Scheme of work – R047 Principles of electronic and programmable systems

## About this scheme of work

**Our redeveloped Cambridge National in Engineering programmable systems J824 is for first teaching from September 2022.**

This qualification provides lots of flexibility, allowing you to find the best route to suit your centre’s needs.Our curriculum planner shows you at a high level how you could teach the course over two or three years. Our schemes of work provide examples of how you could deliver each unit, integrating the knowledge and understanding learned in the externally assessed unit.

All schemes of work should provide an opportunity for integrating the knowledge and understanding learned from the externally assessed unit content alongside the NEA assessment content. This scheme of work provides one example for delivery of this unit. You may find that a different approach would work better in your centre. We have provided a blank template should you wish to create your own or adapt one of the approaches provided.

You’ve given us lots of feedback on what you need from a scheme of work, so we’ve made sure this resource features:

* a **unit-specific** and **lesson by lesson** approach
* **simple** and **editable** Word format – or you can use our [blank template](https://www.ocr.org.uk/Images/639549-scheme-of-work-template.docx) to create your own version
* links to our [curriculum planner’s first model](https://www.ocr.org.uk/Images/619714-curriculum-planner.docx) which is one teacher teaching the qualification over two years, broken down into half terms
* each lesson’s **key words**
* **ideas** for teaching and learning with useful **links**
* some ‘warm up’ teaching ideas if you’re teaching over three years.

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**Our redeveloped Cambridge Nationals can be tailored to suit your needs – so this scheme of work and the lesson ideas are only suggestions.**

## Units and guided learning hours

Here is a reminder of the **three mandatory units** in the redeveloped Cambridge National in Engineering Programmable Systems:

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| **Unit** | **Unit title** | **Guided learning hours (GLH)\*** | **How are they assessed?** | **Mandatory or optional?** |
| **R047** | **Principles of electronic and programmable systems** | 48 | E | M |
| R048 | Making and testing electronic circuits | 36 | NEA | M |
| R049 | Developing programmable systems | 36 | NEA | M |

\*GLH (guided learning hours) is the approximate time that the teacher will spend supervising or directing study time and assessment activities.

## Assumptions

* You will adapt the SOW and lesson content to match your own timetabling arrangements and will choose how to spread the 48 GLH over the two years as best fits your needs. We have worked on the basis that the average lesson time is around 45 minutes.
* Students can access some resources outside of lessons for any online homework or extension tasks.
* You will refer to the [specification](https://www.ocr.org.uk/Images/610948-specification-cambridge-nationals-engineering-programmable-systems-j824.pdf) as the key document for detailed insight into the qualification’s content and assessment requirements.

Summary of software/other equipment in this scheme of work

* Circuit schematic and simulation software (optional, if available).
* Prototyping boards, electronic components (e.g. input, output and process devices), resistors, capacitors, diodes electrical wires (optional, if available).
* Sample printed circuit boards (PCBs) (optional, if available).
* Electronic test equipment (e.g. multimeter, oscilloscope, signal generator, logic probe) (optional, if available).

## First year of teaching

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| Autumn 1 |
| **Summary of what you will cover from the** [**curriculum planner**](https://www.ocr.org.uk/Images/619714-curriculum-planner.docx)**:** | **Electronic circuit theory, laws, and calculations** |

| Lesson no. | Topic areas/sub topic areas | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA1Basic electronic circuit principles1.2.1 Circuit theory1.1 Electronic circuit parameters1.1.2 Unit multiples and submultiples | You could begin this unit with an introduction to electronics and programmable systems and their applications in everyday life.In the first lesson you could:* explain that electronics is based on the flow of electrons in a circuit
* explain how current in a circuit is related to the flow of electrons, and how current flow is required to make circuits function
* define the key electronic circuit parameters and their SI and SI derived units
* show with examples how quantities are represented using unit multiples and submultiples, and how to convert these
* introduce basic circuits and circuit symbols.

Students are required to use circuits, circuit parameters, multiples and submultiples throughout this unit and in R048 and R049 and so will revisit this topic area. | **Electron flow****Circuit parameters – AI and SI derived units****Multiples and submultiples** | Explain electron flow and conventional current flow in circuits.Recall and state the meaning of electrical circuit parameters.Simplify and convert quantities using unit multiples and submultiples. | [elect\_flow\_vs\_conv\_I.pdf (oregonstate.edu)](http://web.engr.oregonstate.edu/~traylor/ece112/beamer_lectures/elect_flow_vs_conv_I.pdf)[Electrical Units of Measure and Descriptions (electronics-tutorials.ws)](https://www.electronics-tutorials.ws/dccircuits/dcp_3.html)[units-and-symbols.pdf (theiet.org)](https://www.theiet.org/media/4173/units-and-symbols.pdf) | R048Students will draw and simulate circuits and test (virtually and physically) which includes interpreting electrical parameters. |
| 2 | TA1Basic electronic circuit principles1.2 Electronic circuit theory, laws and associated calculations1.2.1 Circuit theory | In this lesson you could introduce the types of signals and current used in electronic circuits by:* showing with examples the difference between an analogue and a digital waveform
* explaining alternating current (AC) and direct current (DC) with typical applications
* for an AC sine waveform and DC square waveform, explaining:
	+ amplitude
	+ frequency
	+ periodic time
* providing a worksheet on waveforms and types of current for students to complete.
 | **Signals – analogue and digital** | Identify and sketch analogue and digital signals and explain their relative advantages and disadvantages. | [Analog vs. Digital](https://learn.sparkfun.com/tutorials/analog-vs-digital/all) (learn.sparkfun.com)[Alternating Current](https://www.lunchboxsessions.com/materials/waveforms-signal-generation/alternating-current-lesson)(lunchboxsessions.com) | R048Students will draw and simulate circuits and test (virtually and physically) which includes interpreting electrical signals. |
| 3 | TA1Basic electronic circuit principles1.2 Electronic circuit theory, laws and associated calculations1.2.1 Circuit theory | For this lesson you could focus on series and parallel resistors circuits.You could:* explain with examples the difference between a series and a parallel circuit
* show how to calculate the total resistance of a series resistor circuit
* show how to calculate the total resistance of a parallel resistor circuit
* provide a worksheet with series and parallel circuits for students to complete.

Note that resistance in circuits that combine both series and parallel arrangements is not required. | **Series and parallel circuits** | Identify series and parallel resistor circuits, calculate total circuit resistance. | [Resistance in series and parallel circuits - How do series and parallel circuits work?](https://www.bbc.co.uk/bitesize/guides/zsk4msg/revision/5) OCR 21C - GCSE Physics (Single Science) Revision - OCR 21st Century - BBC Bitesize (bbc.co.uk) | R048Students will draw and simulate circuits and test (virtually and physically) which includes interpreting series and parallel circuits. |
| 4 | TA1Basic electronic circuit principles1.2 Electronic circuit theory, laws and associated calculations1.2.2 The relationship between voltage, current and resistance | In this lesson you could introduce students to Ohm’s Law and its application in electronics.This could be done by:* explaining the historical context of Ohm’s Law
* explaining how Ohm’s Law can be used to relate voltage, current and resistance of a circuit to one another
* showing examples of the application of Ohm’s Law in simple resistor circuits
* showing how to rearrange Ohm’s Law to solve simple circuit problems
* providing an Ohm’s Law worksheet with problems to solve.
 | **Ohm’s Law** | Recall Ohm’s Law and use to solve simple circuit problems that involve rearranging formula. | [Physics for Kids: Ohm's Law](https://www.ducksters.com/science/physics/ohms_law.php) (ducksters.com)[Ohms Law Explained - The basics circuit theory](https://www.youtube.com/watch?v=HsLLq6Rm5tU)(YouTube) | R048Students will draw and simulate circuits and test (virtually and physically) which could include applying Ohm’s Law. |
| 5 | TA1Basic electronic circuit principles1.2 Electronic circuit theory, laws and associated calculations1.2.3 The relationship between power, current and voltage | For this lesson you could introduce students to Watt’s Law (the Power Law).You could do this by:* explaining the historical context of Watt’s Law
* explaining how Watt’s Law is used to calculate the power from current and resistance in a circuit
* showing how Watt’s Law can be used to determine the power dissipated in a simple resistor circuit
* providing a worksheet with problems to solve using Watt’s Law.

