



Level 6 – New Zealand Curriculum  
**DIGITAL TECHNOLOGIES & HANGARAU MATIHIKO**

# Teaching and learning programme

Electronics – Native plant monitoring



Developed by Craig Jefferies, Mt Aspiring College, 2018

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## Summary of the teaching and learning programme

This programme focuses on developing an electronics outcome suitable for monitoring the environmental conditions of plants to enable plant health and survival. The programme is intentionally broad to cover a range of practical skills and theory relating to input and output interfaces. It covers the basics of microprocessors and software programming.

### By the end of this teaching and learning programme, students will be able to:

- apply knowledge and skills to develop an environmental monitoring system that:
  - is capable of measuring a range of environmental conditions of plants, including air temperature, soil temperature, soil moisture, and light
  - includes warning indicator(s) to inform users of the current state of health of plants.

### Duration

40 hours of teaching and assessment:  
approximately 9–10 weeks or one full term.

### Key teaching and learning concepts – the big ideas

- The use of an electronic interface to sense environmental conditions and control output devices
- Identification of components that make an interface
- Construction of input and output interfaces
- An understanding of the purpose and function of interfaces
- Writing code to control a microprocessor.

### Alignment to NZC and/or Te Marautanga – (DTHM progress outcomes and progressions)

#### *Designing and Developing Digital Outcomes*

Students will:

- learn how electronic components and techniques are used to design digital devices
- become increasingly skilled in integrating electronic components and techniques to assemble and test an electronic environment

- develop outcomes that will integrate specialised knowledge of digital applications and systems from a range of areas.

#### *Computational Thinking*

Students will:

- implement algorithms by creating programs that use inputs, outputs, sequence, loops and selection using comparative operators and logical operators.

#### *Links to other learning areas*

This programme has links to:

- Physics: related to direct current (DC) circuit theory
- Science:
  - investigating linear relationships and conducting fair tests, for example, the effect that changing soil moisture has on the electrical resistance of soil
  - plant propagation and the effects of environmental conditions and soil types on plant growth
- Agriculture and horticulture: plant propagation and cultivation.

### Prior knowledge and place in learning journey

Level 5 numeracy and literacy skills are the main prior knowledge needed, as students need to read and interpret written instructions and diagrams. A passion for building, constructing, and making and previous experience in computer programming or electrical circuits would be an advantage. To ensure success at Level 6 of the curriculum, students should have prior experience in microprocessor interfacing and programming.



## Resources required

A substantial amount of electronic components are required for this unit. If you are new to electronics, it is advisable to purchase prebuilt kits for students. There are a number of New Zealand educational retailers that provide such resources and support.

Below is a range of electronic input and output components, including a suitable battery-powered microprocessor. A PC capable of running programs needed to download code.

### Electronic components:

Base kit: per student: LDR x 2; 100k NTC thermistor x 2; BC337 or BC547 transistor x 2; resistors: 330, 470, 1K, 4K7, 10K x 5 each; DC motor (104K/0.1uF capacitor soldered to terminals) x1; propeller (single blade); Piezo Buzzer x1; 5mm LEDs (red, green, orange) or a range of sizes and colours x 2 each; tact switches x 2; breadboard jumper wires x 10, N14148 signal diode.

Components to add to base kit if required in alternative projects: DS18B20 Dallas temperature sensor x 1, servo, motors and gearbox may be required for robotic projects.

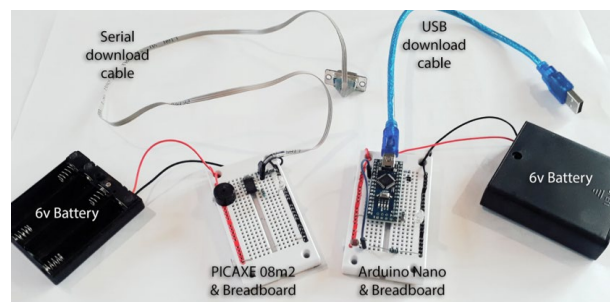
### Hardware:

Hardware can be shared between groups of 3–4: small wire cutters, long-nose pliers, 60cm of solid core wire.

### Development board and battery:

Breadboards are by far the easiest way to enable construction of interfaces.

