**SUBJECT:ROBOTICS TIMELINE: 5 hours**

**UNIT 1: Inventory for VEX Team Bins**

**Essential Questions for this Unit**

1. What are the structural parts I can use to build my robot with the functions it needs?

2. How are the structural parts assembled?

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| Content | Objectives | Assessment | Resources | Vocabulary |
| Although there are no specific standards for this, students need to know all structural parts and how parts are assembled. As well, they need complete inventories of their VEX clear bins so they go to competitions with all the parts they need.  This introductory unit allows them to collaborate with their assigned robot teams.  This unit also allows students to become familiar with the organization of the structural parts in the various drawers of the classroom which is invaluable when students need to find parts. | 1. I can disassemble my robot, separating parts by function and size  2. I can complete a checklist of all structural parts needed for competitions | Performance Tasks:  1. Learn how to use specific robotics tools and how parts are assembled  2. Create inventory of all structural parts in team VEX clear bin  3. Team Scavenger Hunt: time taken to locate and bring back 15 specified structural pieces | Checklist of Competition Kit Contents by function | Use of correct names of structural parts – for example:  4-Post Hex Nut Retainers,  #8-32 x 1/4" Locking Star Drive Screws, 84T High Strength Spur Gears, 30T High Strength Sprockets,  Rubber Shaft Collars, Flat Bearings, 12" Drive Shafts, Battery Clips, #8-32 Keps Nuts, Lock Bars |

**SUBJECT:ROBOTICS Physical Science TIMELINE: 10 hours**

**UNIT 2: Z-SPACE Virtual Reality Computer System - Franklin Lab: Electrical Current**

**Essential Questions for this Unit**

1. How do devices plugged into an outlet get their power?

2. What affects the flow of electricity?

3.What are the relationships that allow you to measure electrical output?

| Standards | Content | Objectives | Assessment | Resources | Vocabulary |
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| **Educational Technology Strand 1 Concept 2***Models and Simulations:* Students use digital models and simulations to examine real-world connections, explore complex systems and issues, and enhance understanding.  ETHS-S1C2-01: Summarize the relationship amongst interdependent elements of a digital model or simulation.  **Educational Technology Strand 2 Concept 2** *Communication and Collaboration:* Students contribute to project teams to produce original works or solve problems.  ETHS-S2C2-01: Communicate and collaborate for the purpose of producing original works or solving problems.  **Science Standards:**  **Physical Science**  **Plus HS+Phy.P4U2.7**  **Design, evaluate, and refine** a devicethat works within given constraints to transfer energy within a system.  **Plus HS+Phy.P4U1.8**  **Use mathematics and computational thinking** to explain the relationships between power, current, voltage, and resistance.  **Crosscutting Concepts:**  Patterns; Cause and Effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Structure and Function; Stability and Change  **Science and Engineering Practices** #2. Develop and Use Models | Builds and extends basic knowledge of electrical current, closed circuits and conductivity | 1. I will close a circuit using combinations of pennies and erasers.  2. I will determine the conductive properties of the penny and the eraser. | 1. Handwritten, typed or verbal answers to discussion questions  2. Schematic drawing of each student’s circuit | Z-Space Activity Video  Investigation: **Conductivity**  Franklin’s Lab  2. Schematic Drawing  Page | Circuit  Closed circuit  Components  Conductive  Electricity  Nonconductive  Open circuit |
| 1. I will observe the transfer of energy and differentiate between open and closed circuits  2. I will observe the absence of electrical current flow through an open circuit.  3. I will identify methods of closing open circuits using materials from the Franklin’s Lab Backpack. | 1. Handwritten, typed or verbal answers to discussion questions  2. Demonstrations | Z-Space Investigation: **Open and Closed**  Franklin’s Lab  3. Franklin’s Lab Backpack |
| 1. I can determine the requirements to light an LED.  2. I will evaluate the purpose of resistors in a circuit. |  | Z-Space Investigation: **Resisting the Flow** | LED  Voltage  Ohm  Resistance  Resistor |
| 1. I will observe how energy can be transferred through electrical circuits.  2. I will compare energy movement in different types of circuits. | 1. Handwritten, typed or verbal answers to discussion questions  2. Demonstrations | Z-Space Investigation: **Series vs. Parallel Circuits** | Parallel Circuit  Series Circuit |
| 1. I will observe four closed circuits with different amounts of current flowing through them.  2. I will compare four closed circuits to determine which circuit seems to have the fastest current.  3. I will evaluate and fix problems involving short circuits. | 1. Handwritten, typed or verbal answers to discussion questions  3. Demonstrations | Z-Space Investigation: **Short Circuit** | Short circuit |

