



Camas School District Framework: Introductory Robotics

Course: STEM Robotics Engineering

Total Framework Hours up to: 600

CIP Code: 150405

Exploratory Preparatory

Date Last Modified: 01/20/2013

Career Cluster: Manufacturing

Cluster Pathway: Manufacturing Production Process Development

Course Resources

This STEM Robotics Engineering Framework is aligned with the curriculum developed by the Camas School District using resources from the Olympia School district, Carnegie Mellon University's Robotics Academy®, Tufts University, LEGO®, Pitsco®, Intel Corp. as well as original content developed in CSD.

The curricular content and teacher collaboration resources are being hosted by Portland State University's [Ensemble STEM Robotics site](#).

This is a STEM course which teaches Science, Technology, Engineering and Math concepts through the [hardware](#) and [software](#) of the LEGO® MINDSTORMS® NXT as well as the [Tetrix® hardware](#) and [RobotC](#) software platforms.

Leadership opportunities are present throughout the course and are aligned with [FIRST® Tech Challenge](#) (FTC), Science Olympiad, and Science and Engineering Fair competitions.

Units 1 - 13: NXT & NXT-G (210 hours)

Many of the introductory NXT-G programming lessons are built around the *NXT Video Trainer 2.0* product from the Carnegie Mellon Robotics Academy® which is available for free [online](#) or for purchase on [DVD](#).

Units 1 through 13 in this framework are aligned with the [Scope and Sequence](#) of [STEM Robotics 101 master curriculum](#).

These units are broken down into lessons, with each lesson containing an Overview, Objectives, Instructor's Guide, Primary Instructional Material and Formative/Summative Assessments provided by the original author of the lesson.

Lessons may also include Differentiated Instructional material and Additional Assessments provided by the original author or other teacher-contributors to the site. The structure, conventions and layout of STEM Robotics 101 portion of this curriculum are summarized on [this page](#).

Units 14-22: RobotC (210 hours)

Units 14 through 22 utilize the *RobotC Curriculum for Tetrix® and LEGO® Mindstorms®* from the Carnegie Mellon Robotics Academy® which is available for free [online](#) or for purchase on [DVD](#).

Programming lesson encompass both the [Robot Virtual World®](#) application as well as the physical [Tetrix® platform](#).

Units 23-30: Tetrix® (125 hours)

Unit 23 uses [the PTC® software](#) provided to FTC teams by *FIRST®* for Computer Aided Design (CAD).

Units 24 through 30 utilize [Getting Started Guide for the Tetrix®](#) curriculum.

Units 31 & 32: Project Management (55 hours)

Units 31 and 32 adapt the resources from [PMforCTE](#) to the *FIRST®* FTC competition.

Unit 0: Safety and STEM Career Awareness (covered as appropriate throughout course)

COMPONENTS AND ASSESSMENTS	
<p>Performance Assessments: Student will demonstrate knowledge and skills of Robotics lab safety. Student will present a plan to pursue a self-selected STEM career pathway</p>	
<p>Leadership Alignment: 1.1 Analyze, refine and apply decision-making skills 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions 1.6 Conduct self in a professional manner in practical career applications, organizational forums, and decision-making goals;</p>	
Standards and Competencies	
<p>Standard/Unit: Describe health and safety procedures in a NXT Robotics lab. Identify STEM careers and pathways.</p>	
Competencies	Total Learning Hours for Unit: 10
<ul style="list-style-type: none"> • Identify health and safety risks in a NXT Robotics lab • Explain health and safety procedures which address risks in a NXT Robotics lab • Identify health and safety risks in a Tetrrix Robotics lab • Explain health and safety procedures which address risks in a Tetrrix Robotics lab • Describe the breadth of possible STEM careers • Identify and explore a STEM career related to an area of student interest • Explain the education pathway to a given STEM career 	

Unit 1: Introduction to Robotics

COMPONENTS AND ASSESSMENTS	
<p>Performance Assessments: Student will create a research report on real and fictional robots. Student will demonstrate key attributes of NXT components. Student will assemble NXT golfing machine.</p>	
<p>Leadership Alignment: 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals</p>	
Standards and Competencies	
<p>Standard/Unit: Describe characteristics of robots and explain/use NXT components</p>	
Competencies	Total Learning Hours for Unit: 15
<ul style="list-style-type: none"> • Identify characteristics of a robot • Create a research report on important/iconic robotics, both real and fictional • Describe how the functions and characteristics of a robot can be seen in the NXT system • Explain the sense and response systems of the NXT system • Document/describe key attributes of the NXT electronic, mechanical and structural components • Explain the function of a two-gear gear train through the bicycle analogy • Construct an NXT Golfing Machine based on Faraday's Principle 	