- If using a PICAXE microprocessor, a 4.5v (3 x AA) battery supply works best. Secure the battery wires to the board. You can purchase prebuilt boards (breadboard & component setup) from local NZ suppliers, such as [electroflash.co.nz](http://electroflash.co.nz)
- If using an Arduino (Nano is recommended), a 6v (4 x AA) battery supply works best. The Arduino often uses a USB cable that can provide power and data.



### Accompanying workbook and materials

A workbook has been developed to accompany the teaching and learning programme. There are two versions: PICAXE and ARDUINO, available at

<https://sites.google.com/mtaspiring.school.nz/electronics/as1-5>

Other resource materials are found on here on [TKI](#).

### How you might adapt this in your classroom

A key focus of the teaching and learning is the opportunity to monitor environmental areas suitable for planting, beyond the four walls of the classroom.

- Native plant monitoring: is there a nearby native planting area that needs monitoring?
- Vegetable garden monitoring: students could monitor home or school gardens during autumn months.
- Keep it alive: give each student a potted herb plant to monitor and 'keep alive' over the term.

### Assessment

Digital technologies achievement standard AS91881. Develop an electronics outcome (6 credits).

# TERM OUTLINE

## Teaching and learning programme

What is being covered	Duration	Specific learning outcomes <i>Students will be able to:</i>	Learning activities	Resources <i>Access all resources <a href="#">here</a></i>
Distribution and organisation of equipment	1 hour	After provision of equipment, storage and any other resources. <ul style="list-style-type: none"> <li>construct their first output interface</li> </ul>	It takes a whole lesson to: <ul style="list-style-type: none"> <li>hand out breadboard and components</li> <li>distribute containers with student names</li> <li>open up the software application</li> <li>write in templated code and download this to the microprocessor</li> <li>watch an LED flash.</li> </ul>	Make sure you have everything ready and set up as kits for the students.

## Interpret and use circuit diagrams to interface output components with a microprocessor

The first week is about making lights flash, buzzers sound and motors spin

Interfacing a 5mm LED with a microprocessor	1 hour	<ul style="list-style-type: none"> <li>select components to interface an LED with a microprocessor</li> </ul>	<b>Workbook exercises available</b> The flashing LED is the 'Hello, World' of electronic interfaces. Take your time with students here. Experiment if time and class dynamic allows. <ul style="list-style-type: none"> <li>Swap the LED legs around.</li> <li>Swap to different coloured LEDs, swap a 330/470 ohm resistor for a larger 1K ohm resistor.</li> <li>What happens?</li> <li>Make the duration of the LEDs' blink change. Start with 1s (1000ms) on and off.</li> <li>Try ½s (500ms) on and off.</li> <li>At what point can the human eye no longer see any blinking? Try 50ms (1s / 0.05 = 20 flashes per second).</li> </ul>	It is important that when a teacher talks about outputs like LEDs they refer to an interface rather than a component. Say something like "Connect an LED and current limiting resistor."  This unit is all about the interfaces!
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What is being covered	Duration	Specific learning outcomes <i>Students will be able to:</i>	Learning activities	Resources <i>Access all resources <a href="#">here</a></i>
Power supplies	½ hour	<ul style="list-style-type: none"> <li>understand a battery cell, and how this relates to the battery packs</li> </ul>	Workbook exercises available	Let's start with the battery pack! 3 x AA batteries cells placed in series. The total voltage is the sum of each battery cell, so $1.5v + 1.5v + 1.5v = 4.5v$ .
Identify the characteristics of a 5mm LED	½ hour	<ul style="list-style-type: none"> <li>recognise characteristics of a 5mm LED</li> </ul>	<p>Workbook exercises available</p> <p>What is an LED? It is a good idea to have a range of LEDs: normal 5mm LEDs, clear bright 5mm LEDs</p> <ul style="list-style-type: none"> <li>What are its current and voltage requirements?</li> <li>Which LED is brightest</li> </ul>	<p>The LED has specific voltage and current characteristics (from datasheet): what are they, what implications does this have for:</p> <ul style="list-style-type: none"> <li>maximum voltage?</li> <li>typical current draw?</li> </ul> <p>Get students to look these up in a datasheet.</p>
Series circuit	1 hour	<ul style="list-style-type: none"> <li>understand characteristics of a series circuit</li> </ul>	Workbook exercises available	<p>The LED + resistor are in series. Use this circuit to introduce some DC circuit theory on series circuits:</p> <ul style="list-style-type: none"> <li>two resistors together or LED and resistor are examples of components in series</li> <li>current is the same</li> <li>voltage is divided among the resistors.</li> </ul>