Note that students are only required to use and rearrange P = I V and not any other form of this equation. | **Watt’s Law** | Recall Watt’s Law (the Power Law) and use to solve simple circuit problems that involve rearranging formula. | [What is Watt's law?](https://www.engineeringclicks.com/watts-law-formula-ohms-law/#:~:text=Watt%27s%20law%20defines%20the%20relationship,Watt%27s%20Law%20is%20P%3DIV.) (engineeringclicks.com)[Electric Power](https://learn.sparkfun.com/tutorials/electric-power/all) (learn.sparkfun.com) | R048Students will draw and simulate circuits and test (virtually and physically) which could include applying Watt’s Law. |

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| Autumn 2 |
| **Summary of what you will cover from the curriculum planner:** | **Electronic circuit components, virtual circuit prototyping and testing** |

| Lesson no. | Topic areas/sub topic areas | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA2Electronic and programmable systems, components and devices2.2 The purpose, function and typical applications of electronic circuit components and devices including the recognition and interpretation of circuit symbols2.2.1 Input components and devices | In the next series of lessons, you could introduce the systems approach including input, output, and process devices.In this lesson you could:* introduce the systems approach, explaining how systems are comprised of input, process, and output devices
* use simple examples to illustrate the systems approach, e.g. microwave oven, mobile phone, burglar alarm system
* focus on the circuit symbols, purpose, function, and typical applications of switches (input devices):
* Single Pole Single Throw (SPST) switches
* push-to-make and push-to-break switches
* tilt switches
* reed switches
* Quantum Tunnelling Composite (QTC) switches

Further aspects of the systems approach could be introduced in later lessons (e.g. signal arrows, open and closed loop, feedback) once students are familiar with input, output, and process control devices. | **Systems approach****Systems block diagrams****Input devices - switches** | Recognise basic parts of a system block diagram – inputs, outputs, process devices.Identify switch types from circuit symbol. Draw circuit symbol. Describe purpose, function, and typical application of each type.Circuit diagrams or schematics are NOT required. | [Systems - Electronic systems](https://www.bbc.co.uk/bitesize/guides/zh8ck2p/revision/1) GCSE Design and Technology Revision - BBC Bitesize (bbc.co.uk)[Switches](https://electronicsclub.info/switches.htm)(electronicsclub.info)[How a Tilt Switch Works (AKA Mercury Switch)](https://www.youtube.com/watch?v=QZWmrRkvHJk)(YouTube)[the-right-switch](https://www.raeng.org.uk/publications/other/the-right-switch)(raeng.org.uk) | R048/R049Students will use a systems approach to circuits and programming in both units, including use of input devices. |
| 2  | TA2Electronic and programmable systems, components and devices2.2 The purpose, function and typical applications of electronic circuit components and devices including the recognition and interpretation of circuit symbols2.2.1 Input components and devices | In this lesson you could continue to focus on input devices covering:* Light dependent resistors (LDRs)
* photodiodes
* NTC thermistors
* pressure sensors
* infrared sensors
* smart (WiFi enabled) sensors.

You could do this by:* showing physical examples to students if available
* explaining the purpose, function, and typical application of these devices
* showing relevant circuit symbols used to represent the devices in circuits (note circuit diagrams or schematics of applications are not required)
* producing a quiz where students match devices to a description of their purpose, function, or typical application.
 | **Input devices** | Identify range of input devices from circuit symbol. Draw circuit symbol. Describe purpose, function, and typical application of each input device.Circuit diagrams or schematics are NOT required. | [Sensors and Transducers and Introduction](https://www.electronics-tutorials.ws/io/io_1.html)(electronics-tutorials.ws)[Light Dependent Resistors](https://technologystudent.com/elec1/ldr1.htm) (technologystudent.com)[The Thermistor - A Level Physics](https://www.youtube.com/watch?v=mzzqyVU3Oro)(YouTube)[Wireless Sensors Remote Monitoring WiFi Temperature Systems IoT - Monnit](https://wireless-sensors.co.uk/) (wireless-sensors.co.uk) | R048/R049Students will use a systems approach to circuits and programming in both units, including use of input devices. |
| 3 | TA2Electronic and programmable systems, components and devices2.2 The purpose, function and typical applications of electronic circuit components and devices including the recognition and interpretation of circuit symbols2.2.3 Output components and devices | For this lesson you could look at output devices, including:* lamps
* light emitting diodes (LEDs)
* LED displays
* liquid crystal displays (LCDs)
* buzzers
* Piezo sounders
* motors.

Again, you could do this by:* showing physical examples to students if available
* explaining the purpose, function, and typical application of these devices
* showing relevant circuit symbols used to represent the devices in circuits (note circuit diagrams or schematics of applications are not required)
* producing a quiz where students match devices to a description of their purpose, function or typical application.
 | **Output devices** | Identify range of output devices from circuit symbol. Draw circuit symbol. Describe purpose, function, and typical application of each output device.Circuit diagrams or schematics are NOT required. | [Sensors and Transducers and Introduction](https://www.electronics-tutorials.ws/io/io_1.html) (electronics-tutorials.ws)[LED Basics](https://www.youtube.com/watch?v=Yo6JI_bzUzo) (YouTube)[7-segment Display and Driving a 7-segment Display](https://www.electronics-tutorials.ws/blog/7-segment-display-tutorial.html)(electronics-tutorials.ws)[Piezo Buzzers vs. Magnetic Buzzers](https://islproducts.com/design-note/piezo-buzzers-vs-magnetic-buzzers/)(islproducts.com)[DC Motor, How it works?](https://www.youtube.com/watch?v=LAtPHANEfQo)(YouTube) | R048/R049Students will use a systems approach to circuits and programming in both units, including use of input devices. |
| 4 | TA3Methods of prototyping and testing systems and circuits3.1 The purpose and characteristics of methods of prototyping circuits and systems | Before moving onto process devices, you could introduce circuit prototyping (virtual and physical) methods, and virtual testing.In this lesson you could:* introduce the reasons for prototyping circuits
* explain how software is used to virtual prototype circuits through schematic entry of circuit and simulation
* show examples of simple circuits comprising input, output and process devices being simulated in software
* hold a class discussion on the advantages and disadvantages of using software to prototype circuits.
 | **Prototyping circuits****Circuit schematic software****Circuit simulation** | Recall methods for prototyping circuits including their purpose, characteristics, reasons for use, advantages, and disadvantages. | [Circuit Simulation - Electronic Systems Video Lecture](https://www.allaboutcircuits.com/video-lectures/circuit-simulation/) (allaboutcircuits.com)[Top Ten Online Circuit Simulators](https://www.electronics-lab.com/top-ten-online-circuit-simulators/) (electronics-lab.com) | R048Students will use software to schematically draw and simulate circuits. |
| 5 | TA3Methods of prototyping and testing systems and circuits3.2 The main characteristics, purpose and use of physical and virtual measurement and test equipment | As a follow-on from the previous lesson, in this lesson you could provide a basic introduction to virtual testing of circuits.You could do this by:* giving a brief introduction to how circuits are tested virtually in software
* showing how virtual test instruments are used to measure basic circuit parameters, e.g. voltage and current
* showing how signals/waveforms are created or measured using virtual equipment
* explaining the process for using virtual instrumentation.

Students will learn, in more detail, about different measurement and test equipment later in this unit. | **Testing - virtual** | Recall methods for virtual testing, including process to be followed. | [Online circuit simulator & schematic editor](https://www.circuitlab.com/)(circuitlab.com)[Online Circuit Simulator with SPICE](https://www.partsim.com/simulator) (partsim.com)[Yenka Electronics](https://www.yenka.com/en/Yenka_Electronics/)(yenka.com)[DesignSpark](https://www.rs-online.com/designspark/home) (rs-online.com)You will find many free and subscription circuit design and simulation software packages available, some of which can be run online and some that require software installation. | R048Students will use virtual testing methods to test circuits. |

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| Spring 1 |
| **Summary of what you will cover from the curriculum planner:** | **Physical circuit prototyping methods, electronic circuit components** |

| Lesson no. | Topic areas/sub topic areas | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA3Methods of prototyping and testing systems and circuits3.1 The purpose and characteristics of methods of prototyping circuits and systems | In this lesson you could look at construction methods for physically prototyping circuits:* Modular systems kits
* Breadboard
* Stripboard
* Printed circuit boards (PCBs).

You could do this by:* explaining the purpose and reasons for physical prototyping
* showing physical examples of different prototyping methods, if available
* alternatively, using videos to illustrate and explain the characteristics of different construction methods
* holding a class discussion to examine the advantages and disadvantages of each method.
 | **Prototyping circuits****Construction methods** | Recall methods for prototyping circuits including their purpose, characteristics, reasons for use, advantages, and disadvantages. | [What's The Best Way To Prototype Circuits?](https://www.freecodecamp.org/news/whats-the-best-way-to-prototype-circuits/)(freecodecamp.org)[Breadboarding and Prototyping Circuits | Analog Devices](https://www.analog.com/en/analog-dialogue/studentzone/studentzone-november-2016.html)(analog.com)[Prototyping using breadboard and strip board](https://www.youtube.com/watch?v=i_1yAJnbR9U)(YouTube) | R048Students will use prototyping methods to construct circuits. |
| 2  | TA2Electronic and programmable systems, components and devices2.2.2 Process components and devices | The following series of lessons could look at different process devices and their application in circuit. This lesson could cover:* amplifiers
* counters
* timers
* latches
* pulse generators.

