iSTEM StarLAB: Design for Space Year 9

Duration:
Term 1 – 3; National Mars Rover Challenge Term 3

Version: 1 (January, 2017)

Date:

Teacher:

Assessment:

iSTEM Module(s)

Focus:
Core 1 - STEM Fundamentals 1
Core 2 - STEM Fundamentals 2
Core 3 - Mechatronics 1
Core 4 - Mechatronics 2
Elective 6 – Motion
Elective 12 - Design for Space

Supporting / Optional:
Elective 7 – 3D CAD/CAM
Elective 9 or 10 – Minor or Major Project
Elective 13 – Statistics in Motion

Summary:
Explore the concept of Mars and space exploration through the practical application of STEM fundamentals and Mechatronics using StarLAB's space geared learning platform and hardware. Students will learn computer programming, robotics and data analysis with optional extension learning in motion, renewable energies and statistical representation with the culminating goal of competing in a national competition.

The Mars Rover is the centrepiece of the StarLAB education system. Students get hands-on with hardware to build a Mars Rover, and learn how to apply their software coding and robotics skills to give it life. They can program the Rover to sit, stay, and navigate alien terrain. Students can also connect with other STEM students across Australia to creatively problem solve in the National Mars Rover Challenge!

- All Python and Robotics course material is supplied via the StarLAB Moodle.
- The learning program below uses a "stacked" learning approach which enables students to learn portions of Python then apply their knowledge to experimenting with the StarLAB hardware. Alternatively, students can complete the Python lessons sequentially prior to commencing the Hardware lessons. Hardware lessons should be completed before Robotics Rover lessons.
- Approximate time for completion of StarLAB Moodle lessons is 60 – 80 minutes each
- Inquiry questions are embedded throughout to encourage teacher facilitation and student investigation of STEM concepts in both theory and practice.
- **Teaching / Learning Codes: T** = Teacher, **S** = Student, **C** = class, **G** = group
- **Advancing and Developing** are indicators of achievement levels or suggestions for differentiation to support students at various learning levels which can be further supplemented with extension activities.
- **Extension activities** are optional and designed to appeal to a variety of learners. These activities could be used as mini projects or expanded for major projects to meet further iSTEM outcomes.
- All links to external videos and websites, other than StarLAB content, are provided for teacher reference only and should be watched or reviewed prior to use to determine suitability for individual classroom use as per teacher discretion.

Prior to starting this unit of work, discuss the following with your IT Administrator:

- Install Python 2.7 on the school network for student use. Installation instructions can be found on the StarLAB website http://www.starlab.education/setupor use the portable python option which doesn't require installation (provided on the StarLAB USB along with additional software)
- Disable any ad-blocking software for our website, entirely.
- Disable any tracking-blocker software for our website, as we use cookies.
- Enrol students / check enrolments for the external StarLAB Moodle course. Login details will be distributed by StarLAB.
- Your school/institution must allow Vimeo videos through the firewall.
- Teacher & Students cannot be logged into more than 2-3 devices per login account.
- Lesson Python 0 via the StarLAB Moodle is available to guide student through the installation of Python 2.7 for BYOD or home computers.

Key Inquiry Questions:

1. Why should I learn Python?
2. What are algorithms, pseudocode and flowcharts?
3. What are the common coding mistakes and what strategies can I use to fix them?
4. What is a micro-controller?
5. What sensors are available and what type of data can be collected?
6. How do each of the sensors work and how are they controlled by code?
7. What are the impacts of software (coding) in the past, current and future space program?
8. What is Australia's past, current and future involvement in space exploration?
9. How is robotics used in NASA programs?
10. How does magnetism, velocity, inertia, momentum and acceleration affect mechanical motion, navigation and human movement on Mars?
11. What energy sources are available on Mars?
12. What are the potential scientific roadblocks to a successful Mars mission?
13. What tools can I use to collaborate on and manage my project?
14. What data have I collected and how is the best way to model it?
15. What creative ways can I use the sensors or what other problems can I use them to solve?

Learning Intensions:

- Computational Thinking – Python Coding
- Data Collection & Simulation – StarLAB Hardware Sensors
- Creative Problem Solving – Mars Rover Challenge
- Collaboration – Mars Rover Challenge
- Experimentation – In Class Experiments using StarLAB Platform
- Investigate Space – StarLAB Platform & Supplement Materials
- Opportunities for expanded learning – Motion, Renewable Energy & Statistics

Theory Topics:

- Computer Science, Mechatronics, Motion, Electromagnetic Spectrum, Ecosystems, Energy & Cultural Perspectives
- Consistently underpinned with applicable Mathematics & History concepts

Teaching and Learning program written by Peggy Mangovski on behalf of RDA Hunter ME Program

Equipment / Software Required:

StarLAB Moodle Access (Student & Teacher Accounts)
StarLAB USB
Python 2.7.9
StarLAB Hardware Platform
Rover Kit
Internet / Computers

Optional:

Office Suite (Word Processor / Spreadsheets)
Image Editing or Graphic Design software
Cloud Storage (Google Drive, One Drive, etc)

Supplementary Resources:

NASA scientific and visualisation tools (website)
NASA Mars 1 year Simulation (article)
Ancient Aboriginal Star Maps (article)
Star Maps and Aboriginal Song Lines (article)
Lockheed Martin Virtual Mars Field Trip (videos)
Make Mars Home Simulation (website)
NASA's Hidden Figures (website/videos)
Women@NASA (website/biographies)
Margaret Hamilton's Code to the Moon (article)
Curiosity Rover Mission (website)
Additional Python Tutorials - Codecademy (interactive tutorials) or HelloWorld (video tutorials)
Physics Classroom (website interactive tutorials & teaching resources)
Lucid Charts – (free software) flowchart & diagramming
Computer Science Unplugged – (non-computer based activities)

All links to external videos and websites are provided for teacher reference and should be watched or reviewed prior to use to determine suitability for individual classroom use as per teacher discretion.

