**The IET**



**Coding the Future**

**Teacher Handbook**

**Could you be our engineer….?**

The IET DIY Faraday Challenge Day ‘Coding the Future’ is based on the Faraday Challenge Day of the same name, a STEM activity day written and delivered by the National Schools Partnership on behalf of the Institution of Engineering and Technology (IET).

The IET Education website hosts a wide range of teaching resources for science, design and technology and maths. These include classroom activities with film clips, online games, posters, careers resources and STEM activity days.

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**Stay safe**

Whether you are a scientist researching a new medicine or an engineer solving climate change, safety always comes first. An adult must always be around and supervising when doing this activity. You are responsible for:

* ensuring that any equipment used for this activity is in good working condition
* behaving sensibly and following any safety instructions so as not to hurt or injure yourself or others

Please note that in the absence of any negligence or other breach of duty by us, this activity is carried out at your own risk. It is important to take extra care at the stages marked with this symbol: ⚠

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**Introduction**

The Institution of Engineering and Technology (IET) is one of the world’s leading professional societies for the engineering and technology community. As a charity we are committed to the advancement of science, engineering and technology, encouraging young people to study the Science, Design and Technology, Engineering and Mathematics (STEM) subjects and to consider careers within the engineering and technology sectors. We provide a wide range of activities, classroom materials and other learning resources, including the IET Faraday Challenge Days, to schools across the UK.

**Who is it for?**

The Faraday Challenge ‘Coding the Future’ has been designed for six teams of six students (36 students in total) aged between 11-13 years. The challenge has been specifically designed to give students the opportunity to research, design, develop and make creative solutions to genuinely tough engineering problems, independent of their level ability. This activity is therefore suitable for a range of different ability levels without adaptation. However, the challenge will work best for students who can work effectively as a team and have good problem solving and perseverance.

**How to use the challenge resources**

The aim of this challenge is to introduce students to cutting edge technology which engineers are, and will be using in the future and this challenge will work best if you have access to the BBC micro:bit or any other processor which can be coded (e.g. Arduino, Raspberry Pi, etc.) at your school or a local venue. Running this challenge could be a great opportunity to make links with a local university, college or industry. This may mean splitting the day into different sessions for example:

Session 1 – Imagine and Design (incorporating stage 1 and 2)

Session 2 – Create (incorporating stage 3)

Session 3 – Present (incorporating stage 4 and 5)

The resources are set up to be used with the BBC micro:bit and Touch Develop code editor ([www.microbit.co.uk](http://www.microbit.co.uk)) and so may need to be adapted to fit with the technology that you have available and the code editor you are using.

# The Context

Coding is part of the world for all of us; from gaming to working our mobile phones, our computers, even our washing machines. Coding enables us to provide instructions in a form which computers can understand. This means that computers can help us to do things which otherwise may be much more difficult.



# The Scenario

As computers become more common in our everyday lives engineers are using coding more frequently to solve everyday problems. Today your challenge is to code your BBC micro:bit for a real-life application. You will work in teams of engineers to solve a problem or to change or improve people’s experience in an area of our everyday lives. You will experience what engineers do as they work together to develop a new product. You will need to use all your STEM skills as well as skills in teamwork, perseverance, creativity and innovation. You will need to be brave – engineering is not for the faint hearted!

**Today is your chance to make a difference, could you be our engineer..........?**

**The Brief**

You will need to choose one of the following four themes:

* Health
* Sport
* Travel
* Home and leisure

You will then need to develop two products for the real-world within the theme. Finally you will pitch your product to the Coding the Future judges.

Divide your team to work on two ideas. These could be separate or linked together. Think about how your idea could solve a problem or change or improve someone’s life. How will they be used by people?

You will need to work effectively as a team. In order to do this your team will need some of you to take on a role in addition to being a Faraday Code Crew Software Engineer. These additional roles will give some of your team the responsibility for manging or marketing the project, budgeting and keeping to time.

You will need to develop a marketing pitch for your presentation to the Coding the Future judges. Your pitch will need to convince the judges that your products are the ones they should invest in.

Your team will need to:

1. **Identify** a range of applications that your BBC micro:bit could be used for.
2. **Identify** the two products that your team are going to put forward. Remember that these must both be from the same theme.
3. **Code** your BBC micro:bit to bring your ideas to life.
4. **Construct** any components you need to add to your BBC micro:bit to make it work effectively.
5. **Develop** your marketing pitch.
6. **Demonstrate** the capabilities of your two ideas by presenting them to the Coding the Future judges.