You could do this by:* explaining the purpose, function, and typical applications of these devices
* showing simple schematic diagrams or circuits using these devices to explain their purpose, function and application
* producing a worksheet where students identify devices from descriptions
* producing a quiz where students match devices to definitions e.g. amplifier = an electronic device for increasing the amplitude of electrical signals.

With suitable resources, you could show the operation of process devices using simulation software or practical demonstrations.Note: it is not required for students to produce circuits or schematic diagrams of specific circuits. | **Process devices****Amplifiers****Counters****Timers****Latches****Pulse generators** | Identify selected process devices from description. Describe purpose, function, and typical application of selected process devices.Circuit diagrams or schematics are NOT required. | [Introduction to the Amplifier an Amplifier Tutorial](https://www.electronics-tutorials.ws/amplifier/amp_1.html) (electronics-tutorials.ws)[Counters in Digital Logic](https://www.geeksforgeeks.org/counters-in-digital-logic/)(geeksforgeeks.org)[555 Timer Tutorial - The Monostable Multivibrator](https://www.electronics-tutorials.ws/waveforms/555_timer.html)(electronics-tutorials.ws)[Introduction to Latches](https://www.electronicshub.org/latches/)(electronicshub.org)[Simple 555 Pulse Generator circuits | Tested |](https://www.eleccircuit.com/simple-555-pulse-generator-circuit/)(eleccircuit.com)[Note that you will find many circuits and schematics that could be used to explain, in simple terms, the purpose, function and application of process devices. Students are not expected to understand these in detail, nor reproduce them.] | R048Students will use a systems approach to circuits including use of selected process devices. |
| 3 | TA2Electronic and programmable systems, components and devices2.2.2 Process components and devices | In this lesson you could continue to look at process devices covering:* analogue to digital converters.

You could do this by:* providing a definition of the A to D converter
* explaining its purpose, function, and application in electronic circuits and systems
* using simulation software to illustrate how an A to D converter works.
 | **Process devices****A to D converter** | Identify A to D converter from description. Describe purpose, function, and typical application of A to D converter.Circuit diagrams or schematics are NOT required. | [Analogue to Digital Converter (ADC) Basics](https://www.electronics-tutorials.ws/combination/analogue-to-digital-converter.html)(electronics-tutorials.ws)[What Is ADC Converter [The Ultimate Guide]](https://dewesoft.com/daq/what-is-adc-converter#what-is-adc)(dewesoft.com) | R048Students will use a systems approach to circuits including use of selected process devices. |
| 4 | TA2Electronic and programmable systems, components and devices2.2.2 Process components and devices | This lesson could focus on logic functions and devices, and truth tables:* AND
* OR
* NOT
* NAND.

In this lesson you could:* provide a basic introduction to digital electronics
* explain the purpose of logic functions
* show the symbols for logic functions
* show how logic functions work, and how to produce truth tables
* produce a worksheet with logic function and truth table problems for students to complete.

You could use free online simulation software to demonstrate logic functions. |  | Identify logic functions from symbols, draw logic function symbol. Complete truth tables for single logic gates. | [Logic AND Function - Digital Logic Gates](https://www.electronics-tutorials.ws/boolean/bool_1.html)(electronics-tutorials.ws)[Logic.ly Online Demo](https://logic.ly/demo/samples)[free online logic simulator] | R048Students will use a systems approach to circuits including use of selected process devices.R049Students will use software to program and implement logic functions. |
| 5 | TA2Electronic and programmable systems, components and devices2.2.2 Process components and devices | For the second lesson on logic functions, you could look at their application singly, and in combination (up to two levels).You could do this by:* reviewing the operation of logic functions singly
* showing typical applications of logic functions (e.g. burglar alarm circuit (OR), machine safety switches check circuit (AND))
* showing how logic functions can be used in combination (up to two levels only)
* producing a worksheet with logic functions (singly and combination) and truth table problems for students to complete.

You could use free online simulation software to demonstrate logic functions singly and in combination. |  | Draw logic circuits and solve logic problems for combination of logic functions up to two levels. | [Logic AND Function - Digital Logic Gates](https://www.electronics-tutorials.ws/boolean/bool_1.html) (electronics-tutorials.ws)[Logic.ly Online Demo](https://logic.ly/demo/samples)[free online logic simulator] | R048Students will use a systems approach to circuits including use of selected process devices.R049Students will use software to program and implement logic functions. |

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| Spring 2 |
| **Summary of what you will cover from the curriculum planner:** | **Passive components, power supplies and wiring** |

| Lesson no. | Topic areas/sub topic areas | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA2Electronic and programmable systems, components and devices2.2.5 Passive components | Over the next series of lessons, you could look at passive components, power supplies and circuit wiring. In these lessons you could focus on resistors, both:* fixed
* variable.

You could do this by:* explaining the purpose, function, and typical applications of fixed and variable resistors
* showing their circuit symbols
* showing physical components to students
* producing a quiz or worksheet where students identify or match resistor descriptions to their circuit symbols.

Note that, throughout this unit, students are not required to produce circuit or schematic diagrams from scratch but could be required to identify components in circuits or complete partially drawn circuits. | **Passive components****Resistors** | Identify selected resistors from circuit symbols. Draw resistor circuit symbols. Describe purpose, function, and typical application of selected resistors.Circuit diagrams or schematics are NOT required. | [Resistors](https://learn.sparkfun.com/tutorials/resistors/all)(learn.sparkfun.com)[A Complete Guide to Resistors | RS Components](https://uk.rs-online.com/web/generalDisplay.html?id=ideas-and-advice/resistors-guide)(rs-online.com) | R048Students will use passive components to simulate and construct circuits. |
| 2  | TA2Electronic and programmable systems, components and devices2.2.5 Passive components | In this lesson you could concentrate on capacitors:* polarised
* non-polarised

You could do this by:* explaining the purpose, function, and typical applications of capacitors
* explaining the differences between polarised and non-polarised capacitors
* showing their circuit symbols, including how polarised and non-polarised capacitors are denoted
* showing physical components to students
* producing a quiz or worksheet about capacitors for students (e.g. circuit symbols, purpose, function, typical applications).

Note that you do not need to cover specific types of capacitors (e.g. electrolytic, ceramic, mica, etc.). | **Passive components****Capacitors** | Identify selected capacitors from circuit symbols. Draw capacitor circuit symbols. Describe purpose, function, and typical application of selected capacitors.Circuit diagrams or schematics are NOT required. | [Capacitors](https://learn.sparkfun.com/tutorials/capacitors/all) (learn.sparkfun.com)[How Capacitors Work](https://electronics.howstuffworks.com/capacitor.htm)(electronics.howstuffworks.com) | R048Students will use passive components to simulate and construct circuits. |
| 3 | TA2Electronic and programmable systems, components and devices2.2.5 Passive components | In this final lesson on passive components, you could concentrate on:* Diodes.

You could do this by:* explaining the purpose, function, and typical applications of diodes
* showing their circuit symbols
* showing physical components to students
* producing a quiz or worksheet about diodes for students to complete (e.g. circuit symbols, purpose, function, typical applications).

Note that you only need to look at standard signal/rectifier diodes, and not any other diode type. | **Passive components****Diodes** | Identify diode from circuit symbol. Draw diode circuit symbol. Describe purpose, function, and typical application of diode.Circuit diagrams or schematics are NOT required. | [Diodes](https://electronicsclub.info/diodes.htm) (electronicsclub.info) | R048Students could use diodes when simulating and constructing circuits. |
| 4 | TA2Electronic and programmable systems, components and devices2.2.4 Drivers and interface devices: | For this lesson you could revisit output devices and look at the need for drivers and interfaces:* NPN transistors
* Darlington drivers
* Relays.

You could:* explain the purpose of driver and interface circuits and devices
* show circuit symbols for individual devices
* give examples of their applications
* explain, in basic terms, how they function
* develop a worksheet on interface drivers and devices for students to complete.