Teacher Resources:

StarLAB Teacher Resources
Moodle modules are self-guided and support different ability paces.

Outcomes	Teaching & Learning Strategies	Differentiation Strategies	Registration
StarLAB 2.3 12.1 **Extension** 1.2 9.2 12.1	**Your First Program (Python)** *Students will familiarise with the StarLAB Moodle learning platform to begin introductory lessons in the Python programming language.* • **Note:** Python 2.7 should be installed on your school network by your administrator prior to starting this learning program. **T:** Introduce unit of work. Direct students to or display Obelisk's website http://www.starlab.education/tech/ **C/G/S:** Discussion or Investigation • What is Python? • Why Should I learn Python? • Who was the first programmer? **T:** Demonstrate how to access StarLAB Moodle using Python Lesson 1 **S:** Python Lesson 1 • Print statement • Syntax error correction **G/C:** Discussion or investigation • What is the significance of 'Hello World' in programming? • Who created Python? • What type of language is python? • Find examples of software made with Python	**Advancing:** • Apply coding skills for syntax correction • Create additional print statements ie: About Me (name, hobbies, likes, dislikes, etc.) **Developing:** • Understand the basics of coding to create output statements • Pair or cluster learners to complete Moodle activities **Extension Activities:** **S:** Complete a KWL chart focusing on the areas of either Python, StarLAB / Obelisk **G:** Create a short digital presentation about the history and significance of "Hello World" **S/C:** Create and maintain a record of learning using a blog (WordPress, Blogger, Weebly, etc.)	
StarLAB 2.3 4.2 12.1 **Extension** 1.2 9.2 12.1	**Variables, Types & Assignment (Python)** *Students will investigate the basics of computer architecture and Computer Science while furthering their skills in the Python programming language. Students will also develop logical thinking skills by learning to flow chart algorithms and apply mathematical skills to develop basic algorithms.* **Tips:** • Use split screen to watch/follow along with the video while typing the code. • Students can copy and paste code; encourage students to modify code examples and screen capture results which can be used in their learning journal. **T:** Introduce the concept of how computers work and think • How a computer works	**Advancing:** • Experiment with additional mathematical operands (-*/) and or create additional customised swap messages • Apply mathematical and logical thinking skills to interpret and create solutions using binary or cryptology • Write flowcharts or pseudocode for multiple step algorithms using decisions **Developing:** • Teacher modify Lesson 2 Code File to create simple errors in the code (syntax or missing semicolon) for students to correct using pen and paper. Provide	

	• Importance of Binary in Computer Science **S:** Develop understanding of the Binary (Base 2) Number System • Learn Binary • Write own name using binary **C/G:** Discussion or Investigation • What is Computer Science? • How does a computer use binary to complete actions? • How is Binary different than our Decimal number system? • Are there any other number systems? **T:** Introduce the basic concepts of flowcharts and or pseudocode to provide students with a visual / symbolic understanding of code providing metacognitive tools for problem solving in later activities. • Overview - why learning to use flowcharts & pseudocode are important. • Level 1 Flowcharts & pseudocode - Learning key terms, symbols & practical activities. • **S:** Create flowcharts of python activities completed. • Level 2 video could be used as review material for concepts covered in the StarLAB Moodle lessons. **S:** Complete StarLAB Python Lesson 2 • Assign integers & strings • Simple mathematical calculations • Print statements. • Classic Swap Exercise • Quizzes **T:** Key Concepts to Computer Science • Moore's Law– transistors, binary & quantum computing • Encryption – Introduction to ciphers & history of computer cryptology • Internet of Things (IOT)– Future of computing **S/G:** Discussion or Investigation • What is a Cipher? • What is Cryptology? • How has encryption changed over time?	correct answers (similar to a cloze passage technique) • Understand and apply basic decoding skills for binary • Read and interpret flowcharts or pseudocode for basic algorithms **Extension Activities:** **T/C/G/:** Hands on activity to simulate how a computer works; downloadable activity builds logical thinking skills and reviews Cartesian plane mathematics **S:** Complete Algorithm Challenges in flowcharts or pseudocode **S:** Investigate the different data types used in programming then create a short digital presentation with examples based on a favourite game **S/G:** Write a short secret message or the answer to a joke in binary to share with the class. Decode messages or answers. This can be done with paper or using online interactives (decode cipher or create a secret message). **T/C:** Create a treasure hunt with certain key words in Binary or a Cipher technique • ***Challenge:*** first student to decode and find all the objects wins a prize. **S/G:** Create a video or podcast interview with one of the following historical figures in Computer Science about the significance of their contribution: Charles Babbage, Ada Lovelace, Alan Turing, Gordon Moore or John Von Neumann **S:** Create an artistic mural, collage or timeline of a significant Programmer, Computer Scientist or past technology that has led to advancements in Computer Science **C/G:** Talk like a computer - simulated Turing Test activity **C/G/S:** Cryptographic protocol activities – Peruvian coin toss	