What is being covered	Duration	Specific learning outcomes <i>Students will be able to:</i>	Learning activities	Resources <i>Access all resources <a href="#">here</a></i>
Interface a Piezo Buzzer with a microprocessor	1 hour	<ul style="list-style-type: none"> <li>interface an LED with a microprocessor</li> <li>write software code to play different tunes or notes</li> </ul>	<p>Workbook exercises available</p> <p>A buzzer is an annoying output device, but students enjoy making a few sounds at different frequencies.</p> <p>This is a programming exercise and a good opportunity to challenge students with code.</p>	
Interface a DC motor using a transistor switch	½ hour	<ul style="list-style-type: none"> <li>interface a motor with a microprocessor</li> </ul>	<p>Workbook exercises available</p> <ul style="list-style-type: none"> <li>The motor interface is the first big challenge. Make sure students connect components correctly: <ul style="list-style-type: none"> <li>Motor connects from 4.5v, positive rail to the leg of the transistor.</li> <li>You can use a BC337 or a BC547 transistor here.</li> </ul> </li> </ul> <p><b>Note:</b> <i>a small 104K (0.1uF) capacitor soldered across the terminals of the motor helps smooth things out on start, stop, stall. Another option if the students' motors struggle to go is a flyback diode connection to switch the motor back to positive.</i></p>	<p>If a student asks “Why do we need to use a transistor switch?”, ask them to try and make the motor go directly from the microprocessor pin ... there's not enough current available. We need to drive the motor directly from the power supply – the transistor acts as a switch allowing us to control flow of current directly from the battery.</p> <p>Common errors:</p> <ul style="list-style-type: none"> <li>motor needs to be connected to the positive</li> <li>transistor needs to be connected correctly</li> <li>a 470 ohm resistor should connect the microprocessor to the base pin.</li> </ul>

What is being covered	Duration	Specific learning outcomes <i>Students will be able to:</i>	Learning activities	Resources <i>Access all resources <a href="#">here</a></i>
Transistor switch	1 hour	<ul style="list-style-type: none"> <li>understand the purpose and function of components used in a transistor switch interface</li> </ul>	<p>Workbook exercises available</p> <p>A DC motor can typically draw 80-120mA of current. A microprocessor pin can supply 20-40mA.</p> <p>The solution to controlling a DC motor and any large current device like a solenoid is the use of a transistor switch.</p>	<p>A motor is a high-power output device when compared to LEDs. We need a method of connecting it directly to the 4.5v terminals of the battery AND controlling it via the digital pins on the microprocessor. Therefore, we use a transistor switch.</p> <ul style="list-style-type: none"> <li>The middle pin of the transistor acts as a switch.</li> <li>When the middle pin has a voltage applied to it, current flows from positive to negative (from collector to emitter), allowing the motor to go.</li> </ul> <p>Depending on your focus, you can go into more depth with the transistor switch sub-system, identify the voltage required in the base or middle pin, and link this to the amount of current that flows through base to emitter and thus through the motor.</p>



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### Interpret and use circuit diagrams to interface input components with a microprocessor

Inputs include digital inputs like tactile switches and analogue inputs like light-dependant resistors, NTC thermistors