Remember, students are not required to produce circuit or schematic diagrams of interfaces from scratch but could be required to identify components in circuits or complete partially drawn circuits. | **Drivers and interfaces** | Identify driver and interface devices from circuit symbol. Draw circuit symbol of single devices. Describe purpose, function and typical application of driver and interface devices.Circuit diagrams or schematics are NOT required. | [Transistors](https://learn.sparkfun.com/tutorials/transistors/applications-i-switches) (learn.sparkfun.com)[Darlington Transistor and the Sziklai Darlington Pair](https://www.electronics-tutorials.ws/transistor/darlington-transistor.html) (electronics-tutorials.ws)[How do relays work?](https://www.explainthatstuff.com/howrelayswork.html)(explainthatstuff.com) | R048Students could use drivers and interfaces when simulating and constructing circuits. |
| 5 | TA2Electronic and programmable systems, components and devices2.2.6 Power supplies:2.2.7 Wiring types and their characteristics | In this lesson you could look at power supplies, and circuit wiring:* Power supplies:
	+ Batteries
	+ Photovoltaic (solar) cells
	+ Supercapacitor
	+ Mains adaptor
* Wiring:
	+ Single strand (solid core) wire
	+ Multi-strand (flexible) wire.

You could do this by:* providing a brief explanation of different forms of power supplies
* providing a brief explanation about different types of wiring
* showing physical examples of power supplies and wiring
* tasking students to find out about different types of power supplies, their typical applications and consider their sustainability
* tasking students to find out about different types of wiring, and their suitability for different applications.
 | **Power supplies****Wiring types** | Explain the suitability of each power supply for different applications including considerations of sustainability.Explain the suitability of different wiring types for different applications. | [How do batteries work? A simple introduction](https://www.explainthatstuff.com/batteries.html)(explainthatstuff.com)[Batteries](https://www.sustainabilityexchange.ac.uk/batteries) (sustainabilityexchange.ac.uk)[How a PV Cell Works - Knowledge Bank](https://www.solarschools.net/knowledge-bank/renewable-energy/solar/how-a-pv-cell-works)(solarschools.net)[How do supercapacitors work?](https://www.explainthatstuff.com/how-supercapacitors-work.html)(explainthatstuff.com)[What is the difference between solid and stranded cables?](https://www.universalnetworks.co.uk/faq/what-is-the-difference-between-solid-and-stranded-cables/) (universalnetworks.co.uk) | R048/R049Students will use power supplies and wiring when constructing circuits and programmable systems. |

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| Summer 1 |
| **Summary of what you will cover from the curriculum planner:** | **Commercial PCB manufacture** |

| Lesson no. | Topic areas/sub topic areas | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA4Commercial circuit production and construction methods | Over the next series of lessons, you could look at the techniques used in commercial PCB production.In this introductory lesson you could:* use physical resources or videos to show commercial PCBs
* explain the purpose and reasons for use of PCBs in products
* provide a brief introduction to how PCBs are manufactured and populated with components.

Students will cover PCB manufacture and construction in more detail in the following lessons. | **Commercial PCB manufacture** | Summarise the use of PCBs in commercial products. | [How Are PCBs Made? A Guide to the PCB Fabrication Process](https://www.newburyelectronics.co.uk/news/how-are-pcbs-made/)(newburyelectronics.co.uk)[How Commercial Printed Circuit Boards Are Made](https://hackaday.com/2017/02/08/how-commercial-printed-circuit-boards-are-made/)(hackaday.com) | R048Students will design and manufacture PCBs when constructing circuits. |
| 2  | TA4Commercial circuit production and construction methods4.1 Printed circuit boards (PCBs)4.1.1 The methods and processes for safely producing printed circuit boards (PCBs) | In this lesson you could focus on methods for manufacturing PCBs by:* photo etching
* CAM milling/routing.

This could be done by:* explaining how each of the methods is used to safely manufacture PCBs
* using practical demonstrations or videos to show the safe application of each method
* summarising the advantages and disadvantages of each method, and reasons for their use.

Students are required to safely use a suitable PCB manufacturing method in Unit R048 so will be able to relate theory with practice. | **Photo etching****CAM milling** | Explain methods and processes for manufacturing PCBs, including safety considerations, advantages and disadvantages and reasons for use. | [Circuit Skills: Circuit Board Etching](https://www.youtube.com/watch?v=tWnfnt2rNO0) (YouTube)[CNC Milling PCB using Eagle, Flatcam and GRBL](https://www.youtube.com/watch?v=yho0H7x6BEQ)(YouTube) | R048Students will design and manufacture PCBs when constructing circuits. |
| 3 | TA4Commercial circuit production and construction methods4.1 Printed circuit boards (PCBs)4.1.2 The types, characteristics, and typical uses of commercial PCBs | For this lesson you could introduce students to different types of commercial PCBs:* single sided
* double sided
* flexible.

You could:* explain each type, its characteristics, and typical uses
* use practical examples or videos to illustrate each type of PCB
* task students to investigate and summarise the applications of each different type of PCB.

Note that students are not required to design each type of PCB. They will undertake PCB design in Unit R048. | **Single sided, double sided and flexible PCBs** | Recall and describe characteristics and applications of different PCB types. | [Single-Sided vs. Double-Sided vs. Multilayer PCBs](https://www.pcbgogo.com/Blog/Single_Sided_vs__Double_Sided_vs__Multilayer_PCBs.html) (pcbgogo.com)[Flexible PCBs: advantages and disadvantages](https://www.proto-electronics.com/blog/flexible-pcbs-advantages-disadvantages)(proto-electronics.com) | R048Students will design and manufacture PCBs when constructing circuits. |
| 4 | TA4Commercial circuit production and construction methods4.2 The characteristics and processes of commercial circuit assembly methods4.2.1 The types, characteristics, and typical uses of commercial PCBs | In this lesson you could continue to look at PCB construction and layout methods with the types of components used on them and how these are configured:* Surface mount technology (SMT):
	+ pick and place assembly
* through-hole construction.

You could do this by:* explaining how through-hole and SMT components are used on PCBs, including reasons for their use
* explaining the advantages and disadvantages of using both component types
* using practical examples or videos to show through-hole and SMT components, and how a pick and place machine operates.
 | **SMT (Surface mount technology)****Pick and place****Through-hole components** | Recall and describe SMT and through-hole techniques including advantages and disadvantages of each method and reasons for use. | [Surface Mount Electronic Components and their Types](https://www.electronicslovers.com/2018/10/surface-mount-electronic-components-and-their-types.html) (electronicslovers.com)[What is SMT: Surface Mount Technology Primer » Electronics Notes](https://www.electronics-notes.com/articles/electronic_components/surface-mount-technology-smd-smt/what-is-smt-primer-tutorial.php)(electronics-notes.com)[Through-Hole Vs. Surface Mount: Contrasting Benefits and Uses](https://telancorp.com/print_through-hole-vs-surface-mount/)(telancorp.com)[PCB Assembly - Pick & Place of SMD Components](https://www.eurocircuits.com/assembly-manufacturing-technology/pick-place/)(eurocircuits.com) | R048Students will design and manufacture PCBs when constructing circuits. |
| 5 | TA4Commercial circuit production and construction methods4.2 The characteristics and processes of commercial circuit assembly methods4.2.1 The types, characteristics, and typical uses of commercial PCBs | In this final lesson on PCB construction, you could look at how components are soldered to the PCB by:* manual soldering
* flow soldering.

You could:* explain how components are assembled to the PCB by the soldering process
* illustrate manual soldering with a demonstration
* use videos to show flow soldering
* explain the advantages and disadvantages of both methods
* hold a class discussion to consider the safety aspects required when performing soldering.