Unit 2: Circuits and Computers

COMPONENTS AND ASSESSMENTS	
Performance Assessments: Student will build NXT circuits and run test programs on the NXT computer	
Leadership Alignment: 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed	
Standards and Competencies	
Standard/Unit: Build Robotic circuits and run robotics programs	
Competencies	Total Learning Hours for Unit: 10
<ul style="list-style-type: none">• Explain the four parts of a circuit and give examples of each• Differentiate between insulators, conductors and semiconductors• Describe how the NXT acts as a circuit• List examples of insulators, conductors and semiconductors within the NXT system• Explain the advantage of each of the NXT power source options• Build five NXT test circuits to demonstrate the capabilities of the various sensors• Explain the four reasons tube based computers stagnated and how the transistor solved these issues• Define and explain Moore's Law• Describe the four parts of a computer• Distinguish between the different type of storage in a computer• Describe how the NXT acts as a computer and the role of its different types of memory chips• Run five NXT test programs and identify the parts of the NXT computer used by each	

Unit 3: Hardware, Software, Firmware

COMPONENTS AND ASSESSMENTS	
Performance Assessments: Students will build a robot and write simple programs to control it using firmware	
Leadership Alignment: 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals	
Standards and Competencies	
Standard/Unit: Understand the roles of hardware, software and firmware, and how they interact in the NXT	
Competencies	Total Learning Hours for Unit: 10
<ul style="list-style-type: none">• Describe the role of each of the three parts of a microprocessor's hardware• Describe the nature and role of software in a microprocessor• Explain how a microprocessor's hardware and software work together• Update the NXT firmware and use it to explore the NXT systems and run test programs• Use the NXT firmware to explore the NXT systems and run test programs• Use the NXT hardware to build a robot from pictorial instructions	

- Write 5-step on-board programs for the NXT using firmware capability

Unit 4: Straight Ahead (programming precision forward and reverse motion)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will manipulate the straight movement of a robot through programming parameters

Leadership Alignment:

1.1 Analyze, refine and apply decision-making skills

1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions

2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals

Standards and Competencies

Standard/Unit:

Program a robot for precise forward and reverse motion.

Determine and use the relationship between power level and travel time/speed

Competencies

Total Learning Hours for Unit: 15

- Manipulate the Video Trainer software
- Download a program from NXT-G to a robot
- Calculate program parameters based on the circumference of a circle
- Program a robot for precision forward and reverse motion
- Measure, plot and interpolate travel time vs power level data
- Calculate, plot and interpolate speed vs power level data

Unit 5: Sights, Sounds and Gears (using light sensors, sound sensors, and gearing)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will program a robot to respond to light and sound sensors.

Student will calculate gears ratios and design a robot to trade off speed vs torque

Leadership Alignment:

1.1 Analyze, refine and apply decision-making skills

1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills

1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions

2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals

2.2 Demonstrate knowledge of conflict resolution and challenge management

2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:

Build robots to responds to light and sound.

Calculate and use gear ratios to optimize robot performance

Competencies

Total Learning Hours for Unit: 15

- Explain each parameter of the light sensor configuration panel
- Calculate a light sensor threshold
- Program a robot to respond to the light sensor
- Explain each parameter of the sound block (audible output) configuration panel
- Program a robot to respond to give an audible response
- Explain each parameter of the sound sensor configuration panel
- Calculate a sound sensor threshold
- Program a robot to respond to the sound sensor
- Explain the timing sensitivity of the sound sensor
- Explain gearing up and down in relation to speed and torque
- Calculate gear ratios
- Describe the difference between Science and Engineering
- Build a robot using the Engineering Process which incorporates precision forward motion, gear ratios, light and sound sensors

Aligned Common Core & Washington State Standards

Unit 6: Taking Turns (programming precision turns and manipulators)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will design and build a robot to maneuver through turns, control an appendage, and design a program from a flow chart

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills;
- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions;
- 1.6 Conduct self in a professional manner in practical career applications, organizational forums, and decision-making goals;
- 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals;
- 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:

Build robots capable of precision maneuvers, including movable appendages.
Plan and develop linear programs.

