energy, power and transportation system. ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. ENG4.b.5.h: Develop and produce a product or system using a design process.	**Outcomes:** In this unit students will learn techniques for successfully integrating a number of disparate subsystems into one cohesive whole. Students will take the lessons learned earlier in the semester and their existing designs to create their overall robot.
Essential Questions: 1. How does the process of system engineering allow for the development of a well-integrated structure? 2. How does the integration of system engineering early in the design process provide benefits to the overall design?	**Learning Targets:** 1. Students will be able to demonstrate how system integration works. 2. Students will be able to demonstrate how they can use the six tips for integration in their design.

Topic 1: **Systems Integration**	**Length:** 3 days
Standard(s): BB1.a.6.h: Describe how the outputs of one subsystem are the inputs of another subsystem given a prominent energy, power and transportation system. ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.	**Academic Vocabulary:** System Integration, Power, Control, Pneumatics, Drivetrain, Lifting Mechanisms, Object Manipulators
Lesson Frame: Definition	We will: determine aspects of integration to the full robotic system
	I will: note aspects of consideration in determining my robot's systems integration
Lesson Frame: Modeling Activity	We will: apply design choices to 3D model
	I will: finish my 3D model of the robot in Autodesk Inventor.
Performance Tasks: Engineering Notebook: Systems integration checklist 3D Design Activity (finish model robot)	Notes: At the end of this design activity, students will have completed their virtual robot.

Topic 2: **Design Activity**	**Length:** 4 days
Standard(s): ENG4.b.5.h: Develop and produce a product or system using a design process.	**Academic Vocabulary:** N/A
Lesson Frame: Application of Design	We will: apply all aspects of systems integration to the robot build
	I will: finish building the robot, applying recent design choices.
Performance Tasks: Design Activity - Finish Competitive Robot	Notes: The competitive robot will be complete at the end of this lesson.

Unit Name: **Testing and the Iteration Process**	**Length:** 12 days
Standards: CD1.d.4.m: Apply decision-making strategies to personal and team interactions. ENG4.c.6.h: Evaluate final solutions and communicate observations, processes, and results of the entire design process using verbal, graphic, quantitative, virtual and written means, in addition to design models. ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.	**Outcomes:** In this unit students will test and improve their robot. All design is iterative. This phase of the semester will focus on students testing, tweaking, and improving their robot as they hone in on a final design. Students will then compete in a final competition against their peers.
Essential Questions: 1. How did the testing process provide you concrete information to make your decisions? 2. How did the iterative process improve the quality of your design? 3. How did your prioritize which subsystems were working on first?	**Learning Targets:** 1. Students will be able to demonstrate the role that testing plays in the design process. 2. Students will be able to demonstrate how the information collected in the testing process is used in the different iterations of their robot design. 3. Students will be able to demonstrate a systematic process to prioritize the improvements dictated from the data collected from their testing.

Topic 1: **Testing and Iteration**	**Length:** 3 days
Standard(s): ENG4.c.6.h: Evaluate final solutions and communicate observations, processes, and results of the entire design process using verbal, graphic, quantitative, virtual and written means, in addition to design models. ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.	**Academic Vocabulary:** Iteration
Lesson Frame: Process of Iteration	We will: understand the process of iteration.
	I will: note questions to consider in the process of iteration in my Engineering Notebo
Lesson Frame: Test Robot	We will: evaluate robot's design and performance
	I will: reflect on my robot's performance in my Engineering Notebook.
Lesson Frame: Redesign	We will: apply feedback from the testing process to redesign of robot
	I will: perform adaptations to design
Performance Tasks: Test and critique robot design - list of questions to consider answered in Engineering Notebook.	Notes: Lesson: https://manawatech.com/courses/course/view.php?id=3&section=14

Topic 2: **Competition**	**Length:** 2 days (possibly 1)
Standard(s): CD1.d.4.m: Apply decision-making strategies to personal and team interactions.	**Academic Vocabulary:** N/A
Lesson Frame: The Final Competition	We will: identify strengths as members of a robotic team.

	I will: actively support my team in competition.
Performance Tasks: Teams compete - final competition	Notes: Lesson: https://manawatech.com/courses/course/view.php?id=3&section=14

Topic 3: **Analysis and Reflection**	**Length:** 7 days
Standard(s): ENG4.c.6.h: Evaluate final solutions and communicate observations, processes, and results of the entire design process using verbal, graphic, quantitative, virtual and written means, in addition to design models. ENG4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.	**Academic Vocabulary:** Project Portfolio
Lesson Frame: Application	We will: identify and apply final iteration to robotic design.
	I will: apply all redesign changes to 3D model and physical robot.
Lesson Frame: Final Presentation	We will: identify components within the communication state of the design process.
	I will: communicate the engineering design process of my robot design.
Performance Tasks: Prepare and communicate final presentation.	Notes: Lesson: https://manawatech.com/courses/course/view.php?id=3&section=14

September	October	November	December	January	February	March	April	May	June
Class Intro	2. Intro to Robotics	4. 3D Modeling using Inventor®.	5. THE GAME!	6. Object Manipulation	8. Mechanical Power Transmission	10. Lifting Mechanisms	12. Testing, Iteration, Improvement	Final Project	Final Project
Syllabus, Classroom expectations & procedures	Students will learn about how the field of robotics operates and how robots work. Students will learn about the role of robots in society and how they are used in all aspects of STEM education.	Students will get an introduction to Autodesk Inventor. They will get an overview of the different ways engineers use Autodesk Inventor and then learn specific ways they can use Inventor to help design and build VEX robots.	Students will learn the rules of the game, which will be necessary to design robots. The students will be able to analyze potential game strategies. Students will learn the effects of applying a cost benefit analysis to the design process.	Students will learn about the different types and categories of robot manipulators. Students will be presented with robot manipulators from the real world and shown the basic principles behind their operation. Students will then create their own object manipulator for use on their competition robot.	Students will learn about the different types of mechanical power transmission. Topics include various gear types, and how to calculate gear ratios. These principles will then be applied to the types of motor - arm systems seen on competition robots (and described in Unit 7.)	Students 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.	Students will learn how important testing, iteration and continuous improvement are in the design process. The students will learn how to develop their final design.	If schedule did not require additional days in the calendar, students will apply the design process to the construction of a robot for the Manawa Rodeo Parade.	
1. Intro to Engineering	3. Intro to VEXnet			7. Speed, Power, Torque, & DC Motors	9. Drivetrain Design	11. Systems Integration			
Students will learn about what engineering is and what engineers do. The concepts of classical mechanics, design and iteration will be defined and worked through.	Students will learn what the core components of the VEX control system are - the Cortex Microcontroller, VEXnet Joystick and VEXnet Wireless link. They will also learn how they each function.			Students will learn about the physical principles of speed, power, and torque. Students will learn about DC motors and how these principles apply to them. Students will apply these concepts on a sample mechanical system to calculate key details of the design.	Students will learn about the physical principles of friction and traction through the exploration of robot drivetrain design.	Students will learn about the techniques that are used in engineering that allow for the successful integration of systems into a cohesive finished product. Students will learn how integration is an integral part of the initial design process.			