Students will undertake practical soldering activities in Unit R048 which will reinforce their understanding of soldering. | **Flow soldering****Manual soldering** | Describe flow and manual soldering processes including advantages and disadvantages of each method and reasons for use. | [How To Solder: A Complete Beginners Guide](https://www.makerspaces.com/how-to-solder/)(makerspaces.com)[Electronics Assembly](https://learn.sparkfun.com/tutorials/electronics-assembly/manual-soldering) (learn.sparkfun.com)[Reflow, wave and hand soldering](https://www.youtube.com/watch?v=saOHrw4ezGw)(YouTube)[Agrowtek Wave Soldering Process for Electronics Manufacturing](https://www.youtube.com/watch?v=VWH58QrprVc) (YouTube) | R048Students will design and manufacture PCBs when constructing circuits. |

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| Summer 2 |
| **Summary of what you will cover from the curriculum planner:** | **Testing systems and circuits** |

| Lesson no. | Topic areas/sub topic areas | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA3Methods of prototyping and testing systems and circuits | Over the next series of lessons, you could look at safe setup and use of test equipment.In this lesson you could:* recap on previous knowledge of the use of virtual test equipment when performing circuit simulation in software
* introduce physical test equipment giving a brief overview of the purpose of key equipment e.g. multimeter for measuring voltage, current and resistance; continuity test for measuring continuity of a conductor; oscilloscope for looking at signals and waveforms, etc
* use physical equipment or videos to show typical test equipment.
 | **Testing – virtual and physical** | Recall and summarise reasons for virtual testing. Identify requirements for physical testing including methods to achieve this.  | [Test Equipment 101 - The Basics of Electronic Testing](https://www.circuitbasics.com/test-equipment-101-the-basics-of-electronic-testing/)(circuitbasics.com)[Testing & Test Equipment](https://www.electronics-notes.com/articles/test-methods/)(electronics-notes.com) | R048/R049Students will use virtual and physical testing techniques to test circuits and programmable systems. |
| 2  | TA3Methods of prototyping and testing systems and circuits3.2 The main characteristics, purpose and use of physical and virtual measurement and test equipment | In this lesson you could focus in more detail on the safe setup and operation of the continuity tester and multimeter.You could do this by:* explaining and showing how a continuity tester is used to check the continuity of a conductor
* explaining and showing how a multimeter is used to measure voltage, current and resistance
* providing physical test equipment for students to practice using
* developing a worksheet with questions and problems on using a continuity tester and multimeter for students to complete.

Students will undertake practical circuit testing in Unit R048 that could reinforce their understanding of safe setup and use. They could already be familiar with measuring voltage and current, and possibly resistance, using virtual instruments. | **Multimeter****Continuity tester** | Describe the safe setup and use of a multimeter to measure DC voltage and current, and resistance.Describe the processes to safely use a continuity tester.Explain the benefits and limitations of each test equipment. | [How to Use a Multimeter](https://learn.sparkfun.com/tutorials/how-to-use-a-multimeter/all)(learn.sparkfun.com)[How to Use a Multimeter](https://www.youtube.com/watch?v=SLkPtmnglOI)(YouTube)[What is Continuity and How to Test for it With a Multimeter](https://www.youtube.com/watch?v=5G622WDZaHg) (YouTube) | R048/R049Students will use physical testing techniques to test circuits and programmable systems. |
| 3 | TA3Methods of prototyping and testing systems and circuits3.2 The main characteristics, purpose and use of physical and virtual measurement and test equipment | For this lesson you could introduce the oscilloscope, and how it is used to display and measure signals.This could be done by:* explaining and showing how an oscilloscope is set up and used to measure voltage signals
* providing physical test equipment for students to practice using
* using videos if you do not have access to physical equipment
* developing a worksheet with questions and problems on using an oscilloscope for students to complete.

Students could have the opportunity to use an oscilloscope when performing testing in Unit R048. They could also be familiar with the oscilloscope from virtual testing. | **Oscilloscope** | Describe the processes to safely use an oscilloscope to test a circuit.Explain the benefits and limitations of the oscilloscope. | [How to Use an Oscilloscope](https://www.youtube.com/watch?v=u4zyptPLlJI)(YouTube)[How to Use an Oscilloscope](https://learn.sparkfun.com/tutorials/how-to-use-an-oscilloscope/all) (learn.sparkfun.com) | R048/R049Students will use physical testing techniques to test circuits and programmable systems. |
| 4 | TA3Methods of prototyping and testing systems and circuits3.2 The main characteristics, purpose and use of physical and virtual measurement and test equipment | In this lesson you could look at how to safely use a signal generator when testing circuits.You could do this by:* explaining and showing how a signal generator is setup and used to generate signals (e.g. sine and square wave, signal amplitude, signal frequency)
* providing physical test equipment for students to practise using
* using videos if you do not have access to physical equipment
* developing a worksheet with questions and problems on using a signal generator for students to complete.

Students could have the opportunity to use a signal generator when performing testing in Unit R048, depending on the type of circuit constructed. They could also be familiar with using a signal generator to produce signals when virtual testing. | **Signal generator** | Describe the processes to safely use a signal generator to test a circuit.Explain the benefits and limitations of using the signal generator. | [Signal generator](https://www.youtube.com/watch?v=833-uwiHnC8)(YouTube)[Operating a signal generator](https://www.youtube.com/watch?v=6hgHp84CqGA) (YouTube) | R048/R049Students will use physical testing techniques to test circuits and programmable systems. |
| 5 | TA3Methods of prototyping and testing systems and circuits3.2 The main characteristics, purpose and use of physical and virtual measurement and test equipment | This lesson could look at how to safely use a logic probe to check logic signals.As for previous lessons, you could do this by:* explaining and showing how a logic probe is safely set up and used to measure logic high and logic low signals
* providing physical test equipment for students to practice using
* developing a worksheet with questions and problems on using a logic probe for students to complete.

Students could have the opportunity to use a logic probe when performing testing in Unit R048, depending on the type of circuit constructed. They could also be familiar with the logic probe from virtual testing. | **Logic probe** | Describe the processes to safely use a logic probe to test a circuit.Explain the benefits and limitations of using a logic probe. | [Logic Probe - special tool tips and tricks](https://www.youtube.com/watch?v=CFqf6DzgDuw) (YouTube)[Fix it Friday! - (Logic Series 01) Using a Logic Probe](https://www.youtube.com/watch?v=PbFqZk9Pyfg)(YouTube) | R048/R049Students will use physical testing techniques to test circuits and programmable systems. |

**Second year of teaching**

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| Autumn 1 |
| **Summary of what you will cover from the curriculum planner:** | **Programmable systems, system block diagrams** |

| Lesson no. | Topic areas/sub topic areas | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA2Electronic and programmable systems, components and devices2.1 Methods of representing electronic circuits and systems and interpretation of them | Over the next series of lessons, you could return to the systems approach, looking at system block diagrams in more detail, including:* input, process and output blocks
* open and closed loop systems
* signal arrows
* feedback loops.

In this lesson you could:* recap on previous knowledge of block diagrams, using examples to show input, output, and process blocks
* explain how signal arrows are used on block diagrams
* hold a class discussion to identify systems where feedback is used to control the system (e.g. an oven where you set the desired temperature and the oven controls this temperature)
* introduce, using examples, the idea of open loop and closed loop systems.
 | **Systems approach****System block diagrams** | Recall from previously the systems approach. Identify input, output, and process parts of block diagrams including signal flow and feedback loops.Identify and explain open and closed loop systems. | [Systems - Electronic systems](https://www.bbc.co.uk/bitesize/guides/zh8ck2p/revision/1)(GCSE Design and Technology Revision - BBC Bitesize)[Open-loop System and Open-loop Control Systems](https://www.electronics-tutorials.ws/systems/open-loop-system.html) (electronics-tutorials.ws)[Closed-loop System and Closed-loop Control Systems](https://www.electronics-tutorials.ws/systems/closed-loop-system.html)(electronics-tutorials.ws) | R048/R049Students will use a systems approach to circuits and programming in both units. |
| 2 | TA2Electronic and programmable systems, components and devices2.2.1 Input components and devices2.2.3 Output components and devices | Before moving on to looking at the systems approach in more detail, you could use this lesson to recap on input and output devices.You could:* explain the purpose of input and output devices
* show how they form part of a system, and are used in the systems approach
* recap the function and operation of selected input and output devices:
* input devices –
	+ switches
	+ Light Dependent Resistors (LDRs)
	+ NTC thermistors
	+ pressure sensors
* output devices –
	+ lamps
	+ Light emitting diodes (LEDs)
	+ LED displays
	+ buzzers
	+ motors.
 | **Input and output devices** | Recall the purpose, function and operation of selected input and output devices in preparation for creating system block diagrams. | [Sensors and Transducers and Introduction](https://www.electronics-tutorials.ws/io/io_1.html)(electronics-tutorials.ws) | R048/R049Students will use a systems approach to circuits and programming in both units, including use of input and output devices. |
| 3 | TA2Electronic and programmable systems, components and devices2.1 Methods of representing electronic circuits and systems and interpretation of them | Over the next two lessons you could focus in more detail on the systems approach, giving students the opportunity to review and complete these.In this lesson you could:* use examples of a selection of simple open and closed loop system block diagrams showing the system layout of familiar products, e.g. oven temperature control, burglar alarm, security light, fridge temperature control, microwave oven
* produce a worksheet for students to identify system components, e.g. inputs, outputs, process blocks, feedback loops.
 | **System block diagrams** | Apply knowledge of system block diagrams, input, output, and process devices to draw or complete system block diagrams. | [Block Diagram - Learn about Block Diagrams, See Examples](https://www.smartdraw.com/block-diagram/) (smartdraw.com)[Understanding Electronics Block Diagrams with Example](https://www.eleccircuit.com/understanding-electronics-block-diagrams-with-example/)(eleccircuit.com) | R048/R049Students will use a systems approach to circuits and programming in both units, including use of input and output devices. |
| 4 | TA2Electronic and programmable systems, components and devices2.1 Methods of representing electronic circuits and systems and interpretation of them | In this lesson you could complete looking at system block diagrams.You could:* develop a quiz where students identify if a system is open or closed loop, giving reasons for use of either type of system
* produce a worksheet with partially completed system block diagrams for students to complete.