Competencies

Total Learning Hours for Unit: 15

- Explain how each parameter of the Move Block can be configured to control a robot's turning response
- Write a program for a robot to maneuver with turns
- Write a program for a robot to maneuver with various precision turns
- Write a program for a robot to combine turning and sensor response
- Create a flowchart to represent a multi-step activity
- Develop a robot program from a flow chart
- Explain each parameter of the Motor Block
- Write a program using the Motor Block to control a third motor in a robot
- Design, build and program a robot to write block characters on a horizontal dry-erase board

Unit 7: See, Touch, Repeat (using ultrasonic sensor, touch sensor and programming with loops)

COMPONENTS AND ASSESSMENTS	
Performance Assessments: Student will design and build a robot to use all four sensors and create programs with repeating behaviors	
Leadership Alignment: 1.1 Analyze, refine and apply decision-making skills; 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions; 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals; 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed	
Standards and Competencies	
Standard/Unit: Build robots that respond to touch and their proximity to objects. Plan and develop programs with repeating behaviors (loops)	
Competencies	Total Learning Hours for Unit: 15
<ul style="list-style-type: none"> • Describe how computers use digital information to represent numbers, words and images • Explain why computers only use digital information • Explain each parameter of the touch sensor configuration panel • Program a robot to respond to the touch sensor • Explain each parameter of the ultrasonic sensor configuration panel • Program a robot to respond to the ultrasonic sensor • Explain each parameter of the loop configuration panel 	

- Program a robot for repeating behavior controlled by timers, counters and sensors
- Design, build and program an animatronic robot which resembles and behaves like a selected animal

Aligned Common Core & Washington State Standards

Unit 8: Decisions, Decisions (using switch blocks and advanced flow charts)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will design and build a robot that makes decisions based on sensory input

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills;
- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions;
- 1.6 Conduct self in a professional manner in practical career applications, organizational forums, and decision-making goals;
- 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals;
- 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:

Build robots that make binary decisions based on sensory input.
Plan and develop branching programs with switch blocks nested inside loops.

Competencies

Total Learning Hours for Unit: 15

- Explain each parameter of the switch block configuration panel
- Program a robot to make decisions based on sensory input
- Explain how a fast switch block nested inside a loop improves detection behavior
- Build and program a robot to continuously detect objects
- Build and program a robot to follow a line
- Create a flow chart to design a hierarchical program
- Design, build and program a sumobot robot which pushes an opponent out of an arena

Unit 9: Get a Grip (using gripper arms and my blocks)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will design and build a robot that manipulates objects with a gripper attachment.

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills;
- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions;
- 1.6 Conduct self in a professional manner in practical career applications, organizational forums, and decision-making goals;
- 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals;
- 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:

Build robots that can grip and manipulate objects.
Plan and develop hierarchical programs.

Competencies

Total Learning Hours for Unit: 15

- Describe how computers chip are designed and manufactured
- Explain why computers chips are manufactured in "clean rooms"
- Build a robot with a gripper attachment
- Program a robot to coordinate object manipulation with sensor input
- Design a hierarchical program using my blocks
- Design, build and program a robot capable of sorting objects by color

Unit 10: Working with Data (using data hubs and wires)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will design and build a robot that use parameters passed from one block of their program to another.

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills;
- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions;
- 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals;
- 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:

Build and program robots that override block data with parameters passed from another block.
Plan and develop hierarchical programs which pass parameters between the levels of hierarchy.

Competencies	Total Learning Hours for Unit: 15
<ul style="list-style-type: none"> • Describe the purpose of a Data Hub in NXT-G • Explain the parameters on the Move Block Data Hub • Program a robot to move with a parameter driven from a Data Hub • Explain the different Data Types in NXT-G • Program a robot to display number-type data using Data Hubs and Conversion Blocks • Design a hierarchical program which passes parameters using data wires with advanced my blocks • Design, build and program a robot capable of line following under remote control 	
Aligned Common Core & Washington State Standards	

Unit 11: Variables and Logic (using variables, math blocks and Boolean logic)

COMPONENTS AND ASSESSMENTS

Performance Assessments:
 Student will design, build and program a robot that uses variable parameters, algebraic calculations and Boolean logic.

Leadership Alignment:
 1.1 Analyze, refine and apply decision-making skills;
 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills;
 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions;
 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals;
 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:
 Build and program robots that override block data with parameters passed from a Variable Block.
 Build and program robots that use algebraic combinations of multiple variables through Math Blocks.
 Build and program robots that use Boolean logic to control program flow.