Interface a tact switch to a microprocessor and read digital input	1 hour	<ul style="list-style-type: none"> <li>interface a tact switch to a microprocessor</li> </ul>	<p>Workbook exercises available</p> <p>A switch is a digital input. Digital inputs like switches are either ON or OFF. A switch interface consists of a switch and a pull-down resistor.</p>	<p>The tact switch is a good first look at digital inputs.</p> <ul style="list-style-type: none"> <li>The circuit connects a resistor to ground (negative, black rail).</li> <li>This is called a pull-down resistor.</li> <li>The switch makes a connection to the positive rail.</li> <li>When the switch is 'closed', current from the positive rail flows to the digital input pin, which goes HIGH.</li> </ul> <p>So if we were to look at the state of the digital pin, we could work out whether it has been pressed (closed) or not.</p> <p>Be careful to watch the way in which the tact switch is connected. In the diagram, the legs are facing lengthways on the breadboard.</p>
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What is being covered	Duration	Specific learning outcomes <i>Students will be able to:</i>	Learning activities	Resources <i>Access all resources <a href="#">here</a></i>
Interface a light-dependant resistor and read analogue input	1 hour	<ul style="list-style-type: none"> <li>interface a light-dependant resistor and read analogue input</li> </ul>	<p>Workbook exercises available</p> <p>For this activity, focus on the construction (what can be observed by the student) and less on the theory.</p> <ul style="list-style-type: none"> <li>A light dependant resistor is a 'resistive sensor'. We often call this type of sensor an analogue sensor.</li> <li>An analogue input consists of a resistive sensor like a LDR in series with a fixed resistor (together these are call a voltage divider).</li> <li>Be careful to refer not to a single sensor component but to the light sensor interface.</li> </ul> <p>Make sure students can use DEBUG or Serial Monitor to view the value of the analogue light inputs and watch the value change on varying light levels.</p>	<p>Analogue inputs are one of the key aspects to this unit and to level 6 of the digital curriculum.</p> <p>Using an LDR, connect up the circuit and allow students to see how a change in light level (dark, light, bright torchlight from phone) affects the digital reading seen on the PC screen.</p> <p>There is quite a bit of theory embedded in this. At level 1, just focus on what can be observed by the student:</p> <ul style="list-style-type: none"> <li>the conversion of analogue light levels to a digital reading of 0-255</li> <li>light level changes lead to LDR resistance changes, which lead to voltage changes across the LDR to finally a digital reading from 0-255 (8-bit).</li> </ul>

What is being covered	Duration	Specific learning outcomes <i>Students will be able to:</i>	Learning activities	Resources <i>Access all resources <a href="#">here</a></i>
Interface an NTC thermistor and read analogue input	1 hour	<ul style="list-style-type: none"> <li>interface an NTC thermistor and read analogue input</li> </ul>	<p>Workbook exercises available</p> <p>Again focus on the construction (what can be observed by the student) and less on the theory.</p> <ul style="list-style-type: none"> <li>The thermistor is a 'resistive sensor'. We often call this type of sensor an analogue sensor</li> <li>An analogue input consists of a resistive sensor like a thermistor in series with a fixed resistor (together these are call a voltage divider).</li> <li>Be careful to refer not to a single sensor component but to the temperature sensor interface.</li> </ul> <p>Make sure students can use DEBUG or Serial Monitor to view the value of the analogue temperature inputs and watch the value change on varying heat levels.</p>	<p>As with the LDR, analogue inputs are key aspects to the unit and to level 6 of the digital curriculum.</p> <p>Using a 100K NTC thermistor, connect up the circuit and allow students to see how a change in heat level (cold, hot) affects the digital reading seen on the PC screen.</p> <p>There is quite a bit of theory embedded in this. At level 1, just focus on what can be observed by the student:</p> <ul style="list-style-type: none"> <li>the conversion of analogue temp levels to a digital reading of 0-255.</li> <li>Heat changes lead to NTC thermistor resistance changes, which lead to voltage changes across the thermistor to finally a digital reading from 0-255 (8-bit).</li> </ul>
Interface a conductivity (moisture) sensor and read analogue input	1 hour	<ul style="list-style-type: none"> <li>interface a conductivity (moisture) sensor and read analogue input</li> </ul>	<p>Workbook exercises available</p> <p>The moisture sensor is a 'resistive sensor'. We often call this type of sensor an analogue sensor.</p> <ul style="list-style-type: none"> <li>An analogue input consists of a resistive sensor like a conductivity sensor in series with a fixed resistor (together these are call a voltage divider).</li> <li>Be careful to refer not to a single sensor component but to the moisture sensor interface.</li> </ul> <p>Make sure students can use DEBUG or Serial Monitor to view the value of the analogue temperature inputs and watch the value change on varying heat levels.</p>	Same as above

What is being covered	Duration	Specific learning outcomes <i>Students will be able to:</i>	Learning activities	Resources <i>Access all resources <a href="#">here</a></i>
Making decisions with code	1 hour	<ul style="list-style-type: none"> <li>recognise and use conditional statements within software code</li> </ul>	<p>Workbook exercises available</p> <p>Go through a conditional statement and how to use comparative operators, such as equals, greater than, less than.</p>	

### Develop and test input and output interfaces

Bring together ideas of input and output interfaces in a series of short, structured projects. There are 3 projects outlined below. Choose 1 or 2 that best suit your course and assessment.