Students could:* select and add suitable input or output devices
* add missing signal arrows
* add missing process blocks
* add missing feedback loops.
 | **System block diagrams** | Consolidate knowledge of system block diagrams, input, output, and process devices to draw or complete system block diagrams.  | [Examples of Closed-Loop Control System](https://electronicscoach.com/examples-of-closed-loop-control-system.html)(electronicscoach.com)[Understanding Electronics Block Diagrams with Example](https://www.eleccircuit.com/understanding-electronics-block-diagrams-with-example/)(eleccircuit.com)[You will be able to find further examples of simple system block diagrams for different products on the Internet] | R048/R049Students will use a systems approach to circuits and programming in both units, including use of input and output devices. |
| 5 | TA2Electronic and programmable systems, components and devices2.3 Programmable components and systems | For this lesson you could begin focussing on programmable systems and their applications.You could do this by:* giving a general introduction to programmable systems and their applications in everyday life
* using physical examples or videos to illustrate different applications of programmable systems
* explaining the reasons for use of programmable systems
* setting a student activity to investigate the advantages and disadvantages of programmable systems.
 | **Programable systems** | Summarise the typical applications of programmable devices including their reasons for use, advantages, and disadvantages. | [What is a microcontroller? ft. Raspberry Pi Pico](https://www.youtube.com/watch?v=ZY-HrRGCQ4w) (YouTube)[What is a Microcontroller?](https://www.youtube.com/watch?v=bFxOVdHbzvs) (YouTube)[What is a microcontroller?](https://www.youtube.com/watch?v=EeRXSKfaYjA)(YouTube) | R049Students will develop and program a programmable system. |

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| Autumn 2 |
| **Summary of what you will cover from the curriculum planner:** | **Programmable systems and programming languages** |

| Lesson no. | Topic areas/sub topic areas | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA2Electronic and programmable systems, components and devices2.3 Programmable components and systems2.3.1 The main characteristics and typical applications of programmable components | Over the next series of lessons, you could focus on different types of programmable systems and how they are programmed. In this lesson you could look at microcontrollers.You could:* begin with a general introduction to the microcontroller, highlighting its use in many everyday products and systems
* use physical examples or videos to illustrate microcontroller applications
* explain, in basic terms, the main characteristics of a microcontroller and how it allows input signals to be processed and outputs to be controlled through programming
* task students to investigate further microcontroller applications.
 | **Microcontroller** | Describe the main characteristics and typical applications of microcontrollers. | [Everything You Need to Know About Microcontrollers | RS Components](https://uk.rs-online.com/web/generalDisplay.html?id=ideas-and-advice/microcontrollers-guide) (rs-online.com)[What is a microcontroller? ft. Raspberry Pi Pico](https://www.youtube.com/watch?v=ZY-HrRGCQ4w)(YouTube) | R049Students will identify and program a microcontroller. |
| 2  | TA2Electronic and programmable systems, components and devices2.3 Programmable components and systems2.3.1 The main characteristics and typical applications of programmable components2.3.2 Types of programming languages and systems and their main features | In this lesson you could continue looking at programmable systems with the Programmable Logic Controller (PLC).You could do this by:* giving a general introduction to the PLC, highlighting its use in industrial systems and applications where they are often in a rugged environment
* using physical examples or videos to illustrate PLC applications
* explaining, in basic terms, the main characteristics of a microcontroller and how it allows input signals to be processed and outputs to be controlled through programming
* tasking students to investigate further PLC applications.
 | **PLC (Programmable Logic Controller)** | Describe the main characteristics and typical applications of PLCs. | [What is Process Automation?](https://www.youtube.com/watch?v=uEhuxYXPTOE)(YouTube)[Programable Logic Controller Basics Explained - automation engineering](https://www.youtube.com/watch?v=uOtdWHMKhnw)(YouTube)[What is Ladder Logic?](https://www.youtube.com/watch?v=qaI48NCUvkA)(YouTube) |  |
| 3 | TA2Electronic and programmable systems, components and devices2.3.1 The main characteristics and typical applications of programmable components2.3.2 Types of programming languages and systems and their main features | Over the next several lessons you could look at how programmable devices are programmed. In this lesson you could focus on text-based languages and block-based editors.You could do this by:* illustrating how text-based languages and block-based editors are used to produce a simple program
* showing side-by-side examples of an identical program function being implemented using a text-based and a block-based editor
* holding a class discussion to identify the advantages and disadvantages of each method.

Note that students are not required in this unit to write or produce a program themselves. | **Text and block-based editors** | Identify the use of text-based languages and block-based editors and describe the advantages and disadvantages of each type.Writing or producing programs is NOT required. | [Coding, Programming, Block-Based, Text-Based… What Does it All Mean?](https://www.teq.com/coding-programming-what-does-it-all-mean/)(teq.com)[Block-Based vs. Text-Based Programming](https://www.teq.com/block-vs-text-based-programming/)(teq.com) | R049Students will use selected programming method to program a microcontroller. |
| 4 | TA2Electronic and programmable systems, components and devices2.3 Programmable components and systems2.3.2 Types of programming languages and systems and their main features | Following on from the previous lesson, you could look at how flowcharts are used for programming systems.You could:* illustrate how a flowchart can be used to produce a simple program
* explain how different flowchart symbols are used, e.g. start, process, arrow, decision, etc.
* hold a class discussion to identify the advantages and disadvantages of using flowcharts for programming.

Note that students are not required in this unit to write or produce a program themselves. | **Flowcharts** | Identify the use of flow charts for programming and describe the advantages and disadvantages of using flow charts.Writing or producing programs is NOT required. | [Guide to Flowchart Symbols, from Basic to Advanced](https://www.gliffy.com/blog/guide-to-flowchart-symbols)(gliffy.com) [Flowgorithm - Flowchart Programming Language](http://www.flowgorithm.org/)(flowgorithm.org)[How to Make a Flowchart for Programming Easy to Understand](https://www.technokids.com/blog/teaching-strategies/how-to-make-a-flowchart-for-programming-easy-to-understand/)(technokids.com) | R049Students will use selected programming method to program a microcontroller. |
| 5 | TA2Electronic and programmable systems, components and devices2.3 Programmable components and systems2.3.2 Types of programming languages and systems and their main features | In this final lesson on programable systems you could consolidate knowledge of their applications, different types of system hardware and how systems are programmed.You could:* produce flashcards on the advantages and disadvantages of different programming techniques for students to match to their relevant programming type, e.g. text-based, block-based, flowchart
* task students to complete a short presentation on the relative merits of each programming type.
 | **Programmable systems** | Summarise the relative merits of using different programming techniques for specific applications. | [Block-Based vs. Text-Based Programming](https://www.teq.com/block-vs-text-based-programming/)(teq.com)[Guide to Flowchart Symbols, from Basic to Advanced](https://www.gliffy.com/blog/guide-to-flowchart-symbols)(gliffy.com)  | R049Students will use selected programming method to program a microcontroller. |

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| Spring 1 |
| **Summary of what you will cover from the curriculum planner:** | **Circuits and circuit theory (revisited)** |

| Lesson no. | Topic areas/sub topic areas | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA1Basic electronic circuit principles1.1.1 Electronic circuit parameters and their SI or SI derived units of measurement:1.1.2 Unit multiples and submultiples1.2.1 Circuit theory | Over the following series of lessons, you could return to topic areas covered previously giving students the opportunity to solve further problems. In this lesson you could revisit:* SI and SI derived units
* multiples and submultiples
* series and parallel resistor circuits.

You could do this by:* providing a general recap to each topic area
* using worksheets with problems for students to solve.
 | **Circuit parameters – SI and SI derived units****Multiples and submultiples****Series and parallel circuits** | Recall and identify circuit parameters and their SI units or derived units.Solve problems involving multiples and submultiples.Solve series and parallel resistor circuit problems. | [Electrical Units of Measure and Descriptions](https://www.electronics-tutorials.ws/dccircuits/dcp_3.html) (electronics-tutorials.ws)[units-and-symbols.pdf](https://www.theiet.org/media/4173/units-and-symbols.pdf) (theiet.org)[Resistance in series and parallel circuits - How do series and parallel circuits work?](https://www.bbc.co.uk/bitesize/guides/zsk4msg/revision/5) OCR 21C - GCSE Physics (Single Science) Revision - OCR 21st Century - BBC Bitesize (bbc.co.uk) | R048Students will draw and simulate circuits and test (virtually and physically) which includes interpreting electrical parameters, series and parallel circuits. |
| 2  | TA1Basic electronic circuit principles1.2 Electronic circuit theory, laws and associated calculations1.2.2 The relationship between voltage, current and resistance | In this lesson you could revisit:* Ohm’s Law.