**Considerations**

Your BBC micro:bit products must:

* both be within one of the four themes
* have relevant and useful real-life applications
* demonstrate engineering skills and show creativity and innovation
* be effective and cost efficient.

**Assessment information and criteria**

Students will be judged on the following criteria

|  |  |
| --- | --- |
| Criteria | Marks |
| 1. Planning and research | 10 marks |
| 1. Development of product | 20 marks |
| 1. Use of budget | 8 marks |
| 1. Functionality of coding | 14 marks |
| 1. Functionality of product | 22 marks |
| 1. The pitch | 16 marks |
| 1. Teamwork | 10 marks |
| **Total** | **100 marks** |

1. **Planning and research (10 marks)**

Using Stage 1 of the planning sheet provided, marks will be awarded for:

* Identifying at least two creative and innovative ideas for the BBC micro:bit in each of the four themes ***(6 marks)****.*
* Identifying how your ideas could solve problems or change or improve our everyday lives ***(4 marks).***

1. **Development of BBC micro:bit products (20 marks)**

Using Stage 2 and 3 of the planning sheet provided, marks will be awarded for:

* Identifying two ideas within the same theme which have real-life applications ***(6 marks)****.*
* Identifying the advantages and disadvantages of your ideas ***(4 marks).***
* Demonstrating a willingness and ability to adapt your designs or overcome problems where necessary ***(5 marks).***
* Demonstrating an understanding of how effectively your chosen engineering roles worked both for the product design and for your team as a whole ***(5 marks).***

1. **Use of budget (8 marks)**

Use of the accountancy sheet to record all of the costs the team has incurred. Marks will be awarded for:

* Accuracy of expenses – maintains an accurate record of expenses ***(2 marks)****.*
* Cost effectiveness – sensible use of budget for research and development of product ***(6 marks)****.*

**4. Functionality of BBC micro:bit coding (14 marks)**

Your BBC micro:bit products will be judged on:

* How appropriate is the code for the intended purpose? ***(4 marks)***
* How well does the code work ***(6 marks)***
* How effectively did your team work on the code? ***(4 marks)***

**5. Functionality of BBC micro:bit product (22 marks)**

Your BBC micro:bit products will be judged on:

* Manufacture quality - how well your prototypes work, including any external components and packaging ***(6 marks).***
* Creativity – how creative and innovative your prototypes are. ***(6 marks).***
* Application – the extent to which your prototypes have a useful real-life application ***(10 marks).***

1. **The pitch (16 marks)**

Your pitch to the judges will be marked on:

* Your reasons for choosing the theme and for the two ideas within your theme ***(3 marks).***
* How effectively you used your STEM knowledge to produce your prototypes ***(3 marks).***
* How effectively you demonstrate the ways in which your prototypes will work in the real world (this may involve you using resources to package or house your prototypes) ***(4 marks).***
* What roles each team member chose and how effectively these enabled you to work together as a team and produce your prototypes ***(4 marks)***
* How effectively you communicate your ideas to the BBC micro:bit Code Crew and remain within the time limit ***(2 marks).***

1. **Teamwork (10 marks)**

Marks are awarded for:

* How well you work as a team with all members working together effectively ***(4 marks)****.*
* How well your team persevered in the development of the BBC micro:bit products ***(4 marks).***
* How tidy, safe and organised your working area is kept ***(2 marks)****.*

**Snapshots and tips for the Faraday Challenge**

**SETUP:**

|  |  |
| --- | --- |
| **08:00**  Set up for the day | * Student workstations, Judges area (room layout and requirements, p. 14). * Laptop charging station * Materials shop/Technician’s area. * Get extra help (at least two colleagues) |
| **09:15-09:30**  Students arrive | * One team per table (6 teams of 6 students). * Teams’ complete registration forms. |

|  |  |
| --- | --- |
| **09:30**  Introduction to coding | * Introduction to the day, IET and housekeeping * Introduce STEM and careers message * Do ‘brushing your teeth’ as introduction to coding |
| **09:40**  Video briefing | * Show the briefing film. * Re-cap of the challenge. * Re-cap of the pitch. * Overview of how students can win points. |
| **10:00**  Tools to help you | * Provides an overview of how students can seek support throughout the challenge. |
| **10:03**  Tips for working safely | * Briefs students on health and safety requirements for the day. |