	• What are the challenges of technology innovation and Moore's Law? • How has and will the Internet of Things impacted the world? • What is the relationship between Moore's Law, Encryption & IOT?		
StarLAB 1.2 2.3 3.1 6.2 9.4 12.1 12.2 12.4 **Extension** 1.2 2.3 9.1 9.2 9.3 9.4 9.5 12.4 12.5	**Introducing the hardware (StarLAB Hardware)** *Students will familiarise with the StarLAB hardware equipment to learn how to control sensors while exploring the role of atmospheric conditions in maintaining habitable ecosystems which is a key component of current and future space exploration.* **T:** Demonstration of StarLAB Hardware **S:** Identify hardware components **C:** Discussion • What is an API? • How does an API work? • What is the purpose of an API? **S:** Complete StarLAB Hardware Lesson 0 – • Familiarisation with hardware • API setup **C:** Discussion • What is a microcontroller? • What sensors are available and what type of data can be collected using StarLAB hardware? • How are microcontrollers used in space? (Satellites, ISS, Radio waves, Rockets) **S:** Complete StarLAB Hardware Lesson 1 (part 1 – 6) • collecting data with sensors (thermometer, barometer & ambient light) **G:** Investigation with examples • What is a terrarium? • Are there different types of terrariums? • How do terrariums work? • How and why would terrariums be used in space exploration? • How does the water cycle impact on ecosystems? ○ NASA water mining robot **S:** Complete StarLAB Hardware Lesson 1, Part 7 – My first terrarium	**Advancing:** • Ability to assist classmates with installation of API and connection of hardware • Theoretical understanding and practical application of sensors to determine atmospheric impacts on ecosystems **Developing:** • Identify the purpose of StarLAB hardware components • Understanding of sensor hardware to determine atmospheric conditions **Extension Activities:** **S:** Using the StarLAB website, investigate each of the sensors available to create a report, brochure or digital presentation explaining the function of each sensor **S:** Create, monitor, record and model the progress of a simple enclosed terrarium - light bulb or plastic bottle **S:** Design a 3D model or poster for a terrarium based on specific environmental conditions or animal life needs (rainforest, desert, frogs etc.) **S:** Collect temperature and barometer readings in various locations throughout the school to analyse data and create graphs of conditions / variations • **Challenge:** repeat at the start and end of the unit or at varying times throughout the unit; analyse and graph data **G:** Create a simple solar still. Investigate efficiency of solar stills and water purification techniques then suggest improvements or create a prototype with increased efficiency	

	• Simulate atmospheric conditions using input and output hardware • Create a flowchart for the My First Terrarium program		
StarLAB 2.3 3.1 4.2 6.1 6.2 12.1 **Extension** 1.1 1.2 6.1 9.1 9.2 9.3 9.4 9.5 12.4 13.4 13.5	**Using Inputs & Outputs (StarLAB Hardware)** *Students will use and correct (debug) python code to manipulate and create logic operators to control input sensors and outputs devices. Students will also explore the science and mathematics of electricity while creating and experimenting with electric circuits in a simulated environment to develop a foundation for further study in electro-mechanics and motion.* **C:** Discuss the difference between inputs and outputs in real life examples, such as websites, games, contact forms & surveys. **S:** Complete Python Lesson 3 – User Inputs (Integers, Strings) **T/C:** Discuss or investigate examples of error types (syntax & logic). **S:** Complete StarLAB Hardware Lesson 2 – User Inputs **G:** Investigate famous error types and strategies for detecting / fixing errors. **S:** Complete Python Lesson 4 • Boolean (True, False) & Operators (And, Or, ==, =, <, >, =) **T/C:** Explain or discuss • What is Binary? • Compare Binary & Boolean • Differences between Boolean Data Types (True, False) vs Boolean Logic Operators (And, Or, Not) • Distinguish between various operators. **S:** Complete StarLAB Hardware Lesson 3 • User Outputs (Screen, OLED, LEDs & Buzzer) **G:** Identify the input and output mechanisms on the StarLAB board. **T:** Introduce or review electric circuits • Types of current and voltage • Circuit Types – series & parallel (basic & standard) • Electrical components – resistors, capacitors, diodes, transistors • OHM's Law **S/G:** Discussion or investigation • How is electricity measured, calculated and controlled in a circuit? • What type of circuits are used in the StarLAB hardware? • What is the difference between AMPs, VOLTs & OHMs? **S:** Create and experiment with circuit diagrams	**Advancing:** • Understand and apply logical processes to debug code and apply multiple logic operators to create functional code • Apply knowledge of electric circuits and components to create complex parallel circuits with switches to control light, sound and or motors; calculate current and illustrate circuits **Developing:** • Use of logical operators to create code • Apply knowledge of electric circuits and components to create and illustrate simple circuits **Extension Activities:** **S/G:** Investigate the use and importance of validation for user input. Using Google Forms or Survey software, create a survey that uses data validation **S:** Find two websites, internet forms or game examples of ineffective user inputs or output messages and suggest suitable / appropriate fixes **S:** Case Study – Admiral Grace Hopper (Software engineer), Margret Hamilton or NASA's Hidden Figures **S:** Design a collaborative experiment using sensors to input and output data. Use data modelling tools (excel, infographic creator) to analyse and present findings (data represented as statistics) **G:** Using the LEDs output, program a synchronised light show to a 10 - 30 second snippet of music **S:** Design a circuit diagram for an input or output device for StarLAB. This could be an existing I/O or a new feature **S:** Create an electric circuit using a lemon or potato	

	• Intro to 123 AutoDesk • Light a LED with resistor • Measure Current • Measure Voltage		

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	Decisions & Loops (Python & StarLAB Hardware)
	Students will further their computer programming skills to use logic and scenario parameters to make code based decisions and learn to efficiently repeat steps using sensor data. Students will also explore the mathematical formulas and scientific properties of waves through both theory and practical activities to establish a foundation for further study in the electromagnetic spectrum.
	