Competencies	Total Learning Hours for Unit: 15
<ul style="list-style-type: none"> • Describe the purpose of a Variable Block in NXT-G • Explain the parameters on the Variable Block • Program a robot to write and read variables • Program a robot to display variables on the NXT screen • Describe the purpose of a Math Block in NXT-G • Explain the parameters on the Math Block • Program a robot to respond to algebraic combinations of variables using Math Blocks • Describe the Boolean logic data type and operators in NXT-G 	

- Explain the Boolean logic data plugs in various NXT-G blocks
- Program a robot to respond to a logic-controlled Loop Block

Unit 12: Data Logging with Sensors (using sensors for scientific experimentation)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will design experiments and program the NXT to perform scientific data logging of sensor readings

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills
- 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills
- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions
- 1.6 Conduct self in a professional manner in practical career applications, organizational forums, and decision-making goals;
- 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals
- 2.2 Demonstrate knowledge of conflict resolution and challenge management
- 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:

Program the NXT to perform real time data logging with NXT sensors.
 Program the NXT to perform remote logging with NXT sensors.
 Program the NXT to perform data logging with advanced sensors.
 Analyze logged data with NXT-G analysis tools and spreadsheets.
 Design, build and program a robot to perform active data logging.

Competencies

Total Learning Hours for Unit: 30

- Describe the role of data logging in the Scientific Method
- Program the NXT to perform real time data logging with NXT sensors.
- Program the NXT to perform remote logging with NXT sensors.
- Program the NXT to perform data logging with advanced sensors (real time and remote)
- Analyze logged data with NXT-G analysis tools
- Upload logged data to a spreadsheet for advanced analysis
- Program an embedded Data Logger into a NXT-G program
- Design, build and program a robot to perform active data logging with NXT-G

Unit 13: Advanced NXT Sensors (Bluetooth and third party sensors)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will design, build and program a robot that uses advanced (third party) sensors and Bluetooth communications.

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills
- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions
- 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals
- 2.2 Demonstrate knowledge of conflict resolution and challenge management
- 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:

Build and program robots that use Bluetooth communication
Build and program robots that use advanced third party sensors

Competencies

Total Learning Hours for Unit: 15

- Explain each parameter of the Bluetooth, Send Message and Receive Message blocks' configuration panel
- Program a robot to send and receive Bluetooth messages
- Design, build and program a robots that communicate to compete a group task
- Design, build and program a multi-NXT brick robot
- Import and install NXT blocks for third party sensors
- Explain each parameter of the third party block configuration panel
- Design, build and program a robot using third party sensors

Unit 15: Introduction to RobotC Programming (basic & precision movement)

COMPONENTS AND ASSESSMENTS	
Performance Assessments: Student will program Tetrax robots to move using both dead reckoning and odometry	
Leadership Alignment: 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed	
Standards and Competencies	
Standard/Unit: Create RobotC programs for dead reckoning movement of Tetrax robots (time and power based movement) Create RobotC programs for odometry movement of Tetrax robots (encoder based movement)	
Competencies	Total Learning Hours for Unit: 15
<ul style="list-style-type: none"> • Demonstrate proficient use of RobotC for Tetrax programming environment • Configure RobotC for Tetrax DC motor operations • Write, test and debug programs for Tetrax robot straight movement with dead reckoning • Write, test and debug programs for Tetrax robot turning movement with dead reckoning • Write, test and debug programs for Tetrax robot complex movement with dead reckoning • Write, test and debug programs for Tetrax robot straight movement with odometry • Write, test and debug programs for Tetrax robot turning movement with odometry • Write, test and debug programs for Tetrax robot complex movement with odometry 	

Unit 16: RobotC Manipulators (using servos)

COMPONENTS AND ASSESSMENTS	
Performance Assessments: Student will program Tetrax robots to use servo motors	
Leadership Alignment: 1.1 Analyze, refine and apply decision-making skills 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed	
Standards and Competencies	
Standard/Unit: Create RobotC programs for single servo operations on Tetrax robots Create RobotC programs for multi-servo operations on Tetrax robots Create RobotC programs for complex servo and movements operations on Tetrax robots	
Competencies	Total Learning Hours for Unit: 15
<ul style="list-style-type: none"> • Configure RobotC for Tetrax servo motor operations • Write, test and debug programs for Tetrax robot precision servo control • Write, test and debug programs for Tetrax robot precision multi-servo control • Write, test and debug programs for Tetrax robot coordinated movement and manipulator control • Write, test and debug programs for Tetrax robot coordinated movement and complex apparatus control 	

