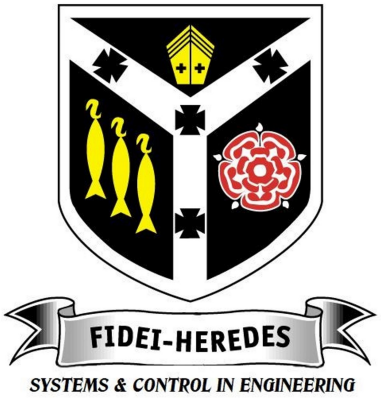
OCR Systems and Control in Engineering



The title of the qualification is:-

OCR Level 2 Cambridge National Certificate in Systems Control in Engineering

(120 GLH) code J843

Link to the Specification website (external link to the OCR qualification page)

This qualification is divided into four units of work. Each part is worth 25% of the overall course.

Each unit is 30 guided learning hours.

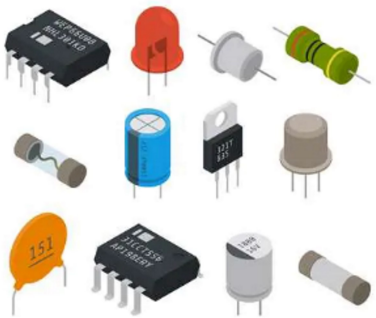
The examination will be completed at the end of Year 10. It will be 1 hour long.

The school based assignments contain both a practical and written method of assessment marked by Mr. Hodgson. You will complete these in class using a combination of electronics tools, equipment, computer simulations, and evidence including a report summary.

You will be required to pass all the units of work to gain the Level 2 qualification.

Unit Number	Unit Title	GLH	Assessment Method
113	Electronic Principles	30	1 hour exam (Taken at then end of Year 10)
114	Simulate, Construct and Test Electronic Circuits	30	School based assignment marked and assessed by Mr Hodgson (Year 10)
115	Engineering Application of Computers	30	School based assignment marked and assessed by Mr Hodgson (Year 11)
116	Process Control Systems	30	School based assignment marked and assessed by Mr Hodgson (Year 11)

Unit 113 - Electronic Principles



PURPOSE OF THE UNIT

This unit will develop your knowledge of basic electronic principles and considers how these can be applied to the design, maintenance and repair of electrical/electronic systems used within engineering products.

You will develop knowledge and understanding of basic electronic principles such as values for voltage, current, resistance and power, circuit components, symbols and diagrams, circuit configurations, potential dividers and power sources.

You will learn the fundamentals of electronic circuits and be able to calculate resistor and capacitor values applying them to a range of electronic circuits.

You will use techniques to identify potential electrical hazards and apply fault-finding procedures using multi-meter for voltage, current, resistance and continuity.

On completion of this unit, you will have knowledge of how basic electronic circuits operate and understand how to measure and calculate circuits and their component values as well as how to test circuits.

You will be able to apply knowledge and understanding gained in this unit to help with the completion of units R115 and R116.

Unit 113 - Learning Outcomes

Learning Outcome — You will:
LO1 Understand basic electronic principles
LO2 Understand the operating principles of electronic components
LO3 Know test methods for electronic circuits
LO4 Understand commercial circuit construction methods