	T/C: Discussion - How do decisions affect programs? What type of decisions can be used and how are they different?
	S: Complete Python Lesson 5 – Decision Making & Conditions (If, If else, elif)
	T/C: Discussion –
	• How is Maths used in computer programming?
	• Give examples of how real life software solutions, such as Facebook, Google Maps or Games (Battlefield, Sims, WOW etc.) use Maths.
	S: Complete Python Lesson 6 – More involved Math (Multiplication, Division, Power, MODULO, Includes)
	• **S:** Experiment with coding mathematical algorithms
	• **S:** Create flowcharts based on coding activities.
	T: Demonstration / activity– using two or three different types of small objects (marbles, cotton balls, gummy bears, M&Ms, etc.) and small clear containers, demonstrate the process of decision making to sort the objects into the containers. Conditions to be met:
	• Same objects into the same container or based on size, colour, etc.
	  ○ **S:** Write out instructions (pen & paper) using *If*, *If else* or *elif* based on properties of the object.
	  ○ **C:** Discussion – is making multiple repetitive decisions using an If or If else efficient based on the number of decisions and objects or properties of objects?
	• Introduce the concept of decisions that use multiple repetitions. While container one is empty, fill with object one (Pre-test loop)
		Advancing:
		• Modify and extend skills in multiple decisions and loops to create functional code with the ability to apply knowledge in the creation of accurate flowcharts
		• Articulate the relationship between radio waves and light waves in the creation of a Theremin
		Developing:
		• Create mostly accurate flowcharts to represent the use of decisions and loops in python activities
		• Use of light waves to create a Theremin device
		
		Extension Activities:
		S: Write code to combine mathematical operations to solve complex word problems involving loops or decisions
		S: Write code to create calculator for common mathematic problems such as area, volume, perimeter, etc.
		• ***Example:*** Farmer needs to calculate the area of his paddock based on user inputs
		S: Create an instruction flowchart to complete a daily task that uses repetition (tying shoe laces or washing dishes) clearly indicating multiple decisions / conditions and the use of loops
		C/G: Using a logic game from CoolMaths (Aztec Escape), determine the use of inputs and outputs to users (instructions, controls, triggers, processes, decisions etc.)
		• **C:** Identify the inputs, outputs and loops /decisions for the start screen & level 1.
		• **G:** Write instructions or flowcharts to solve level 1 (Move right x2 etc.)	

	○ **S:** write out instructions for repetition (While loop) and compare the number of lines to the previous. ○ **C:** Discussion – What happens if the objects are gone but the container isn't full? (Loop isn't closed – infinite loop) • Introduce the concept of counting in loops. Only the first four of the same object are placed in container two and the next ten are placed in container three (Counted Loop) or five blue M&M's go into container then eat one and repeat until all the blue are gone (Counted & Post-test Loop). ○ **S:** Write out instructions for counted loop. ○ **C:** Discussion – How can the ability to loop or repeat instructions be used in real life coding problems or special equipment used in STEM industries? **S:** Complete StarLAB Python Lesson 7 – Loops • **S:** Code Post-Test, Pre-test and Counted loops • **S:** Code a guessing game using inputs, outputs and loops • **S/G:** Choose a scenario (Spacecraft, Submarines, Aircraft, etc) and write out instructions (pseudocode or flowcharts) using loops to solve a problem or accomplish a task related to their chosen scenario. **T/C/G:** Discussion or Investigation • What are Radio Waves? ○ **S:** Identify/explain/illustrate the properties of waves – hertz, band, frequency, amplitude ○ Impacts of radio waves on our daily lives (uses, device, etc) ○ Importance of radio waves in space exploration or travel ○ Radio waves in deep space – current theories or discoveries • What is the electromagnetic spectrum? • What is a Theremin and how does it make music? • Can light be used to create a Theremin device? **S:** Complete StarLAB Hardware Lesson 4 – Spectrum (using sensors for output based on looping / decision based mathematical calculations for distance and light levels) **T/C:** Discussion/Investigation – • What are the differences and similarities between radio and light waves?	**S/G:** Create a YouTube style video that demonstrates the programming concepts of decisions and loops using everyday objects **S/G:** Investigate a chosen light sensor Ambient Light, UV, IR. Create a diagram labelling the components with a short description of how the sensor receives, process and utilises light. • ***Challenge:*** creation of an exploded CAD diagram **S:** Investigate the electromagnetic spectrum and the impacts on our daily lives **S:** Research, design and create a timeline diagram or infographic depicting the significant discoveries, advancements and inventions based on radio waves with either a focus on daily life or space exploration **S/G:** Create a short animation explaining the function of a chosen device that uses radio waves **S:** Write a report comparing the different waves on the electromagnetic spectrum and their uses with examples • ***Challenge:*** include the past, current and emerging scientific theories or technological advancements **C/G:** Using the buzzer and lessons learned in the Spectrum activity, plan, design and play a StarLAB "Theremin" based on a short snippet of chosen music • ***Challenge:*** Groups could compete for the best Theremin inspired rendition	