Unit 17: RobotC Sensors (using basic NXT sensors)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will program Tetrax robots to use the four basic NXT sensors

Leadership Alignment:

1.1 Analyze, refine and apply decision-making skills

1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions

2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals

2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:

Create RobotC programs using the touch, light, ultrasonic and sound sensors on Tetrax robots

Create RobotC programs for Tetrax robots using while, if/else, switch case and timer control constructs

Competencies

Total Learning Hours for Unit: 15

- Write, test and debug programs for Tetrax robots using the touch sensor
- Write, test and debug programs for Tetrax robots using the While loop
- Write, test and debug programs for Tetrax robots using the ultrasonic sensor
- Write, test and debug programs for Tetrax robots using the light sensor
- Write, test and debug programs for Tetrax robots using the If/Else
- Write, test and debug programs for Tetrax robots using the Switch-Case
- Write, test and debug programs for Tetrax robots using Timers
- Write, test and debug line following programs for Tetrax robots
- Write, test and debug programs for Tetrax robots using the sound sensor

Unit 18: RobotC Functions (using variables, functions and debugging)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will program Tetrax robots using variables and functions

Leadership Alignment:

1.1 Analyze, refine and apply decision-making skills

1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions

2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals

2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:

Create RobotC programs for Tetrax robots using variables to improve flexibility and efficiency

Create RobotC programs for Tetrax robots using functions to improve flexibility and efficiency

Competencies

Total Learning Hours for Unit: 15

- Demonstrate proficiency with variables and data types in RobotC
- Write, test and debug programs for Tetrax robots using variables and different data types
- Write, test and debug programs for Tetrax robots using variables for While loop. If/Else and Switch-Case control constructs
- Write, test and debug programs for Tetrax robots using functions
- Write, test and debug programs for Tetrax robots using variables within functions

Aligned Common Core & Washington State Standards

Unit 19: RobotC Teleop (Remote Control)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will program Tetrax robots for Bluetooth wireless remote control

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills
- 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills
- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions
- 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals
- 2.2 Demonstrate knowledge of conflict resolution and challenge management
- 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies**Standard/Unit:**

Create RobotC programs for Tetrax robot remote control movement through joystick commands
Create RobotC programs for Tetrax robot remote control manipulators through joystick button commands

Competencies**Total Learning Hours for Unit: 10**

- Demonstrate proficiency with establishing Bluetooth communication between PC and Tetrax robot
- Write, test and debug programs for Tetrax robot remote control of basic movement through joystick commands
- Write, test and debug programs for Tetrax robot remote control of optimized movement through joystick commands
- Write, test and debug programs for Tetrax robot remote control of manipulators and mechanical apparatus through joystick and button commands
- Write, test and debug programs for Tetrax robots combining remote control and sensor-based autonomous actions

Unit 20: RobotC Advanced Sensors (third party sensors)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will program Tetrax robots using advanced third party sensors

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills
- 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills
- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions
- 1.6 Conduct self in a professional manner in practical career applications, organizational forums, and decision-making goals;
- 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals
- 2.2 Demonstrate knowledge of conflict resolution and challenge management
- 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies**Standard/Unit:**

Create RobotC programs for Tetrax robots using an advanced third party sensors
Create RobotC programs for Tetrax robots using a sensor multiplexor and multiple sensors

Competencies**Total Learning Hours for Unit: 15**

- Demonstrate proficiency with installing third party sensor software
- Write, test and debug programs for Tetrax robots using a third party sensor
- Write, test and debug programs for Tetrax robots using a third party sensor multiplexor
- Write, test and debug programs for Tetrax robots using multiple sensors (LEGO and third party) and a third party sensor multiplexor

Unit 21: RobotC Multi-Robot Communication (using swarm robotics)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will program Tetrax robots for multi-robot communication

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills
- 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills
- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions
- 1.6 Conduct self in a professional manner in practical career applications, organizational forums, and decision-making goals;
- 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals
- 2.2 Demonstrate knowledge of conflict resolution and challenge management
- 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:

Create RobotC programs for Tetrax robots using Bluetooth communication between robots