<p><b>Project 1:</b> Scared of the dark</p> <p>Construct and test an electronic system for the darkness detector</p> <p><b>Project 2:</b> Temperatures for seed growth</p> <p>Construct and test an electronic system for the temperature detector</p> <p><b>Project 3:</b> Fan control</p> <p>Construct and test an electronic system for the fan control</p>	1–3 hours	<ul style="list-style-type: none"> <li>recognise and follow a process of construction and testing to develop an electronics outcome</li> </ul>	<p>Workbook exercises available</p> <p>This activity looks to bring together all the ideas covered so far as well as introduce calibration and testing.</p> <p>You will need a digital thermometer for projects 2 and 3.</p> <ol style="list-style-type: none"> <li>Develop input interfaces (sketch and label).</li> <li>Calibrate analogue input.</li> <li>Develop output interfaces (sketch and label).</li> <li>Create programs that read input, assign data to variables, make decisions using conditional statements and change the output state of an electronic component.</li> <li>Test the electronic system.</li> </ol>	<p>These are guided projects that will provide a process that students will use when developing electronic systems in their actual assessment. For example, in project 1:</p> <ol style="list-style-type: none"> <li>Construct a light sensor interface (sketch and label the interface).</li> <li>Calibration table: Read in light levels and map these to a number 0–255; record their findings.</li> <li>Construct an LED interface, (sketch and label the interface).</li> <li>Testing table: trial the electronic system under a range of lighting conditions to test if it works.</li> </ol> <p>Projects 2 and 3 will have relevant measures and ranges for temperature.</p> <p>A reflection on the project is a good idea:</p> <ul style="list-style-type: none"> <li>What were the stages of development?</li> <li>What did students do at each stage?</li> <li>What could have been evidenced at each stage?</li> </ul>
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### Understanding the purpose and function of interfaces

The voltage divider	1 hour		<p>Workbook exercises available</p> <p>All analogue resistive sensors, such as LDRs and thermistors, are used in a voltage divider.</p> <ul style="list-style-type: none"> <li>• An LDR or thermistor is a resistor.</li> <li>• Two resistors are in series.</li> <li>• Current is the same through resistors (and can be ignored for discussion).</li> <li>• Voltage is divided among components.</li> <li>• The larger of the resistors will use up more voltage.</li> </ul>	<p>The purpose of a voltage divider is to create a voltage signal to the microprocessor that corresponds to changes in the resistance of the sensor.</p> <p>For example, in the LDR interface</p> <ol style="list-style-type: none"> <li>1. Darkness on the LDR means a large resistance.</li> <li>2. Large resistance increases the voltage across the LDR</li> <li>3. The microprocessor can look and see the voltage across the LDR and convert it to an integer value.</li> </ol>
Calculations of current limiting resistor	1 hour		<p>Workbook exercises available</p> <p>You placed a 330 ohm resistor in series with your LED: did you ever question why?</p> <p>At some point in the unit, students should look at Ohm's law and the link between current, voltage and resistance in a series circuit.</p>	<p>This topic is later in the unit as it is only used to enable students to justify the selection of resistor values in a series circuit (Excellence).</p> <p>Using calculations to help justify the choice of resistor in the LED interface circuit is a good introduction to DC circuit theory.</p> <p>If you assume the digital output of your microprocessor is 4.5v, it is likely that connecting the LED directly to the output pin will provide far more current and voltage than is recommended.</p> <p>If students can use their knowledge of series circuits and of Ohm's law to calculate the approximate value of the series resistor needed in the LED interface, that would be awesome.</p>



What is being covered	Duration	Specific learning outcomes <i>Students will be able to:</i>	Learning activities	Resources <i>Access all resources <a href="#">here</a></i>
Understanding relevant implications and how to use these to inform and refine an electronic system	1 hour		Students need some knowledge of implications, such as 'robust', 'reliable', 'understandable'. Give examples of a robust electronic system including securely mounted components, testing connections and joints. Give examples of reliable by showing accurate calibration of an analogue sensor and the code used to make a good decision. Give examples of understandable by looking at code and how to make it readable and by looking at the physical user interface. Would labelling help?	<p>While the wording of 'relevant implications' may not be the best, the ideas of and ability to address concerns over reliability, robustness, understandable, etc. are important for electronics systems.</p> <p>What makes a system reliable? Responding correctly to expect input such as light level, temperature, moisture. Are input sensors correctly positioned to sense the environment? If a student has only recorded analogue values for light and dark. how will the system know what to do in dim lighting, overcast days? Students need to use tests to show that the system performs in all expected input conditions. Did they just trial in darkness and say it worked, or did they show trials in a range of input conditions and record the response of the system?</p> <p>What makes a system robust? Are wires, cables and components securely mounted on the board? Securely mounted into enclosure? If the students' breadboard is a spaghetti mess of jumper leads, they may need to improve their layout with solid core wires of correct length placed securely on the board.</p> <p>What makes a system understandable? Using correct colours or labels for warning indicators, labelling of switches.</p>