**SUBJECT: ROBOTICS Physical Science TIMELINE: 10 hours**

**UNIT 3: Z-SPACE Virtual Reality Computer System - Franklin Lab: Troubleshooting Circuits**

**Essential Questions for this Unit**

1. How does energy flow through a circuit?

2. How can trial and error be used to troubleshoot problems?

3. How is energy converted from one form into another?

| Standards | Content | Objectives | Assessment | Resources | Vocabulary |
| --- | --- | --- | --- | --- | --- |
| **Same Standards as Unit 2** | Provides opportunities for students to apply their knowledge of circuits and motors to evaluate and repair broken quadcopters by using parts from a functioning quadcopter | 1. I will repair multiple circuits with unknown malfunctions  2. I will determine how to light an LED  3. I will evaluate broken drone motors(quadcopters), determine the cause of the problem and restore the system to working order  4. I can design a solution to a problem and build a circuit based on that design  5. 2. I can test the circuit and analyze how the circuit might work with LEDs instead of light bulbs | 1. Demonstrations  2. Handwritten, typed or verbal answers to discussion questions  3. Demonstrations  Handwritten, typed or verbal answers to discussion questions  4. Z-Space Investigation: Classic Riddle | Z-Space Activity Video  Investigation: **Troubleshooting Basics**  Franklin’s Lab  Z-Space Investigation: Quadcopter 1, 2 and 3  Franklin’s Lab | Troubleshooting Flow Chart  Circuit  Electricity  Motor  Prototype  Quadcopter  Closed Circuit Efficiency Incandescent LED  Open Circuit |

**SUBJECT: ROBOTICS Units 4 – 9: Engineering and Design (85 hours in total)**

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| **Overview of Engineering and Design** |
| Students using the VEX EDR curriculum focus on several areas at the same time. Units 5, 6, 7 and 8 are designed to follow each other but Unit 7, Playing the Game, occurs at all stages as soon as students have a working robot.  Unit 4 Programming Virtual Robots to learn basics of coding begins simultaneously with Unit 5, so students are learning programming principles using their Virtual Robot at the same time they are building robots.  Unit 9 Programming Physical Robots for the autonomous section of the VEX competition game begins simultaneously with Unit 6 (once students have their basic robot built). Typically, students spend one day a week programming and four days a week building. |