Create RobotC programs for Tetrax robots using WiFi communication between robots

Competencies**Total Learning Hours for Unit: 15**

- Demonstrate proficiency with establishing Bluetooth communication between a PC and a Tetrax robot
- Demonstrate proficiency with establishing Bluetooth communication between two or more Tetrax robots
- Write, test and debug programs for coordinated task accomplishment with Tetrax robots using Bluetooth communication
- Demonstrate proficiency with establishing WiFi communication between a PC and a Tetrax robot
- Demonstrate proficiency with establishing WiFi communication between two or more Tetrax robots
- Write, test and debug programs for coordinated task accomplishment with Tetrax robots using WiFi communication

Unit 22: Software Design for Competition (FIRST® Tech Challenge)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will program Tetrax robots for competition in the FIRST® Tech Challenge, Science Olympiad or Science and Engineering Fair

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills
- 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills
- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions
- 1.6 Conduct self in a professional manner in practical career applications, organizational forums, and decision-making goals;
- 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals
- 2.2 Demonstrate knowledge of conflict resolution and challenge management
- 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:

Create autonomous RobotC programs for Tetrax robots competing in the FIRST® Tech Challenge

Create teleop RobotC programs for Tetrax robots competing in the FIRST® Tech Challenge

Competencies**Total Learning Hours for Unit: 40**

- Demonstrate proficiency with the setup and use of the FTC Samantha module
- Demonstrate proficiency with the setup and use of the FTC Field Control System
- Demonstrate proficiency with use of the FTC competition software templates
- Demonstrate proficiency with use of the FTC competition software checklist
- Write, test and debug programs for multiple FTC autonomous mode scenarios
- Write, test and debug programs for FTC teleop mode operations
- Demonstrate proficiency with software management techniques, including revision, backup, quality and reliability controls

Unit 23: CAD for Robots (Computer Aided Design of Tetrix Robots)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will design (Tetrix and/or NXT) robots in a 3-D CAD environment

Leadership Alignment:

1.1 Analyze, refine and apply decision-making skills

1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills

1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions

2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:

Design 3-D models of Tetrix robots with CAD tools

Manipulate and animate Tetrix robots in a 3-D CAD environment

Competencies

Total Learning Hours for Unit: 50

- Demonstrate proficient use of 3-D CAD environment
- Design and manipulate Tetrix structural sub-assemblies with CAD
- Design, manipulate and animate Tetrix active mechanical sub-systems with CAD
- Design, manipulate and animate complete Tetrix robots with CAD

Unit 24: Introduction to Tetrix Hardware

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will identify Tetrix components and best practices

Leadership Alignment:

1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions

2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:

Identify Tetrix hardware components and their uses

Demonstrate knowledge of Tetrix safety and best building practices

Competencies

Total Learning Hours for Unit: 10

- Identify Tetrix structure components and their uses
- Identify Tetrix mechanical components and their uses
- Identify Tetrix electronic components and their uses
- Demonstrate proficiency with Tetrix safety guidelines
- Demonstrate proficiency with Tetrix best building practices

Unit 25: Tetrix First Build (2WD platform with sensors)

COMPONENTS AND ASSESSMENTS**Performance Assessments:**

Student will build a basic Tetrix robot

Leadership Alignment:

- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions
 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies**Standard/Unit:**

Construct a two wheel drive Tetrix robot with all four basic sensors

Competencies

Total Learning Hours for Unit: 15

- Build and test a Tetrix robot chassis
- Demonstrate proficiency with DC motor installation and wiring, including encoders
- Build and test a Tetrix robot with a 2WD drivetrain
- Build and test a Tetrix robot with sound, light, ultrasonic and touch sensors
- Test front-wheel-drive, rear-wheel-drive, and various idler wheel combinations

Unit 26: Tetrix Manipulators (attachments using servo motors)**COMPONENTS AND ASSESSMENTS****Performance Assessments:**

Student will build Tetrix robots with active attachments

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills
 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills
 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions
 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals
 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies**Standard/Unit:**

Build Tetrix robots with active attachments utilizing both Tetrix servo and NXT motors

Competencies

Total Learning Hours for Unit: 15

- Demonstrate proficiency with servo motor installation and wiring
- Build and test an arm and gripper attachment
- Build and test a harvester and transporter attachment
- Build and test a dispenser attachment
- Build and test a launcher attachment
- Design, build and test a custom attachment