What is being covered	Duration	Specific learning outcomes <i>Students will be able to:</i>	Learning activities	Resources <i>Access all resources <a href="#">here</a></i>
Justifying selection of components	1 hour		<p>Justifying selection of components takes the understanding of interfaces one step further.</p> <p>At level 1, a student would not be required to justify all of these, and while calculations help, they are not essential to gaining excellence in the standard.</p>	<p>Let's look at three interfaces</p> <ol style="list-style-type: none"> <li>1. The LED and current limiting resistor: <ul style="list-style-type: none"> <li>- What LED was selected?</li> <li>- What is the forward voltage drop across LED?</li> <li>- What is recommended current?</li> <li>- Based on these specifications, calculate an appropriate value of the current limiting resistor, or at least calculate the minimum resistor value needed to keep the voltage and current within acceptable levels.</li> </ul> </li> <li>2. The LDR, thermistor and voltage divider: what resistive sensor and fixed resistor was selected?</li> <li>3. Motor and transistor switch: <ul style="list-style-type: none"> <li>- What transistor was selected?</li> <li>- Why was the type of transistor important for operation of the motor?</li> </ul> </li> </ol>

# ASSESSMENT TASK

<b>Achievement standard:</b>	91881
<b>Standard title:</b>	Develop an electronics outcome
<b>Total credits:</b>	6

Please be aware that NZQA have read the assessment task but they will still need to be checked by the teacher using the assessment to ensure it meets all requirements.

## OVERVIEW

Design and develop an environmental sensor that allows long-term monitoring of native plants in a chosen landscape.

This assessment activity requires students to develop an electronic outcome suitable for monitoring potential areas of native planting. Students must demonstrate the use of basic iterative processes to develop and test their electronic outcome, ensuring that they construct an outcome that meets specifications and addresses relevant implications. The assessment starts in week 6 and finishes in week 9 of the programme.

## HOW WILL YOU BE ASSESSED?

You will be assessed on how well you develop and test an electronic outcome that will enable the monitoring of native plants.

## TASK

Te Kakano Community Trust is a local, community-run native plant nursery. They need you to develop an electronic outcome that will enable monitoring of native plants. You must use the list of specifications provided to inform the development of your electronic outcome.

## SPECIFICATIONS

<b>Native plant monitoring</b>	<b>Specifications</b>	<b>Relevant implications</b>
<p>Along Plantation Road on Mt Aspiring College grounds. Select two possible environmental variables to monitor plant health:</p> <ul style="list-style-type: none"><li>• air temperature</li><li>• soil temperature</li><li>• light level</li><li>• soil moisture</li><li>• rainfall.</li></ul> <p>Note that one of your variables must be analog.</p>	<p>Inputs:</p> <ul style="list-style-type: none"><li>• two environmental variables</li></ul> <p>One of these must be analog.</p> <p>Output:</p> <ul style="list-style-type: none"><li>• plant health warning indicator</li></ul> <p>Power supply:</p> <ul style="list-style-type: none"><li>• 4.5v (3 x AA) supply</li></ul>	<p>Te Kakano Nursery have identified the following relevant implications:</p> <ol style="list-style-type: none"><li>1. Functionality:<ul style="list-style-type: none"><li>- reliability and sensitivity of input</li><li>- robustness of electronic outcome and enclosure</li></ul></li><li>2. End-user considerations:<ul style="list-style-type: none"><li>- understandable/labelled/visible warning indicators.</li></ul></li></ol>

# ASSESSMENT TASK

<b>Achievement standard:</b>	91881
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## COMPLETING THE TASK

As you perform the task, make notes and gather evidence for inclusion in your portfolio:

1. Project brief

It's good to start by clarifying what you intend to do

- a. Identify the environmental variables you will monitor.
- b. Describe the relevant implications and warning indicators you will use how these will be addressed.