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| **Standards** |
| Although there are not specific Arizona standards for Robotics, this course provides the necessary prerequisite knowledge for students to achieve proficiency in the following standards:  **Engineering Strand 6 *Technology Operations and Concepts* Concept1 *Understanding:***  E08-S6C1-03: Recognize, define and use technology processes, systems, and applications.  **Educational Technology Strand 2 Concept 2** *Communication and Collaboration:* Students contribute to project teams to produce original works or solve problems.  ET08-S2C2-01: Communicate and collaborate for the purpose of producing original works or solving problems.  **In addition, this course fulfills the following discipline-specific standards.**  **ISTE Standards (formerly NETS)**   * 1.c - Use models and simulation to explore complex systems and issues. * 2.d - Contribute to project teams to solve problems. * 4.b - Plan and manage activities to develop a solution or complete a project. * 6.a – Understand and use technology systems. |
| **Discipline-specific Standards - continued** |
| **ITEEA Standards for Technological Literacy 9.K Design**  Students will develop an understanding of engineering design. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.   * 10.F Design **-** Troubleshooting is a problem-solving method used to identify the cause of a malfunction in a technological system   **CSTA K-12 Computer Science Standards**   * CT.L1:3-03 - Understand how to arrange information into useful order without using a computer. * CT.L1:6-01 - Understand and use the basic steps in algorithmic problem-solving. * CT.L1:6-02 - Develop a simple understanding of an algorithm using computer-free exercises. * CT.L1:6-05 - Make a list of sub-problems to consider while addressing a larger problem. * CPP.L1:3-04 - Construct a set of statements to be acted out to accomplish a simple task. * CPP.L1:6-05. Construct a program as a set of step-by-step instructions to be acted out (e.g., make a peanut butter and jelly sandwich activity). * CT.L2-03. Define an algorithm as a sequence of instructions that can be processed by a computer. * CT.L2-06. Describe and analyze a sequence of instructions being followed. * CT.L3A-03. Explain how sequence, selection, iteration, and recursion are building blocks of algorithms.   **NGSS Science and Engineering Practices**   * HS-PS3-2 - Use tools and materials provided to design and build a device that solves a specific problem or a solution to a specific problem. * HS-PS3-3 – Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy * HS-ETS1-2 - Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. |

**SUBJECT: ROBOTICS Engineering and Design TIMELINE: 5 hours**

**UNIT 4: Programming Virtual Robots**

**Essential Questions for this Unit**

1. What syntax does ROBOTC use for programming?

2. How do I control basic robot movements?

3. How can I use problem-solving strategies to solve Engineering Challenges?

| Content | Objectives | Assessment | Resources | Vocabulary |
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| **Basic Movements**  1. Moving Forward Unit – these lessons explain what the introductory lines of code do and teaches some of the syntax related to ROBOTC  2. Speed and Direction Unit – students learn to change the power levels using programming, and make different types of turns | 1. To understand the syntax of coding  2. To effectively use ROBOTC to write basic movement programs  3. Solve the open-ended programming challenges embedded into the Movement and Remote Control Units | 1. Students complete online checkpoints to earn Progress badges:  Driving Straight I and II  Sumo Bot  2. Students complete online checkpoints to earn Progress badges:  Sentry Simulation  Bull-in-the-Ring  Minefield Challenge | VEX Video Curriculum  Curriculum Companion – virtual robot  ROBOTC | Motors, Ports  Open loop,  Reverse  Code generation  Compilation  Configuration Statements - “#pragma config”  Power levels  Milleseconds – “Wait1Msec” |

**SUBJECT: ROBOTICS Engineering and Design TIMELINE: 15 hours**

**UNIT 5: The Engineering Process**

**Essential Questions for this Unit**

1. How is Design an iterative process?
2. What process do engineers use to solve a problem?
3. What is an Engineering Design Notebook and how is it kept updated?

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| Content | Objectives | Assessment | Resources | Vocabulary |
| The Engineering Design Process | 1. I understand the phases in the Engineering Design Process  2. I can follow the steps in the Engineering Design Process when solving a problem  3. I know how to evaluate an optimal solution  4. I can maintain an Engineering Log  5. Through self-evaluation, I can improve my communication skills | VEX Curriculum Notes   * Students watch videos, complete note outlines and take online quizzes   Engineering Logbook   * Documentation of build   VEX Curriculum Notes | VEX Video Curriculum  **Daily Log**   * Our goal for today was… * Our accomplishments today were: * Some of the difficulties we encountered were… * My personal role or contribution(s) to the group effort was/were…   ROBOTC  Robomatter website | Chassis  Subsystems  Hex key  Allen key  Open-ended wrenches  Terminology of VEX Parts |