	• How do light sensors work? • What type of light is visible to human eye? • How are light sensors used in space vehicles or transportation?		
StarLAB 2.1 2.3 4.2 6.2 6.3 6.4 12.1 **Extension** 1.2 2.3 6.1 6.2 6.3 6.4 6.5 7.1 9.1 9.2 9.3 9.4 9.5 12.1	**Functions & Arrays (Python & StarLAB Hardware)** *Students will apply Python's mathematical and built in functions to store and manipulate sensor data. Practical activities will allow students to experiment with the principles of motion and electromagnetic fields using StarLAB hardware.* **S:** Complete Python Lesson 8 - Creating & Calling Functions • Function inputs & outputs • Apply mathematical operations • Modifying and streamline code for re-useability **T/C:** Discussion or Investigation • What is the purpose of functions in code? • How do functions improve programmer efficiency? • What is the difference between built in functions and functions that I write? • What are common python functions? **S:** Complete Python Lesson 9 – Arrays • Len & List functions • Create, modify & transverse lists • Functions with multiple decisions • Random numbers • Iteration (repetition) in Arrays **T/C:** Discussion • What is an array? • How does the use of array improve program / coding efficiency? • Give an example of how arrays could be used in real-life examples, such as games, apps or social media (high score list) **S:** Complete StarLAB Hardware Lesson 5 – Inertial Measurement • Use sensors to investigate and measure Acceleration, Rotation and Magnetism • **C:** Discussion or Investigation ○ Give examples of how mobile devices use accelerometer and gyroscope sensors.	**Advancing:** • Create own functions and variables for common mathematical concepts (area, volume, Laws of Motion) to create a personal library of reusable code for future activities • Expand the game controller code to include a new feature or control another object • Understanding of the relationships within the electromagnetic spectrum between electric fields and magnetic fields **Developing:** • Modify function code to change the input and output statements to ask additional questions or create another list based on the scenario • Understanding of how magnetism affects motion **Extension Activities:** **S:** Choose a mobile game that uses an accelerometer or gyroscope for game play. Explain how the use of these sensors can help or hinder the user or game? **S:** Investigate the use of the python LEN and List functions to count the number of characters in a string or characters in a list as an introduction to randomisation. Modify the 'Gift Giving' code to accept multiple inputs for gifts and generate an output based on the number of characters in the user's name or the number of items in a list • ***Challenge:*** include the use of mathematical operations to increase the appearance of randomisation. **C/G:** Create a text based 'Choose Your Own Adventure' game using mathematics, decisions, lists and functions. • ***Challenge:*** incorporate StarLAB sensors to determine choices in the game	

	○ How does magnetism affect acceleration and rotation? • StarLAB Electromechanical devices and electromagnetism **S/G:** Investigation of electro-mechanics • What does an electromechanical engineer do? • How are electromechanical systems used in space or space exploration? (Rockets, Satellites, Probes, Telescopes, ISS etc.) • How is energy controlled and or powered by electromechanical devices? • How do electromagnetic fields affect our daily lives and or space exploration? **T/G:** Discussion or investigation • What is motion? • How do you calculate and measure motion? • Experiment with the 3 Laws of Motion using interactive simulations. • What forms of energy can used to create motion?	**S/ G:** Investigate electromagnetism and its use in transportation – trains, cars and home energy or automation **S:** Choose an electromechanical device used in space and create an exploded 3D model using technical drawing or CAM to demonstrate the components of the device with a brief description on how it functions **S:** Research the impacts of Electromagnetic Fields on the human body and the common sources of EMF in the home; create a digital presentation or infographic to present findings	
StarLAB 1.2 2.3 12.1 12.3 12.5 **Extension** 1.1 1.2 2.3 9.2 9.4 9.5 12.1	**Classes & Games (Python)** *Students will learn the basics of Object Oriented Programming to create mini games using StarLAB sensors. This section further develops problem solving and mathematical skills as well as developing essential skills for future success in the Rover Robotics competition.* **T:** Introduce the concept of Programming Paradigms • Procedure vs Object Oriented Programming (OOP) languages - Video • Introduction to Classes **C:** Discussion • What is a Class? (blueprint for an object) • What are the main components of Classes? (objects, attributes & methods) • How does using Classes benefit programmers? (faster to code, reusability, reduces likelihood of errors & easier to maintain) **S:** Complete StarLAB Python Lesson 10 - Classes • Creating classes • Instantiating objects • Defining attributes & methods • Using Classes to calculate the area of a Prism • Apply knowledge of classes to create a small artwork	**Advancing:** • Create multiple objects for multiple classes to create functions with output statements • Use multiple built-in Python functions to modify games **Developing:** • Modify classes and objects (attributes & methods) • Use the Random function to create functional games **Extension Activities:** **S:** Create flowcharts for one of the games using the random function **S:** Research games made with Python to create a timeline or digital presentation **S:** Expand artwork code or game code to incorporate the use of sensor data in the program **S/G:** Create a multiplayer game • Battleship • Lines using PyGame	

	S: Complete StarLAB Python Lesson 11 – Fun & Games
	• Use the Random function to create
	  ○ Dice Game
	  ○ Number Guessing Game
	  ○ Magic 8 Ball Game
		○ StarLAB lessons provide the basics of learning python which can be applied to other solutions and software, such as PyGame (requires additional software installation and learning outside of what is provided as part of this iSTEM teaching and learning program).	