2. Circuit schematics of electronic system

- a. Sketch a circuit schematic for your proposed electronic system, include correct circuit symbols and labels for components you select.

3. Construct and test your electronics outcome

Evidence constructing, testing, and debugging your electronics system on all input/output interfaces. Include:

- a. Testing/calibration of your analogue sensor on a range of environmental conditions (inputs)
- b. Testing of warning indicators (outputs) on all expected input conditions
- c. Evidence of modifying and debugging software code
- d. Show how you addressed the relevant implications within development

4. Iterative improvement of the Electronics outcome

Iterative improvement within your work will show evidence of using documented cycles to refine functionality, reliability, end-user considerations and fitness for purpose. Evidence needs to show:

- a. Input sensors; how you made improvements to reliability
- b. Software; how you improved the microprocessor code to be logical and understandable
- c. Robustness; how you improved the electronic circuit & enclosure to be secure, robust
- d. End-user considerations; How you improved understandability/visibility of warning indicators

# ASSESSMENT TASK

<b>Achievement standard:</b>	91881
<b>Standard title:</b>	Develop an electronics outcome
<b>Total credits:</b>	6

## COMPLETING THE TASK (CONTINUED)

### 5. Purpose and function of components and interfaces

Include evidence that shows you are able to describe/explain/justify the interfaces and functions of the components of the systems used:

a.) A photograph of your electronics system. Annotate your photographs with descriptions of:

- i. each component (what it does, how it functions)
- ii. each interface (what it does, how it functions)

b.) Explain the behaviour and function of the electronics outcome

- i. Voltage characteristics of the batteries and battery pack
- ii. LED voltage and current characteristics (use datasheets)
- iii. Resistance and voltage characteristics of the voltage divider
- iv. Voltage and current characteristics of the LED + current limiting resistor interface
- v. LED voltage and current characteristics
- vi. Resistance and voltage characteristics of the voltage divider interface
- vii. Voltage and current characteristics of the LED + resistor interface.

c.) Justify your choice of the components and systems used

- i. Justify sensors and how these enable monitoring of plant health
- ii. Justify resistors in voltage divider and how this affects sensitivity (calculations not required)
- iii. Justify your selection of LED + current limiting resistor. Use calculations to determine current limiting resistor value for LED.

## HAND IN

Your completed portfolio.



## ASSESSMENT SCHEDULE

EVIDENCE/JUDGMENTS FOR ACHIEVEMENT/PAETAETAE	EVIDENCE/JUDGMENTS FOR ACHIEVEMENT WITH MERIT/KAIATA	EVIDENCE/JUDGMENTS FOR ACHIEVEMENT WITH EXCELLENCE/KAIRANGI
Develop an electronics outcome.	Develop an informed electronics outcome.	Develop a refined electronics outcome.
<p><b>The student has:</b></p> <ul style="list-style-type: none"> <li>used appropriate resources and techniques when developing a functional combination of hardware and software that performs to specifications</li> </ul> <p><i>For example (partial evidence)</i></p> <p>The student has used electronic components (hardware), including power supply and a microcontroller, to construct functional input and output interfaces for their electronic system that meet specifications. In this assessment students will include one analogue input (such as temperature, light, moisture) and a output such as a warning indicator.</p> <p><b>The student has:</b></p> <ul style="list-style-type: none"> <li>modified and debugged embedded software</li> </ul> <p><i>For example (partial evidence)</i></p> <p>Student is able to identify errors in the program that prevent it running properly,. Student then is able to correct program errors so that the system performs to specifications. This will likely involve:</p> <ul style="list-style-type: none"> <li>reading and storing analogue/digital inputs ,</li> <li>making a decision based on state of input via a conditional statement (IF ELSE)</li> <li>controlling outputs such as LED warning indicator(s)</li> </ul>	<p><b>The student has:</b></p> <ul style="list-style-type: none"> <li>modified, debugged and used commented software so that the program is logical and readily understandable</li> </ul> <p><i>For example (partial evidence)</i></p> <p>Student is able to identify and correct errors in code AND also constructs logical and understandable code which could include:</p> <ul style="list-style-type: none"> <li>(a) declares variables for use within the program</li> <li>(b) uses meaningful naming conventions for constants, variables or subroutines</li> <li>(c) comments code to identify its purpose</li> <li>(d) uses modular code such as subroutines.</li> </ul> <p><b>The student has:</b></p> <ul style="list-style-type: none"> <li>undertaken testing procedures to debug and diagnose the electronic system to improve the reliability</li> </ul> <p><i>For example (partial evidence)</i></p> <p>Student should show improvements as a direct result of testing and debugging. This may include students (a) identifying a wide range of expected analogue values for their chosen sensor. (b) testing outputs (LEDs) function on expected input values. (c) trials system in-situ to make sure it functions in soils with plants inside and outside.</p>	<p><b>The student has:</b></p> <ul style="list-style-type: none"> <li>undertaken testing procedures to debug and diagnose the electronic system to ensure it is fit for purpose</li> </ul> <p><i>For example (partial evidence)</i></p> <p>The student calibrates and tests analog inputs using a wide range of expected values in situ and may identify boundary or out-of-range inputs, such as handling Invalid sensor input (temperature sensor recording no value, moisture sensor not in soil, light sensor recording no values). These tests are used to show the outcome's fitness for purpose.</p>