**STAGE 1:**

|  |  |
| --- | --- |
| **10:05**  Planning and research | * Identifying ideas in each of the four themes and considering how these might improve people’s lives. * Brainstorming, planning and research. * At the end of this stage, teams should complete stage 1 on their planning and reflections sheet. |
| **10:20**  Role allocation | * Each team must decide which roles they will need to adopt in order to achieve success. Not all students need to take on a role but stress the importance of a project manager and accountant. * Stress that all students will be software engineers and therefore should be involved in the coding. * A brief overview of these roles has been provided on page 24. |
| **10:25**  Role allocation | * Introduce students to the BBC micro:bit and handout two laptops to each team. * The coding apprenticeship can be short or removed if students are used to using the processor and the code editor selected. |

**STAGE 2:**

|  |  |
| --- | --- |
| **10:35**  Development | * The shop opens – suggest that only the Accountant plus one other member of the team goes to the shop to purchase materials in avoid the shop manager becoming inundated. * Students commence development and build of solution. |

|  |  |
| --- | --- |
| **11:10** | Short break |

**STAGE 3:**

|  |  |
| --- | --- |
| **11:20**  Modifications | * In this session students will continue the build and development of their solution. * They must also discuss and implement modifications of their solution. * At the end of this stage, teams should complete stage 2 and 3 on their planning and reflections sheet. |
| **12:10**  Pitch briefing | * Brief the marketing managers and/or project managers on the contents of the pitch. This should be one pitch containing the two products. * Remind them to read the marking criteria for the pitch. * Remind them they must demonstrate their two prototype products. You may wish to provide battery packs to those teams which want to move around with their products during the pitch. |

|  |  |
| --- | --- |
| 12:30 | Lunch |

**STAGE 4:**

|  |  |
| --- | --- |
| **13:00**  Final preparations | * Students will finalise the build and development of their two products’ * They will begin to prepare their pitch. Provide paper for notes if required. |
| **13:30**  Shop closes | * Ask the accountants to take their accounts sheet and any remaining Faradays back to the shop. * Collect in laptops and mark codes. * Ask students to practise their pitch. |

**STAGE 5:**

|  |  |
| --- | --- |
| **14:00**  The pitch | * Teams to present their products. Teams should have a maximum of 7 minutes to present. * Judges to ask questions to clarify ideas or elicit discussions which have taken place during the construction and development of their products. |
| **14:40**  The pitch | * Students to tidy up and return resources to the shop. * Students’ complete evaluation (if required). * Judges complete marking. |

**WRAP UP:**

|  |  |
| --- | --- |
| **14:45** | * Highlight strengths and areas for improvement on each teams’ solution. * Announcement of winning team. |
| **15:00** | * Students depart |

**Checklist for running the Faraday Challenge Day**

|  |  |  |
| --- | --- | --- |
| **Student tables** | **Quantity** | **Notes** |
| Student booklet | 1 per table | See Student booklet |
| Roles and responsibilities (laminated) | 1 per table | See p. 24 |
| A4 Reflections and planning sheet | 1 per table | See Planning Sheet |
| Team station label (team number) | 1 per table | See Teacher pack |
| Faraday branded currency | **Each team** - 8 Faradays  1 x 20F  3 x 10F  4 x 5F  10 x 1F | See Teacher extras pack |
| Role cards (name cards) | 6 role cards per table | See Student booklet |
| Student team registration form | 1 per student table | See p.23 |
| **Teacher** | **Quantity** | **Notes** |
| Teacher’s booklet |  | Current document |
| Presentation | Hard copy with notes and electronic copy | See Introductory presentation |
| Projector and screen with sound |  | Provided by your school |
| Assessment matrix | 1 per event (can be entered into electronic version for calculating scores and uploading for IET | See p.18 |
| Certificates | 1 per student | See Teacher extra pack |
| A4 plain paper | 2 sheets free per team for notes/planning | Provided by your school |
| Laptops and charging leads | 2 per team (14) | Provided by your school |
| **Shop** | **Quantity** | **Notes** |
| Resource list for shop manager/technician |  | See p.20 |
| Materials price tags |  | See Teacher Extra pack |
| Faraday branded currency | Shop change kitty:  10 x F10  20 x F 5  30 x F1 | See Teacher Extra pack |
| STEM consultant name tag |  | See Teacher Extra pack |
| STEM consultant card |  | See Teacher Extra pack |
| **Signage** | **Quantity** | **Notes** |
| Shop | 1 | See Teacher Extra pack |
| Judges table | 1 | See Teacher Extra pack |

**Room layout**

Notes:

* Each team table will need 6 chairs and be large enough for 6 students to work comfortably with 2 laptops and peripheral items. The judges’ table and shop will each need 2 chairs. Table positions do not need to be exact and can be arranged to best accommodate the shape and size of the venue.
* The laptop charging tables must be next to a minimum of 2 plug sockets and be near the front of the room.