You could:* recap how Ohm’s Law can be used to determine resistance, voltage or current in a circuit
* provide a worksheet with Ohm’s Law problems for students to work through.
 | **Ohm’s Law** | Recall Ohm’s Law and rearrange to solve circuit problems. | [Physics for Kids: Ohm's Law](https://www.ducksters.com/science/physics/ohms_law.php) (ducksters.com)[Ohms Law Explained - The basics circuit theory](https://www.youtube.com/watch?v=HsLLq6Rm5tU) (YouTube) | R048Students will draw and simulate circuits and test (virtually and physically) which could include applying Ohm’s Law. |
| 3 | TA1Basic electronic circuit principles1.2 Electronic circuit theory, laws, and associated calculations1.2.3 The relationship between power, current and voltage | For this lesson you could revisit:* Watt’s Law.

You could do this by:* recalling how Watt’s Law can be used to determine power in a circuit
* providing a worksheet with Watt’s Law problems for students to work through.

Note that students are only required to use and rearrange P = I V and not any other form of this equation. | **Watt’s Law** | Recall Watt’s Law and rearrange to solve circuit problems. | [What is Watt's law?](https://www.engineeringclicks.com/watts-law-formula-ohms-law/#:~:text=Watt%27s%20law%20defines%20the%20relationship,Watt%27s%20Law%20is%20P%3DIV.) (engineeringclicks.com)[Electric Power](https://learn.sparkfun.com/tutorials/electric-power/all) (learn.sparkfun.com) | R048Students will draw and simulate circuits and test (virtually and physically) which could include applying Watt’s Law. |
| 4 | TA2Electronic and programmable systems, components and devices2.2 The purpose, function and typical applications of electronic circuit components and devices including the recognition and interpretation of circuit symbols2.2.1 Input components and devices | In this lesson you could revisit the purpose, function and application of:* input devices.

You could:* develop a worksheet where students identify or draw circuit symbols
* develop a match card quiz where students match input devices to their purpose, function or application
* task students to produce a poster summarising selected input devices.
 | **Input devices** | Identify input devices from circuit symbols.Draw circuit symbols. Describe the purpose, function, and application of selected input devices. | [Inputs - Electronic systems](https://www.bbc.co.uk/bitesize/guides/zh8ck2p/revision/2)GCSE Design and Technology Revision - BBC Bitesize (bbc.co.uk)[Sensors and Transducers and Introduction](https://www.electronics-tutorials.ws/io/io_1.html) (electronics-tutorials.ws) | R048/R049Students will use input devices in circuits and programmable systems. |
| 5 | TA2Electronic and programmable systems, components and devices2.2 The purpose, function and typical applications of electronic circuit components and devices including the recognition and interpretation of circuit symbols2.2.3 Output components and devices | For this lesson you could revisit the purpose, function, and application of:* output devices.

You could:* develop a worksheet where students identify or draw circuit symbols
* develop a match card quiz where students match output devices to their purpose, function, or application
* task students to produce a poster summarising selected output devices.
 | **Output devices** | Identify output devices from circuit symbols.Draw circuit symbols. Describe the purpose, function, and application of selected output devices. | [Outputs - Electronic systems](https://www.bbc.co.uk/bitesize/guides/zh8ck2p/revision/6)(GCSE Design and Technology Revision - BBC Bitesize)[Sensors and Transducers and Introduction](https://www.electronics-tutorials.ws/io/io_1.html)(electronics-tutorials.ws) | R048/R049Students will use output devices in circuits and programmable systems. |

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| Spring 2 |
| **Summary of what you will cover from the curriculum planner:** | **Electronic components (revisited)****Examination revision (revision of Topic Areas)** |

| Lesson no. | Topic areas/sub topic areas | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA2Electronic and programmable systems, components and devices2.2 The purpose, function and typical applications of electronic circuit components and devices including the recognition and interpretation of circuit symbols2.2.2 Process components and devices | In this lesson you could return to looking at process devices. This could include:* amplifiers
* counters
* timers
* latches
* pulse generators.

You could:* produce a quiz for students to match applications to their equivalent process device
* produce a worksheet for students to explain the purpose and function of selected process devices.
 | **Process devices** | Identify selected process devices from description. Describe purpose, function, and typical application of selected process devices.Circuit diagrams or schematics are NOT required. | [Introduction to the Amplifier an Amplifier Tutorial](https://www.electronics-tutorials.ws/amplifier/amp_1.html)(electronics-tutorials.ws)[Counters in Digital Logic](https://www.geeksforgeeks.org/counters-in-digital-logic/)(geeksforgeeks.org)[555 Timer Tutorial - The Monostable Multivibrator](https://www.electronics-tutorials.ws/waveforms/555_timer.html)(electronics-tutorials.ws)[Introduction to Latches](https://www.electronicshub.org/latches/)(electronicshub.org)[Simple 555 Pulse Generator circuits](https://www.eleccircuit.com/simple-555-pulse-generator-circuit/) (eleccircuit.com)Note that you will find many circuits and schematics that could be used to explain, in simple terms, the purpose, function and application of process devices. Students are not expected to understand these in detail, nor reproduce them. | R048Students will use process devices in circuits. |
| 2  | TA2Electronic and programmable systems, components and devices2.2 The purpose, function and typical applications of electronic circuit components and devices including the recognition and interpretation of circuit symbols2.2.2 Process components and devices | You could, in this lesson, continue looking at process devices. This could include:* analogue to digital converters
* logic functions.

You could do this by:* producing a worksheet about the A to D converter for students to complete, e.g. purpose, function, and typical applications
* producing a worksheet or quiz with logic function problems to solve, e.g. logic functions singly and in combination.
 | **Process devices** | Identify selected process devices from description. Describe purpose, function, and typical application of selected process devices.Circuit diagrams or schematics are NOT required. | [Analogue to Digital Converter (ADC) Basics](https://www.electronics-tutorials.ws/combination/analogue-to-digital-converter.html)(electronics-tutorials.ws)[What Is ADC Converter [The Ultimate Guide]](https://dewesoft.com/daq/what-is-adc-converter#what-is-adc) (dewesoft.com)[Logic AND Function - Digital Logic Gates](https://www.electronics-tutorials.ws/boolean/bool_1.html)(electronics-tutorials.ws)[Logic.ly Online Demo](https://logic.ly/demo/samples)[free online logic simulator] | R048Students will use process devices in circuits. |
| 3 | TA3Revision | The final series of lessons covers revision of the topic areas. You could use worksheets and quizzes to test student knowledge and understanding across selected topics from each area.The first revision session covers methods for prototyping circuits:* virtual prototyping and circuit simulation
* modular systems kits
* breadboard
* stripboard
* printed circuit boards (PCBs).
 | Revision TA3 | Recall methods for prototyping circuits including reasons for use, advantages, and disadvantages of each method. | [What's The Best Way To Prototype Circuits?](https://www.freecodecamp.org/news/whats-the-best-way-to-prototype-circuits/)(freecodecamp.org)[Breadboarding and Prototyping Circuits | Analog Devices](https://www.analog.com/en/analog-dialogue/studentzone/studentzone-november-2016.html)(analog.com)[Prototyping using breadboard and strip board](https://www.youtube.com/watch?v=i_1yAJnbR9U) (YouTube) |  |
| 4 | TA3Revision | In this revision session you could look at methods for testing circuits including the safe use of test equipment:* multimeter
* continuity tester
* oscilloscope
* signal generator
* logic probe.
 | Revision TA3 | Recall methods for testing circuits including the process for safe use of selected test equipment, advantage, and disadvantage of each. | [Test Equipment 101 - The Basics of Electronic Testing - Circuit Basics](https://www.circuitbasics.com/test-equipment-101-the-basics-of-electronic-testing/)(circuitbasics.com)[How to Use a Multimeter](https://learn.sparkfun.com/tutorials/how-to-use-a-multimeter/all) (learn.sparkfun.com)[What is Continuity and How to Test for it With a Multimeter](https://www.youtube.com/watch?v=5G622WDZaHg)(YouTube)[How to Use an Oscilloscope](https://learn.sparkfun.com/tutorials/how-to-use-an-oscilloscope/all) (learn.sparkfun.com)[Operating a signal generator](https://www.youtube.com/watch?v=6hgHp84CqGA)(YouTube)[Fix it Friday! - (Logic Series 01) Using a Logic Probe](https://www.youtube.com/watch?v=PbFqZk9Pyfg)(YouTube) |  |
| 5 | TA4Revision | For this lesson you could develop a worksheet to look at commercial PCB production:* photo etching
* CAM milling/routing
* single sided
* double sided
* flexible.
 | Revision TA4 | Recall methods for commercial PCB production, including reasons for use and advantages and disadvantages of each method. | [How Commercial Printed Circuit Boards Are Made](https://hackaday.com/2017/02/08/how-commercial-printed-circuit-boards-are-made/)(hackaday.com)[Circuit Skills: Circuit Board Etching](https://www.youtube.com/watch?v=tWnfnt2rNO0) (YouTube)[CNC Milling PCB using Eagle, Flatcam and GRBL](https://www.youtube.com/watch?v=yho0H7x6BEQ)(YouTube)[Single-Sided vs. Double-Sided vs. Multilayer PCBs](https://www.pcbgogo.com/Blog/Single_Sided_vs__Double_Sided_vs__Multilayer_PCBs.html) (pcbgogo.com)[Flexible PCBs: advantages and disadvantages](https://www.proto-electronics.com/blog/flexible-pcbs-advantages-disadvantages) (proto-electronics.com) |  |

