Moon Rabbit Syllabus

First Term

### ****Term 1 Introduction: Building Moon Rabbit****

Term 1 of the after-school STEM course provides students with the foundational knowledge and technical skills required to build a Moon Rabbit CO2 sensor which we will deploy in Terms 2 and 3 (see CO2 Monitoring Projects document).

The **Moon Rabbit** is a compact, Raspberry Pi–based CO2 monitoring system designed to collect CO2 measurements and associated metrics. During this first term, students will construct and deploy of their own Moon Rabbit units while developing skills in 3D design, electronics assembly, programming and calibration.

#### ****Focus of Term 1****

Term 1 is structured around guided skill-building, preparation, build and calibration of the Moon Rabbit sensor. Students will:

* Gain an overview of the Moon Rabbit project and its objectives
* Learn the basics of 3D modelling using TinkerCAD
* Design/Modify and print custom enclosures for their devices
* Develop practical soldering skills and assemble core electronic components
* Install and configure the Raspberry Pi operating system
* Begin programming in Python, including basic control structures and system navigation
* Calibrate and test their Moon Rabbits

Students will work in pairs throughout the term, encouraging collaboration and peer learning. Team roles will be established early to support division of tasks during the project.

#### ****Outcomes****

By the end of Term 1, students are expected to have:

* Completed and printed their custom Moon Rabbit enclosures
* Installed key components, including Raspberry Pi Zero and sensors
* Installed Raspberry Pi OS and configured the system for operation
* Installed and tested pre-built Python scripts for system control and data handling
* Calibrated and tested the Moon Rabbits

This work ensures that students are well-prepared to move into the applied phases of the course in Terms 2 and 3, where the emphasis shifts to CO2 monitoring in different circumstances and determining the impact of varying levels of CO2 on their environments.

### Week 1: Introduction and Project Overview

Objectives:

* Introduce students to the project goals and timeline
* Familiarise students with Moon Rabbit basics
* Form working pairs and establish team roles.
* Learn basics of 3D design
* Start designing an enclosure

Activities:

1. Welcome and introduction to the project (10 minutes)
2. Overview of Moon Rabbit and its capabilities (30 minutes)
3. Demonstration of a completed Moon Rabbit (20 minutes)
4. Form pairs (10 minutes)
5. Team building activity: Pairs create team names and discuss project goals (15 minutes)
6. Introduction to 3D design principles (20 minutes)
7. Overview of TinkerCAD 3D design software (15 minutes)

Homework: Design a hollow project box on TinkerCAD.

### Week 2: 3D Design Introduction

Objectives:

* Understand design considerations for electronics enclosures
* Complete Moon Rabbit designs.

Activities:

1. Feedback on Project Box designs (15 minutes)
2. Review of design principles and addressing questions (15 minutes)
3. Measuring Moon Rabbit for SD Slot (15 minutes)
4. Pairs begin designing their own SD Slots (30 minutes)
5. Finalising Moon Rabbit designs with proper ventilation and access ports (20 minutes)
6. Peer review of designs in groups (15 minutes)
7. Saving designs and preparing for next session (10 minutes)

Homework: Finalise Moon Rabbit designs.

### Week 3: Finalising 3D Design and Starting Prints

Objectives:

* Prepare files for 3D printing.
* Introduction to Cura slicing software.
* Slice Moon Rabbit case.
* Start printing process.
* Learn soldering safety and techniques
* Practice basic soldering skills

Activities:

1. Introduction to Cura slicing software and print settings (20 minutes)
2. Preparing files for printing and estimating print times (20 minutes)
3. Starting the printing process for some groups (20 minutes)
4. Introduction to soldering safety and equipment (20 minutes)
5. Demonstration of proper soldering techniques (20 minutes)
6. Solder BME280 joints (20 minutes)

Homework: Complete printing.

### Week 4: Soldering RPi 0 headers

Objectives:

* Prepare Raspberry Pi headers for the project.
* Clean up prints

Activities:

1. Inspecting solder joints and troubleshooting common issues (15 minutes)
2. Practice soldering with simple components (header pins to Raspberry Pi Board) (60 minutes)
3. Inspecting solder joints and troubleshooting common issues (15 minutes)
4. Clean-up and proper disposal of soldering materials (5 minutes)
5. Collecting completed 3D prints (10 minutes)
6. Post-processing of 3D Moon Rabbit cases (sanding, spray) (20 minutes)

Homework: Complete clean-up.

### Week 5: Assembly and Integration

Objectives:

* Assemble 3D printed enclosures
* Mount Raspberry Pi and sensors
* Test the integrated system

Activities:

1. Mounting Raspberry Pi in the enclosure (30 minutes)
2. Installing sensors in appropriate locations (30 minutes)
3. Connecting all components in the final configuration (30 minutes)
4. Initial testing of the assembled system (30 minutes)

Homework: Prepare for final testing and think about potential projects.

### Week 6: Operating System Setup and Basic Linux Commands

Objectives:

* Install and configure Raspberry Pi OS
* Learn basic Linux commands
* Understand file system navigation

Activities:

1. Review of first half and address questions (15 minutes)
2. Install Raspberry Pi OS using the Raspberry Pi Imager (30 minutes)
3. First boot and initial configuration (20 minutes)
4. Basic setup: Connecting Pi to monitor, keyboard, mouse, connect to WiFi (40 minutes)
5. Introduction to Terminal and basic Linux commands (cd, ls, mkdir, etc.) (10 minutes)
6. Saving work and proper shutdown procedures (5 minutes)

Homework: Practice Linux commands using an online terminal simulator

### Week 7: Introduction to Python Programming

Objectives:

* Learn Python basics
* Write simple programs on the Raspberry Pi
* Understand variables, loops, and conditionals

Activities:

1. Introduction to Python and why it's used for this project (15 minutes)
2. Setting up Python development environment on Pi (15 minutes)
3. Guided coding: Variables, data types, and simple operations (30 minutes)
4. Pair programming exercise: Creating a simple temperature monitoring program (30 minutes)
5. Introduction to conditional statements and loops (20 minutes)
6. Saving and running Python scripts (10 minutes)
7. Introduction to sensor calibration principles (20 minutes)

Homework: Complete a simple Python challenge related to weather data

### Week 8: Testing, and Troubleshooting

Objectives:

* Ensure all systems are functioning correctly
* Troubleshoot any issues

Activities:

1. Final system checks and troubleshooting (30 minutes)
2. Testing the complete CO2 monitoring system (20 minutes)
3. Each pair presents their project and demonstrates functionality (30 minutes)

Homework:

### Week 9: Calibration with Vacuum Pump and Calibration Gas

Objectives:

* Understand the importance of sensor calibration
* Learn calibration techniques for pressure and CO2 sensors
* Implement calibration in code

Activities:

1. Safety briefing for working with vacuum pumps and calibration gas (15 minutes)
2. Demonstration of calibration setup and equipment (20 minutes)
3. Calibrating pressure sensors using vacuum pump (30 minutes)
4. Calibrating CO2 sensors using calibration gas (30 minutes)
5. Implementing calibration offsets in Python code (5 minutes)

Homework:

### Week 10: Catchup, Final Testing and Presentation

Objectives:

* Complete any unfinished work from previous weeks
* Ensure all systems are functioning correctly
* Discuss future applications
* Present final projects

Activities:

1. Catchup time for groups who need to complete previous steps (30 minutes)
2. Final calibration checks and adjustments (20 minutes)
3. Each pair presents their project and demonstrates functionality (30 minutes)
4. Discussion of potential applications and future enhancements (15 minutes)
5. Project wrap-up and celebration of achievements (5 minutes)