StarLAB 1.1 1.2 12.1 12.2 12.3 **Extension** 1.1 1.2 2.2 7.1 7.4 9.2 9.4	**Cameras & Space Exploration (StarLAB Hardware)** *Students will explore the history and principles of Astrophotography, digitising of light and mechanical functions of cameras. This section builds on the previous learning in the electromagnetic spectrum, sensors and Computer Science.* **T/C:** Review of light waves **T:** Introduce the concept of Astrophotography • History of Space Photography **S/G:** Research and compare the technical specifications of imaging equipment throughout history to the specifications in their mobile phone or device. (Examples: Lunar Orbiter 1, Apollo 11, Hubble Telescope, Mars Rover) **T/C/G/S**: Science of Photography • Photoelectric Effect (video) • Properties of Lenses (video) • Science of Lenses (video) • Or a more simplified explanation of how Photography works (website) **T/C:** Discussion or Investigation • How do we manipulate crystals for traditional film and digital photography to produce an image? • How does the speed of light impact on photography? • What type of light waves can be captured using different types of camera sensors? • How does the size and shape of lenses change an image? • How does aperture and shutter speed affect images? • What is spatial and tonal sampling? • What roadblocks or challenges exist in Astrophotography compared to photography on earth? **T:** Mathematics of Colour Codes	**Advancing:** • Write code to create an image recognition program • Understanding of chemical reactions in photography and the relationship between photography and electromagnetic spectrum **Developing:** • Use an image editing program to stitch together images taken using the magnetometer and accelerometer data • Understanding of concave and convex lenses **Extension Activities:** **S:** Compile or create an image gallery slideshow of his/her favourite space images spanning from the start of the space program to current space missions **S/G:** Investigate the elements used in the processes of creating film and digital images • ***Challenge:*** create a poster, infographic or digital presentation to demonstrate the chemical compositions and reactions in photography **G/S:** Investigate how a chosen camera mechanically functions • ***Challenge:*** create a cardboard prototype to demonstrate concepts **S:** Create or find a pixel art image of earth. Using a graphics editor program (ie: Adobe Photoshop or any program with a colour picker tool); find and label the RGB /Hexadecimal colour codes **S:** Investigate the different types of cameras or career options using photographic equipment	

	• Code side of colour – understanding Hexadecimal codes
	• RGB – Mathematics of digitising colour
	• **C:** Discussion –
	  ○ How do Computers and Humans see or understand colours differently?
	  ○ What is a pixel and how do they affect image quality?
	S: Complete StarLAB Hardware Lesson 6 – Camera
	• Digitizing light
	• Calling and disabling StarLAB Camera functions
	• Coding sensors to create panoramic photos
		S: Chose a camera (GoPro, Polaroid, popular DSLR, space telescope, etc.)
		• ***Challenge:*** Create a 3D exploded CAD drawing to label each of the primary components	

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Extension
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	Hello Rover (Rover Robotics)
	Students will build upon and expand their knowledge of motion and electricity to experiment with motors to control the StarLAB Rover equipment. This section will develop essential skills for the Rover Robotics Competition. Students will also begin to investigate the use of energy and robotics in space exploration.
	
	T/S: Review
	• Electromechanical devices – give examples
	• Laws of motion
	• API &Hardware Library
	T: Introduce the concept of motors and how they work
	• S: Explore the concept of electric motors and electricity efficiency
	  ○ Who was Michael Faraday?
	  ○ What role does current and voltage have in creating? electromagnetic fields?
	  ○ What are the mathematical formulas for calculating electrical charges, electrical efficiency and the cost of energy?
	  ○ What is wasted energy?
	T/C: Discussion
	• What are the past, current and future role of computer code in space?
	• How do the laws of motion affect or are used in robotics? Give examples.
		Advancing:
		• Apply knowledge of electromechanical devices and the laws of motion to modify pre-programmed settings for motors
		Developing:
		• Understanding the laws of motion in relation to motors and robotics
		
		Extension Activities:
		S/G: Create a podcast interviewing an inventor responsible for past, current and emerging technologies in motion or energy
		• How did or will their contribution impact on daily life?
		S: Research different types of motors. Create a timeline or infographic.
		• Compare functionality, pros & cons
		• Evolution of motor technology
		S: Compare NASA robots
		• Technical specifications (sensors)
		• Mission objectives
		• Construction materials
		• Applications for Mars Rover technology on earth. (Nissan automated cars).	

	• How do robots use sensors? • When did the Mars Rover program start? • What types of robotics are used in space exploration? **S:** Explore the NASA Mars Rover website • Missions • Technology • Rover Discoveries • How Rovers drive on Mars? **S:** Complete StarLAB Robotics Rover Lesson 0 • Familiarise with the Rover API • Connecting remotely • Execute demonstration code **T/C:** Discussion or Investigation • What is a DC brushless motor? • What is the difference between brushed and brushless motors? • Why do robots have multiple motors? • How does a brushless motor work? • Are there other types of motors and how do they work differently to a brushless motor? **S:** Complete StarLAB Rover Robotics Lesson 1 – Using Motors • Using motors to control pre-programed motion (direction, speed & bearing) • Controlling individual motor speeds **S:** Create flowcharts to represent the pre-programmed motion code	**S/C:** Experiment with magnetism to create simple electric motors or simple electric trains. • ***Challenge:*** build a car or train with a class race day. • ***Challenge:*** Combine with dominos to make creative challenges using forces of motion. **S:** Investigate the concept of Faraday cages and impacts on the flow of electricity **S:** Using a spreadsheet program (Excel or Google Sheets) identify and record the number of light bulbs and electrical devices in the home or a specific room in the home (number of items, efficiency rating, current, voltage, cost to run, etc). • ***Challenge:*** Develop a plan or strategy to improve the home's electricity cost & usage. **S/G:** Investigate the use of mains electricity and alternative energies for daily use. • Create a model (paper or 3D) or digital presentation (animation, how to video or infographic) to demonstrate how electricity works (life cycle of energy, efficiency, cost, etc.)	
StarLAB 1.2 2.3 3.1 3.2 4.1 4.2 6.1 6.2 6.4 6.5 12.1 12.2	**Sensing & Navigation (Rover Robotics)** *Students will use sensors and mathematics to develop essential skills in rover navigation and obstacle avoidance. This section builds upon their knowledge of magnetism and motion to program the rover to adjust to terrain differences. Students will also investigate the principles of and cultural contributions to technological advancements in navigation.* **T/C:** Review & Discussion • Sensors used for detecting distance & motion • Why is it important to avoid obstacles? **S:** Complete StarLAB Rover Robotic Lesson 2 – Distance Sensor • Sensing and calculating object distance	**Advancing:** • Using a variety of sensors and writing code to complete complex navigation and solve problems for obstacle avoidance • Identify scientific principles affecting space navigation • Applying coding skills to accommodate terrain changes in robotic navigation **Developing:** • Modifying code to sense and avoid objects	