Unit 27: Tetrix Advanced Hardware (treads and chain/sprocket)**COMPONENTS AND ASSESSMENTS****Performance Assessments:**

Student will build Tetrix robots with advanced hardware

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills

- 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills
- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions
- 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals
- 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:
 Build Tetrix robots with chain and sprocket assemblies
 Build Tetrix robots with tank-tread assemblies

Competencies	Total Learning Hours for Unit: 15
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- Demonstrate proficiency with chain and sprocket assemblies
- Build and test a Tetrix robot with chain and sprocket propulsion
- Build and test a Tetrix robot with a chain and sprocket manipulator
- Build and test a Tetrix robot with beveled gear assemblies
- Demonstrate proficiency with tank-tread assemblies
- Build and test a Tetrix robot with tank-tread propulsion
- Build and test a Tetrix robot with a tank tread manipulator

Unit 28: Tetrix Custom Hardware (plexiglass & aluminum fabrication)

COMPONENTS AND ASSESSMENTS

Performance Assessments:
 Student will build Tetrix robots with FTC-legal fabricated materials

Leadership Alignment:
 1.1 Analyze, refine and apply decision-making skills
 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills
 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions
 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals
 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies

Standard/Unit:
 Build Tetrix robots with fabricated plexiglass assemblies
 Build Tetrix robots with fabricated aluminum assemblies

Competencies	Total Learning Hours for Unit: 15
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- Demonstrate proficiency and safety with plexiglass cutting, drilling and molding equipment
- Build and test a Tetrix robot with a fabricated plexiglass assembly
- Demonstrate proficiency and safety with aluminum cutting, drilling and manipulating equipment
- Build and test a Tetrix robot with a fabricated sheet aluminum assembly
- Build and test a Tetrix robot with a fabricated tube aluminum assembly

Unit 29: Tetrix Advanced Sensors (third party and custom sensors)

COMPONENTS AND ASSESSMENTS

Performance Assessments:
 Student will build Tetrix robots with third party and custom sensors

Leadership Alignment:
 1.1 Analyze, refine and apply decision-making skills
 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills
 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions

Unit 31: Introduction to Project Management

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will develop and execute a mock project plan

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills
- 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills
- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions
- 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals
- 2.2 Demonstrate knowledge of conflict resolution and challenge management
- 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies**Standard/Unit:**

Initiate and develop a detailed project plan
Execute and monitor a detailed project plan

Competencies**Total Learning Hours for Unit: 15**

- Demonstrate proficiency with conventions and tools for project planning
- Initiate a project plan, including project analysis, scope, stakeholders and charter
- Develop a project plan, including work breakdown, budget, schedule, roles/responsibilities and communication plan
- Execute a project plan, including resource acquisition/allocation, deliverables and quality assurance
- Monitor a project plan, including performance measurement, risk management and adapting to change
- Close a project plan, including post-project review

Unit 32: Applied Project Management (Competition)

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Student will develop and execute a detailed project plan for a *FIRST*[®] Tech Challenge competition, Science Olympiad or Science and engineering Fair

Leadership Alignment:

- 1.1 Analyze, refine and apply decision-making skills
- 1.3 Demonstrate oral, interpersonal, written and electronic communication and presentation skills
- 1.4 Be involved in activities that require applying theory, problem-solving and using critical thinking skills while understanding the outcomes of related decisions
- 1.6 Conduct self in a professional manner in practical career applications, organizational forums, and decision-making goals;
- 2.1 Communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals
- 2.2 Demonstrate knowledge of conflict resolution and challenge management
- 2.6 Use knowledge, build interest, guide, influence decisions, organize efforts, and involve members of a group to assure that a pre-planned group activity is completed

Standards and Competencies**Standard/Unit:**

Initiate and develop a detailed project plan for a *FIRST*[®] Tech Challenge competition
Execute and monitor a detailed project plan a *FIRST*[®] Tech Challenge competition
Close out a project plans for a *FIRST*[®] Tech Challenge competition

Competencies**Total Learning Hours for Unit: 30**

- Initiate a FTC project plan, including detailed project analysis and stakeholder identification/buy-in
- Develop a FTC project plan, including work breakdown, budget, schedule, roles/responsibilities and communication plan
- Execute a FTC project plan, including resource acquisition/allocation, deliverables and quality assurance
- Monitor a FTC project plan, including performance measurement, risk management and adapting to change
- Close a FTC project plan, including post-project review and documentation of learning/best-known-methods