**SUBJECT: ROBOTICS Engineering and Design TIMELINE: 15 hours**

**UNIT 6: Clawbot Build**

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| **Overview of Clawbot Unit** |
| The VEX EDR curriculum is heavily focused on mechatronic principles. In this first unit, working in partners, students build prototypes of the Clawbot robot for the 2017-2018 competition *Change Up*. Students also work together to build the competition field, refining the set-up and take-down process in order to efficiently build the field where needed. |

**Essential Questions for this Unit**

1. How do robots benefit society?

2. How do the different subsystems work together in a robot?

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| Content | Objectives | Assessment | Resources | Vocabulary |
| As well as building a prototype of the Clawbot robot for the 2017-2018 competition *Change Up*, students expand their understanding of the Engineering Process by completion of Daily Logs in personal Engineering logbooks.  During this unit, students become proficient playing and scoring the 2017-2018 game - *Change Up*. They will also build the competition field. | 1. I will build a Clawbot that is competition ready  2. I will sync the VEX cortex with the joystick to manipulate the robot on tether  3. I will set up the wireless remote to manipulate the robot wirelessly  4. I can set up the competition field  5. I understand the game and its scoring | Performance Tasks:   * Functioning Robot * Joystick on tether * Joystick using wireless   Engineering Logbook   * Documentation of build   VEX Curriculum Notes | VEX Video Curriculum  ROBOTC  Robomatter website | Chassis  Subsystems  Hex key  Allen key  Open-ended wrenches  Terminology of VEX Parts  Motor Ports  Reversing motor polarity |

**SUBJECT: ROBOTICS Engineering and Design TIMELINE: 20 hours**

**UNIT 7: Playing the Game**

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| **Overview of Playing the Game** |
| The VEX EDR curriculum uses an annual game as the motivator for learning robotics. This year’s game is called *Change Up*. Students form alliances, working collaboratively to stack cones in multiple point areas. Although speed is essential as each game lasts less than 2 minutes, robots have to be heavy enough to allow for manipulation of the claw and large enough to push mobile goals over barriers for maximum points. |

**Essential Questions for this Unit**

1. How can I manipulate my robot to maximum performance while playing *Change Up*?

2. What techniques will achieve optimal performance for my specific alliance?

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| Content | Objectives | Assessment | Resources | Vocabulary |
| Using the joystick, students perfect the manipulation of their robot in performing the game, *Change Up*. | 1. I can use the joystick, manipulating my robot to stack cones quickly  2. I will work together with my alliance to stack maximum number of cones in high point areas  3. I can park my robot in 10 seconds  4. I can score the game | Performance Tasks:   * Stacking cones on mobile goals * Pushing mobile goals over barriers * Stacking cones on high goals * Competitions – participation in at least one round-robin *Change Up* tournament | VEX Video Curriculum  ROBOTC  Robomatter website  YouTube videos of actual *Change Up* games | Mobile Goals  Alliance  Fixed Goals  High point areas |

**SUBJECT: ROBOTICS Engineering and Design TIMELINE: 10 hours**

**UNIT 8: Modifications**

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| **Overview of Modifications** |
| Once students have built a robot and become proficient at playing *Change Up*, they realize that the basic Clawbot will not allow them to reach maximum performance. In order to achieve maximum points in the game, students must be able to stack cones in high point areas on mobile goals. At least one robot in the alliance must be strong enough to move mobile goals over barriers to reach the high point areas. Another area of weakness is the lack of weight of the basic Clawbot. When manipulating the claw to stack cones on the high point fixed goals, the basic Clawbot tends to be pulled over backwards. |

**Essential Questions for this Unit**

1. How can I rebuild my robot to reach maximum performance while playing *Change Up*?

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| Content | Objectives | Assessment | Resources | Vocabulary |
| Using the booster kit, students rebuild robots to reach maximum performance in playing the game, *Change Up*. | 1. I can rebuild my robot to be able to push mobile goals over barriers into high point areas  2. I can add more weight to my robot in order to prevent the claw from tipping the robot over backward when fully extended | Performance Tasks:   * Moving mobile goals over barriers * Fully extending claw without tipping robot backwards | ROBOTC  Robomatter website  YouTube videos of actual *Change Up* games  for structural ideas  *Change Up* forum | None |