**Schedule for the day**

|  |  |
| --- | --- |
| **08:00** | **Challenge Day Leader arrives – assistance required to unload kit and connect laptops to internet.** |
| **09:00** | **Engineering teams arrive at school** |
| **09:15** | **Teams to tables to register their team** |
| **09:30** | **Introduction to coding** |
| **09:40** | **Introduction to the Faraday Challenge** |
| **10:05** | **STAGE 1: Identifying the problems and generating initial ideas**   * Brainstorming of ideas |
| **10.20** | **Introduction to the BBC Micro:bit** |
| **10:25** | **STAGE 2: Development** ⚠   * Complete coding entry apprenticeship * Agree on final product designs |
| **10:40** | **Allocation of roles** |
| **10:45** | **Shop opens** ⚠   * Create shopping list |
| **11:10** | **Break** |
| **11:20** | **STAGE 3: Modifications**⚠   * Continue to design and code and modify where necessary |
| **12:10** | **Briefing for the pitch**   * Project and/or marketing managers are briefed on the content of the pitch |
| **12:30** | **Lunch** – Tools down |
| **13:00** | **STAGE 3 continued: Final preparations**⚠   * Finalise coding * Prepare pitch with notes |
| **13:30** | **STAGE 4: Presentation**   * Shop closes and coding finishes – laptops are removed * Submit accounting sheet to the Shop keeper * Practise pitch |
| **14:00** | **STAGE 5: Final test** ⚠   * Teams pitch their designs to the judges |
| **14:45** | **Award ceremony**   * Final feedback and evaluation of the day and winning team announced |
| **15:00** | **Finish - Engineering teams depart, Challenge Day Leader packs away kit.** |
| **15:45** | **Challenge Day Leader departs** |

**Risk assessment example** (page 1 of 2)

|  |  |  |  |
| --- | --- | --- | --- |
| **Risk Assessment and Operating Procedure - IET** | | | |
|  | | | |
| **Activity: Faraday Challenge Days Coding the Future** | | | |
| **Persons at risk** | Students taking part in the Faraday Challenge Day and adults in the location | | |
| **Maximum Group Size** | 36 students | Recommended Staffing/Student Ratio | 1:6 |
|  | | | |
| **Risk Assessment** | | | |
| **Hazards** | | **Control Measures** | |
| 1. **Use of electrical equipment – risk of electric shock** | | All electrical equipment is low voltage. | |
| 1. **Use of electrical equipment – short circuit causing heating** | | Warn students of the possibility of burns when connecting and disconnecting components. All pupils will receive a briefing about correct use of electrical components. | |
| 1. **Basic use of hand tools (screwdrivers, scissors, hole punches, staplers) – risk of cutting or abrasion** | | Warn students of the risks and advise them of safe working practices. | |
| 1. **Use of extensions cables – risk of tripping** | | Make sure that extension cables are not extended across the floor where students and adults will be walking. Ensure students and adults are aware of the location of the cable. | |
| **Location issues** (to be completed by Host School) | |  | |
| Further Action Required: 1. Ensure all persons staffing the Faraday Challenge Days are aware of and competent to comply with this risk assessment and the control measures. | | | |

**Risk Assessment** (page 2 of 2)

|  |  |
| --- | --- |
| **Working Practice** | |
| **Group structure** | Two members of staff from the host school to be present during the whole day to oversee use of equipment and to keep order. |
| **Restrictions** | Unknown premises. |
| **Emergency**  **Procedure** | Follow the lead from the Host School.  Facilitator to be fully briefed on risk assessment procedure prior to the day. |
| **Safety Equipment** | First aid kit and fire extinguisher (electrical fires) to be provided by Host School. |
| **Name and role of IET Faraday Challenge representative** |  |
| **Name and role of school representative** |  |
| **Signature of the school representative** |  |
| **Date of this Review** |  |