12.3
 	
Extension
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9.5
	• Using sensors to avoid obstacles
	T/C: Investigate ancient, non-mechanical & digital methods of navigation.
	• **G/S:** Case study of cultural or historical navigation techniques
	  ○ Aboriginal Song Lines and the relationship to astral objects.
	  ○ Norse navigation technology
	  ○ Han & Song Dynasty's magnetic compasses
	• **G/S:** Compare traditional compass navigation to GPS navigation.
	  ○ What is a bearing and why is it important to navigation?
	  ○ How do magnetic fields affect navigation?
	  ○ How do satellites transmit information used for navigation?
	S: Complete StarLAB Rover Robotics Lesson 3 – Magnetometer Sensor
	• Calculate bearing using magnetometer
	• Turning using bearing and degrees
	T/C: Discussion or Investigation
	• Why are we using magnetometers to determine bearings on the rover?
	• How do rovers obtain bearings or navigate on Mars?
	S: Complete StarLAB Rover Robotics Lesson 4 – Advanced Accelerometer & Gyroscope Sensing
	• Using accelerometer & gyroscope for navigation
	• Determine terrain tilt and calculating slopes
	• Mapping an area's slope
	• Create flowcharts to represent the above activities
	T/C: Discussion or Investigation
	• How is the terrain of Mars similar to or different than Earth?
	• Is navigating in space different than navigating on planets?
	• How do atmospheric conditions affect navigation?
	• S: Explore Mars
	  ○ 3D Images or 3D Models
	  ○ Games (requires installation of Unity Web Player)
	  ○ Panoramic Viewer
	  ○ Visualisations
	  ○ Virtual Reality
	  ○ Simulation experiments – 1 Year experiment on Earth (article) & Making Mars Home (website simulation)
		• Apply the core principles of navigation to solve problems
		• Understanding the impacts of terrain changes to motion and navigation in robotics
		
		Extension Activities:
		S: Investigate local Aboriginal Song Lines
		S: create a simple magnetic compass
		G/S: Create a map of the school using an Image Editing program (Adobe Photoshop or Paint); use the StarLAB Rover to calculate bearings of objects within rooms on the map then label the bearings on the map.
		• ***Challenge:*** This could also be used to create a treasure hunt/map or to experiment with the accuracy of different compasses in comparison to StarLAB equipment (homemade, store bought, mobile phone apps, etc.)
		S/G: Investigate missions or plans for Mars habitation or exploration (pros, cons, challenges, technology, etc.); create poster or digital presentation.
		S: Write lyrics for a Mars 'National Anthem' or design a Martian flag for the first human inhabitants	

StarLAB	Fuel & Brains (Rover Robotics)	Advancing:

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12.4
 	
Extension
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	This is an advanced section of work that provides students with practical opportunities to further explore energy production and introductory levels of learning of the computer science behind machine intelligence. This section pairs well with other iSTEM modules, such as Statistics, Solar Cars or Electric Vehicle.
	
	T/C: Review How Energy is Produced & electro-mechanics
	G/S: Investigate fuel types & storage
	• How do each of the following forms of energy work to produce energy and give examples of electromechanical devices that use each type of fuel. Identify the pros and cons of each.
	  ○ Hydro, Wind, Solar, Fossil, Geo Thermal & Radionuclides
	  ○ Is there a difference between renewable energy and sustainable energy?
	• How do rechargeable and non-recharge batteries work differently?
	  ○ Find examples of rechargeable batteries and how they work. (Lithium Ion, Nickel Hydride, etc.)
	• What type of power & batteries do satellites, probes, space ships and rovers use?
	• How are Thermophotovoltaics used in deep space exploration?
	S: Complete StarLAB Rover Robotics Lesson 5 – Advanced Power Monitoring
	• Advanced level coding
	• Rover power management
	• Alternate sensor integration
	T/C: Introduce the concept of Artificial Intelligence (AI)
	T/C/G: Discussion or Investigation
	• Is Artificial Intelligence different than Machine Intelligence?
	• Find and compare examples (5Ws & H) of AI in daily life, entertainment, business & education
	• How is NASA and other private companies using or planning to use AI or Machine Intelligence in space exploration?
	C/G: Debate
	• Is Artificially Intelligent Machines the future of space exploration?
	• Is Artificial Intelligence the future of humanity?
	• Pros & Cons of Artificial intelligence
		• Apply knowledge of sensors, energy management, electro-mechanics and coding to develop introductory levels of rover autonomy
		Developing:
		• Experimenting with code and power management techniques to understand rover autonomy
		
		Extension Activities:
		
		S: Investigate and experiment with NASA's open source API's and developer tools
		S/G: Choose a topic (fuel types, renewable batteries/energy or AI) to create a mini project of choice
		S/G: Using the StarLAB sensors collect, analyse and present statistical findings in a chosen format based on a chosen topic to solve a practical research based problem
		S/G: Experiment with solar energy and electric circuits to create a solution that uses renewable energy