**SUBJECT: ROBOTICS Engineering and Design TIMELINE: 20 hours**

**UNIT 9: Programming Physical Robots for the Autonomous Section of the VEX Competition Game**

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| **Overview of Programming Unit** |
| Programming tasks are designed to involve some – but not extensive – mechanical consideration, so that hands-on design tasks may remain authentic without becoming logistically difficult.  A typical plan for each programming section (Movement, Remote control and Sensing) is:  1. Review the unit challenge which is always the first lesson on the page  2. Proceed through the video trainer materials at each student’s own pace, watching the video  3. Answer the “Check Your Understanding” questions  4. Complete the Engineering Investigations and/or Programming Challenges in the order they are presented  Students will develop programming skills by modifying simple programs that run autonomously on a robot. Programs will become increasingly complex and students will progress from one program to the next only through the mastery of each program in sequential order.  The overarching goal of each student is to create programs that are capable of a high level of autonomous control over the Clawbot using data sensors that collect data on the environment external to the Clawbot in order to be competitive in the VEX competition game. |

**Essential Questions for this Unit**

1. How do I control basic robot movements?

2. How can I use problem-solving strategies to solve Engineering Challenges?

3. What role does teamwork play in Engineering?

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| Content | Objectives | Assessment | Resources | Vocabulary |
| **Movement Chapter**  1. Labyrinth Challenge – students program robot to travel a specific distance, turn accurately and then repeat these behaviors multiple times  2. Moving Forward Unit – these lessons explain what the introductory lines of code do and teaches some of the syntax related to ROBOTC  3. Speed and Direction Unit – students learn to change the power levels using programming, make different types of turns and make robot march around a square  4. Shaft encoders – students learn how to program shaft encoders and how to use the Motors and Sensors Setup window and how to use a While Loop | 1. To understand the syntax of coding  2. To effectively use ROBOTC to modify existing programs  3. Solve the open-ended programming challenges embedded into the units that make up Movement, Remote Control, Sensing and Engineering Units | Engineering Logbook   * Documentation of builds and programming   Answers to the “Check Your Understanding” questions  Engineering Investigations and Programming Challenges: each group constructs its own solution to the Unit Challenge, documenting their solutions in their personal logbooks | VEX Video Curriculum  VEX Forum  ROBOTC  RBC files  Robomatter website  Reference videos:   * Boolean Logic Pt 1 * Boolean Logic Pt 2 | Power levels  Rotational torque  Acceleration  Reversing motor polarity  Sensor Debug Window  Values and variables |

**SUBJECT: ROBOTICS Engineering and Design TIMELINE: 10 hours**

**UNIT 10: Disassembly of Robots and Inventory Control**

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| **Overview of Disassembly of Robots** |
| At the end of the course, students take apart their robots, separating parts and taking a complete inventory. Students learn apply organizational skills using check lists of the competition kit contents. The end-of-year inventory that the students participate in teaches responsibility in a hands-on activity. |

**Essential Questions for this Unit**

1. What organizational system can I use to keep track of inventory?

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| Content | Objectives | Assessment | Resources | Vocabulary |
| An Inventory Control Clerk can work for a variety of different companies that are in need of someone to be in charge of inventory. This clerk will be responsible for keeping track of inventory levels and ordering more when it is needed.  Skills involved with this job include management, organizational, customer service, problem solving and analytical. | 1. I can disassemble my robot, separating parts by function and size  2. I can complete a checklist for inventory to allow for ordering of missing parts | Performance Tasks:  1. All structural robotic parts are cataloged and separated in the rectangular clear VEX bin  2. All electronic parts are cataloged and separated in the smaller clear bin | Individual inventories from the beginning of the year  Checklist of Competition Kit Contents by function | None |