**Assessment matrix**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Assessment Criteria | | Team  1 | Team  2 | Team  3 | Team  4 | Team  5 | Team  6 |
| Planning and research | 10 |  |  |  |  |  |  |
| Development of prototype | 20 |  |  |  |  |  |  |
| Use of budget | 8 |  |  |  |  |  |  |
| Functionality of coding | 14 |  |  |  |  |  |  |
| Functionality of product | 22 |  |  |  |  |  |  |
| The pitch | 16 |  |  |  |  |  |  |
| Teamwork | 10 |  |  |  |  |  |  |
| **Total score** | **100** |  |  |  |  |  |  |
| **Faradays spent** |  |  |  |  |  |  |  |

|  |  |
| --- | --- |
| **Team** | **School/Team name** |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |

**Full list of materials to purchase from the shop**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Item** | **Description** | | **Unit** | **Cost** |
| Crocodile leads |  | Lead with crocodile clips at each end | Each | 5 Faradays |
| Piezo buzzer |  | Connect to the rings in a circuit to give a sound output | Each | 8 Faradays |
| LEDs – green + resistor |  | LED which can be connected to the rings in circuit – green. Must be used with a resistor. | Each | 10 Faradays |
| LEDs – amber + resistor |  | LED which can be connected to the rings in a circuit – amber. Must be used with a resistor. | Each | 10 Faradays |
| Thermistor  + resistor |  | Component that detects the ambient temperature and changes resistance to allow a current to flow through a circuit. Must be used with a resistor. | Each | 15 Faradays |
| Light Dependent Resistor + resistor |  | Component that detects the light level and changes resistance to allow a current to flow through a circuit when it becomes dark. Must be used with a resistor. | Each | 15 Faradays |
| Resistor |  | Component used in a circuit to ensure that the correct current is supplied to other electrical components in the circuit. | Each | Comes free with LED, thermistor and LDR |
| Potentiometer |  | Component used to adjust the sensitivity of a sensor in an electrical circuit. | Each | 10 Faradays |
| Polyfoam |  | A5 foam sheet – assorted colours | Each | 10 Faradays |
| Coloured card |  | A4 sheet of card – assorted colours | Each | 5 Faradays |
| Tin foil |  | A conductive material | 30cm strip | 5 Faradays |
| Masking tape |  | Can be used to secure parts in your design - do not stick anything to your BBC micro:bit or it may not work properly. | 30cm piece | 5 Faradays |

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Description** | **Unit** | **Cost** |
| Sticky tape | Can be used to secure parts in your design - do not stick anything to your BBC micro:bit or it may not work properly. | 30cm piece | 5 Faradays |
| Rectangular sponges | Can be used to make pressure switches or enhance your design. | Each | 5 Faradays |
| Cardboard tube | Can be used to reduce or focus light levels or enhance your design | Each | 5 Faradays |
| Cable ties | Can be used to hold your BBC micro:bit onto a background | Each | 5 Faradays |
| Scissors | Used for soft materials only – do not use to cut wires or any part of your BBC micro:bit. | Each | 5 Faradays |
| Stapler | Used to staple soft materials only – do not use to staple anything to your BBC micro:bit | Each | 5 Faradays |
| Hole punch | Used to make small holes in soft materials | Each | 5 Faradays |
| Rulers | Used to measure any part of your product or additional items | Each | 5 Faradays |
| String | Can be used as part of your product design | 30cm piece | 5 Faradays |
| Calculators | Can be used to calculate resistance and to help with accounting | Each | FREE |
| Codes to buy | Complete codes which your team can buy to copy or adapt – ask the shop keeper for information on the codes available for purchase | Each | 50 Faradays |

**AVAILABLE ON THE LAPTOP:**

|  |  |  |
| --- | --- | --- |
| **Item** | **Description** | **Cost** |
| Coding support sheets | PDFs of support sheets and PowerPoints under ‘New to Coding’ | FREE |
| PowerPoint | Basic software for creating a presentation | FREE |

**AVAILABLE ON THE JUDGES/PRESENTATION TABLE:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Description** | **Cost** | |
| Coding support sheets | Hard copies (laminated) of ‘How to …..’ support sheets | FREE |

The Coding Support sheets can be provided to help students get started on their products. We recommend you print 3 or 4 of each so that students have access to these when needed. You may also wish to put an electronic copy of the document on the laptops/computers the students are working on.