	S: Complete StarLAB Rover Robotics Lesson 6 – Giving Your Rover Brains • Advanced level coding • Sensing and processing data		
StarLAB 1.2 2.3 4.1 4.2 4.3 6.1 6.2 6.3 6.4 6.5 12.1 12.2 12.3 12.4 12.5 **Extension** 1.1 1.2 2.1 2.2 2.3 3.2 6.1 6.2 6.3 6.4 6.5 12.1 12.2 12.3 12.4 12.5	**Go Time (Rover Robotics & Mars Rover Competition)** *Students will work collaboratively to complete various challenge activities for preparation and participation in the Mars Rover Robotics Competition.* **Note:** StarLAB Moodle lessons will be released late term 1, 2017. Updates will be provided via email or the ME program website. **T:** Explain the rules and guidelines for the competition **G/S:** Complete the Preparing for the Rover Competition Lessons • Details of lessons to be released late term 1 **G/S:** Compete in the Mars Rover Competition	**Advancing:** • Innovative, collaborative and autonomous solutions to competition preparation **Developing:** • Consistent and collaborative contributions to competition preparation **Extension Activities:** **C/G/S:** Create an obstacle course for the StarLAB Rover to navigate then write code to sense and avoid obstacles using appropriate input sensors and output signals **C/G:** Brainstorm unique science based team names • Design a team logo • Create posters or t-shirts	

Optional

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9.1 or 10.1
9.2 or 10.2
9.3 or 10.3
9.4 or 10.4
9.5 or 10.5
12.3
12.5

Extension

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7.2
7.3
7.4

Space Prototyping & Modelling

This unit or topic is an optional supplement to build upon student learning throughout the StarLAB program in the areas of 3D CAD/CAM (Elective 7) which could also be implemented to meet the outcomes for Minor or Major Tasks (Electives 9 & 10).

S: Investigate Space

- What's it like at Mission Control?
- Research 2 - 3 prototype or design concepts in development for space exploration (NASA or other space agencies).
    - Critically evaluate the designs using a PMI or SWOT analysis

T: Introduce students to Rapid Prototyping technologies and materials

- What is additive manufacturing? – 3D Printing examples
- What is subtractive manufacturing?
- Cardboard and paper prototyping

C/G/S: Investigate Rapid Prototyping methods and tools.

- **G/S:** Create a comparison report or SWOT analysis addressing the pros, cons, costs, procedures and social impacts or concerns of use of a variety of equipment for at least two Rapid Prototyping solutions.
- **S:** Build a paper model of a Mars Spacecraft

T: Introduce students to project options

- Using a 3D CAD program
    - Design rover or space vehicle (StarLAB or NASA) modifications for different terrains/atmospheric conditions/planets/etc.
    - Create a habitat for Mars or space travel
    - Space related data collection or communication devices (satellite/ telescopes/probes)

T: Review the Design or Engineering Process

G/S: Create a digital template (headings, formatting, etc.) based on either the Design or Engineering Process to record evidence of project or design work.

- Brainstorm, select and plan project ideas
- Conduct relevant research to support design concept or goals
- Create hand drawn or digital sketches of concept(s)

Advancing:

- Self-directed in the development of creative design solutions to meet a clearly defined goal with a detailed Design or Engineering Process Diary

Developing:

- Consistent contribution to a Design or Engineering process diary for a space related design concept

Extension Activities:

C/G/S: Create and apply technical drawing skills to the creation of scaled design concept sketches and evolutionary design modifications with measurement annotations.

C/G/S: Rapid prototyping of design solutions using 3D printing, Paper Prototyping or CNC equipment

	• Justify design choices and clearly explain design concept (purpose/function) • Learn or review a chosen 3D modelling software and techniques to create a 3D Model of the design concept • Document the project completion process with evidence of time management (blog, GANTT chart or work log) • Conduct self and peer reflections to identify areas of design improvement and provide achievement feedback ○ ***Optional:*** Self and Peer marking or presentation to an authentic audience (project expo)		

Teacher Comments	Student or Program Modifications
Example: Pro's / Con's, what the students liked/disliked or tips for next year	**Program Modification Example:** added alternative energy research task with practical activity using solar panels to create a mini solar car addressing motion outcomes **Student Learning Adjustment Example:** Neil – low literacy; provided small group tutorials to demonstrate sensors

Key Terms

A	**D**	**I**	**M**	**S**
Acceleration	Debouncing	IDLE	Machine Intelligence	Satellite
Accelerometer	Debugging	IOT	Magnetism	Sensor
Actuator	**E**	Index	Mechatronic	Solar
Algorithm	Electromagnetism	Inertia	Method	Spectrum
Amplitude	Electro-mechanics	Input	Micro-controller	Statistic
API	Encapsulation **F**	Insulator	Momentum	String
Artificial Intelligence	Flowchart	Integer	MODULO	Sustainable
Attributes	Frequency	**L**	**O**	Syntax **T**
B	Functions	Latching	Objects	Terrain
Bearings	**G**	LEN	Output	Tilt
Binary	GPS	Logic Error	**P**	Theremin
Boolean	Gyroscope	Logic Gate	Power Pneumatics	**V**
Brushless Motor	**H**	Loop	Pseudocode Python	Variable
C	Hydraulics		**R**	Velocity
Capacitor	Hydrogen		Renewable	
Character			Rotation	
Cipher			Resistor	
Classes				
Code				