## ASSESSMENT SCHEDULE

### The student has:

- undertaken testing procedures to debug and diagnose the electronic system

#### *For example (partial evidence)*

The student records DEBUG values on expected analog variables (light levels, temperature levels, moisture levels, etc) and tests that the system performs under these inputs values.

### The student has:

- described the interfaces and functions of components and systems used

#### *For example (partial evidence)*

The student has shown evidence of four or five from:

- identify purpose and function of all components used
- identify purpose and function of all interfaces used
- use circuit symbols to create schematics for their outcome
- describe function of their battery power supply
- describe current & voltage characteristics of series components like LED + Resistor
- describe resistance changes in their chosen analogue sensor and how this links to voltage signal to Micro
- describes purpose and function of transistor switch
- Use a multimeter to label voltage loss across components and voltage gain from power supply.

### The student has:

- explained the behaviour and function of the electronics outcome

#### *For example (partial evidence)*

The student has explained (with example) how voltage and current behave within a circuit in relation to the outcome. This could include:

- explanation of LED characteristics including forward voltage drop, maximum current and effects on LED when voltage/current are not within expected parameters
- explanation of voltage across components, current through components in a current limiting resistor + LED interface
- explanation of resistance changes and resulting voltage signals to microprocessor from analogue sensor voltage divider interface.

### The student has:

- addressed relevant implications

#### *For example (partial evidence)*

The student has been able to address implications that may include:

- functionality:
  - reliability and sensitivity of input
  - robustness of electronic system and enclosure
- end-user considerations:
  - understandable/labelled/visible warning indicators.

### The student has:

- shown iterative improvement throughout the development and testing process

#### *For example (partial evidence)*

The student has shown documented cycles of development leading to refinement. This will include more than one of (a) refinement of resistive sensor parameters (different voltage divider resistors for LDR, NTC Thermistor, Conductivity Probe) to increase range of readings and improve accuracy (b) refine mounting and wiring of enclosure to improve robustness (c) refine placement and reliability of sensors (light, temp, moisture) in soil when electronic system placed in situ (d) refine software so system responds correctly to invalid data (temp sensor recording no value, moisture sensor not in soil, light sensor recording no values) (e) refine software to be modular eg use of functions or subroutines.

## ASSESSMENT SCHEDULE

### The student has:

- described relevant implications

#### *For example (partial evidence)*

The student has been able to describe implications that may include

- functionality:
  - reliability and sensitivity of input
  - robustness of electronic system and enclosure
- end-user considerations:
  - understandable/labelled/visible warning indicators.

### The student has:

- justified the choice of components and systems used in the development of the electronics outcome

#### *For example (partial evidence):*

Justify means to give a reason. These may include:

- reasons for the selection and positioning of specific sensors based on their relevance to monitoring plant health
- justifying selection of LED colour for plant health indicator and use calculations to determine current limiting resistor value for LED by considering the LED forward-operating voltage and maximum current allowed (using Ohm's law to calculate RLED).
- justifying selection of fixed resistor value in the analog sensor voltage divider, eg, why they used a 10K resistor in their voltage divider (calculation not required).

*Final grades will be determined on a holistic examination of the evidence provided against the criteria in the achievement standard.*

All supporting materials are supplied with this programme and can be found on the TKI website.