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| Summer 1 |
| **Summary of what you will cover from the curriculum planner:** | **Examination revision (revision of Topic Areas)** |

| Lesson no. | Topic areas/sub topic areas | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA4Revision | This session could look at PCB assembly methods:* surface mount technology (SMT):
	+ pick and place assembly
	+ flow soldering
* through-hole construction
* manual soldering.
 | Revision TA4 | Recall PCB types, characteristics, and typical applications. Recall methods for placing and soldering components to PCBs. | [What is SMT: Surface Mount Technology Primer » Electronics Notes](https://www.electronics-notes.com/articles/electronic_components/surface-mount-technology-smd-smt/what-is-smt-primer-tutorial.php)(electronics-notes.com)[Through-Hole Vs. Surface Mount: Contrasting Benefits and Uses](https://telancorp.com/print_through-hole-vs-surface-mount/) (telancorp.com)[Electronics Assembly](https://learn.sparkfun.com/tutorials/electronics-assembly/manual-soldering) (learn.sparkfun.com)[Agrowtek Wave Soldering Process for Electronics Manufacturing](https://www.youtube.com/watch?v=VWH58QrprVc) (YouTube) |  |
| 2  | TA2Revision | For this lesson you could return to looking at programmable systems:* microcontrollers
* Programmable Logic Controllers (PLCs).
 | Revision TA2 | Recall the advantages and disadvantages of using programmable systems. Recall the characteristics and typical applications of microcontrollers and PLCs. | [What is a Microcontroller?](https://www.youtube.com/watch?v=bFxOVdHbzvs)(YouTube)[What is a microcontroller?](https://www.youtube.com/watch?v=EeRXSKfaYjA)(YouTube)[What is Process Automation?](https://www.youtube.com/watch?v=uEhuxYXPTOE)(YouTube)[Programable Logic Controller Basics Explained - automation engineering](https://www.youtube.com/watch?v=uOtdWHMKhnw)(YouTube) |  |
| 3 | TA2Revision | In this lesson you could revisit how programmable systems are programmed using:* text-based languages
* block-based editors
* flowchart systems.
 | Revision TA2 | Recall the use of different methods for programming systems including their advantages, disadvantages, and relative merits for specific applications. | [Coding, Programming, Block-Based, Text-Based… What Does it All Mean?](https://www.teq.com/coding-programming-what-does-it-all-mean/) (teq.com)[Block-Based vs. Text-Based Programming](https://www.teq.com/block-vs-text-based-programming/)(teq.com)[How to Make a Flowchart for Programming Easy to Understand](https://www.technokids.com/blog/teaching-strategies/how-to-make-a-flowchart-for-programming-easy-to-understand/)(technokids.com) |  |
| 4 | TA1Revision | In the final revision sessions, you could return to selected parts of circuits and circuit theory. This could include:* SI and SI derived units
* multiples and submultiples
* series and parallel resistor circuits.
 | Revision TA1 | Recall circuit parameters, multiples, and submultiples, and solve problems for series and parallel circuits. | [Electrical Units of Measure and Descriptions](https://www.electronics-tutorials.ws/dccircuits/dcp_3.html)(electronics-tutorials.ws)[units-and-symbols.pdf](https://www.theiet.org/media/4173/units-and-symbols.pdf) (theiet.org)[Resistance in series and parallel circuits - How do series and parallel circuits work?](https://www.bbc.co.uk/bitesize/guides/zsk4msg/revision/5) (OCR 21C - GCSE Physics (Single Science) Revision - OCR 21st Century - BBC Bitesize) |  |
| 5 | TA1Revision | In this revision session you could provide worksheets with problems using:* Ohm’s Law
* Watt’s Law.
 | Revision TA1 | Recall Ohm’s Law and Watt’s Law and rearrange to solve circuit problems. | [Physics for Kids: Ohm's Law](https://www.ducksters.com/science/physics/ohms_law.php)(ducksters.com)[Ohms Law Explained - The basics circuit theory](https://www.youtube.com/watch?v=HsLLq6Rm5tU)(YouTube)[What is Watt's law?](https://www.engineeringclicks.com/watts-law-formula-ohms-law/#:~:text=Watt%27s%20law%20defines%20the%20relationship,Watt%27s%20Law%20is%20P%3DIV.) (engineeringclicks.com)[Electric Power](https://learn.sparkfun.com/tutorials/electric-power/all) (learn.sparkfun.com) |  |

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| Summer 2 |
| **Summary of what you will cover from the curriculum planner:** | **Examination revision (practice questions)** Note: this could occur in parallel with revision work of Summer 1. |

| Lesson no. | Topic areas/sub topic areas | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 onwards | Exam revision | You could reserve the final series of lessons for examination revision using practice questions:* give students different types and styles of questions to practise answering, including short and long answer questions
* show students how to analyse and decompose the requirements of question, including how command verbs are used
* show how marks are allocated across questions, and what is required to achieve the marks indicated on the exam paper
* get students to attempt questions, peer mark others’ answers and discuss.
 | Exam revision | Analyse and practise exam style questions. Be able to provide responses to a selection of different types of exam question.Use teacher and peer review to inform further revision. | [OCR’s guide to understanding the assessment – examined and moderated](https://www.ocr.org.uk/Images/612302-understanding-the-assessment-examined-and-moderated.pdf):* p 9 command words
* pp 12-18 exam question types

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**Teaching over three years**

Some centres may choose to start their delivery of the qualification earlier in Year 9, and so deliver over three years. The following topic areas are suggestions of what could form part of early delivery.

|  |  |  |
| --- | --- | --- |
| Topic area | Warm up/introductory activities | Length of time activity may take |
| TA1 | Students could start to become familiar with circuit theory through the construction of simple circuits. You could include series and parallel circuit using a battery and lamps. You could show how a series circuit requires all devices to be connected for current to flow, and how in a parallel circuit the current divides (e.g. with two or more lamps in series, brightness is less in each lamp than a parallel circuit). You could use this to explain, in simple terms, Ohm’s Law and Watt’s Law. Safe working will be essential for this activity. | 3-4 hours |
| TA2 | You could introduce students to selected input and output devices, which they could use to construct simple circuits. Devices could include switches (toggle, push, reed, tilt), lamps, buzzer, relays, motors. You could extend this to creating simple logic functions with physical circuits (e.g. AND, OR) by connecting switches in series or in parallel. Safe working will be essential for this activity. | 4-5 hours |
| TA2 | You could introduce students to programmable systems with an activity to investigate their applications in everyday products around the home, in transport such as cars, and in industrial applications and machines. Students could undertake research, working in groups, and present their findings as a presentation or as a poster. This activity will also be useful for Unit R049. | 2-3 hours with extra time for working in small groups to create a presentation or poster. |
| TA3 | Students could start to familiarise themselves with the safe use of test equipment with looking at how the multimeter is safely used to measure voltage, current and resistance. You could extend the circuit construction activities above to allow students to measure voltages at points within the circuit, flow of current, and check resistance of components. This will include safe setup and operation of the multimeter. This activity will also be useful for Unit R048. | 3-4 hours |

Please note – web links are correct at date of publication but other websites may change over time. If you have any problems with a link you may want to navigate to that organisation’s website for a direct search.



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