Unit 113 – LO1 Understand basic electronic principles

Content	Activities	Timings	Relevance to
1 Components and Circuits	You will be given real electrical components to handle, and workbooks will be completed with pictures and circuit symbols of components to identify. You will be asked to research components using catalogues, data sheets and supplier websites such as:- https://www.rapidonline.com/ https://uk.rs-online.com/web/ Learning various aspects of different electrical components such as purpose, description, aesthetics, function, size, units, values and cost. You will be shown circuit diagrams to identify various components and to encourage them to research components not yet recognised. An outcome of the activity will be an expectation that learners develop their skills in identifying a range of electrical components alone and as part of circuits.	1 hour	R101 (LO2) R114
2 Principles, Units and Measurement	You will be taught an understanding of principles through practical demonstrations and have simple practical experiments for the learners to perform. Simulation software will also be used. (Circuit Wizard) Other ways of showing electrical principles and units might be through the use of videos and resources from the internet Such as induction show at http://www.youtube.com/watch?v=KGTZPTnZBFE or those at http://www.schoolscience.co.uk/home You will use practical test equipment to make circuit measurements, and use the simulation software to explore the types of measurement equipment available and their applications. Circuits will be modelled/explored to reinforce the link between principles, units and measurement. As an outcome you will be expected to be able to explain a number of electrical principles (e.g. electromotive force, potential difference, resistance, capacitance, induction, frequency) and their associated units of measurement. See Lesson Element: Principles, Units and Measurement.	2 hours	R101 (LO2) R114

Unit 113 – LO1 Understand basic electronic principles

Content	Activities	Timings	Relevance to
3 Ohms Law and power law	You will learn and then be able to use Ohms Law to determine voltage, resistance and current in a circuit. Ohms Law: https://www.youtube.com/watch?v=-mHLvtGjum4 You will learn about the power law which allows you to calculate how powerful an electronic product is. The wattage of a product is the term used to describe the power. Energy used by a device such as a bulb is typically measured in Kw/hour or in joules. You will build and test practical circuits using simple components to understand Ohms Law and the power law. Simulation software will also be used. (Circuit Wizard) The workbook will allow you to practice the calculations required for simple circuits. Familiarity and practice is the key to learning Ohms Law and the power law. Through practice it is an expectation that you could understand and confidently perform calculations using Ohms Law and the power law.	1 hour	R101 (LO2) R114
4 Series and Parallel Resistors and Potential Divider	You will learn about how to combine resistors together to form specific values. By selecting resistors from the E12 series and placing them in series and parallel it is possible to make any value that may be required in a circuit. You will learn about the potential divider which can be used to reduce a voltage in a circuit. This will allow a smaller voltage to be made from a larger supply. It can also be used in a sensor circuit which can be used to trigger another system such as a light/dark/hot/cold/wet/dry sensor. You will build and test practical circuits using resistors as the teacher explains the theory of how series and parallel circuits and how a potential divider works. Simulation software will be used to reinforce the learning of the topic. Internet videos will also be a useful way to show the theory involved in combining resistors. e.g. parallel resistors:- https://www.youtube.com/watch?v=MxH7hnuBfC4 You will practice calculating series and parallel resistance and potential divider values with the aid of a suitably developed workbook. Through practice examples you should be able to securely develop their understanding of this area.	1 hour	R101 (LO2)
5 Power Sources and Regulators	You will learn how to select different power sources and their applications in society. Voltage regulators will be demonstrated practically by the teacher, and you will perform practical experiments using real life components and simulations. Datasheets, manufacturer catalogues and supplier websites will be used for you to select and find technical data about voltage regulators. It will be expected that as a result you could identify and explain a range of electrical power sources matching them to suitable applications, and also explain the purpose and function of voltage regulators.	1 hour	R101 (LO2)

Unit 113 - LO2 Understand the operating principles of electronic components

Content	Activities	Timings	Relevance to
1 Cables, Resistors and Capacitors	You will be given wires, cables, resistors and capacitors to investigate, and research their function and operation using catalogues, datasheets and the internet. You will use workbooks to learn and explain the components. You will be encouraged to appreciate the different applications and capabilities of different types and style of components. An outcome of the activity is an expectation that you could identify different types of cable, resistors and capacitors along with giving examples of where they are used.	2 hours	R114
2 RC Applications	You will learn about the need for electrical time delays in different situations (e.g. security light time delay, bathroom fan delay, intermittent car wipers) before moving on to learning about RC (Resistor/capacitor) circuits where a time delay can be used. Practical demonstrations and learner-performed experiments will be a way of showing RC circuits in action. These will also be done using circuit simulation software, and with Microsoft Excel to plot graphs. This will be a way to develop your ICT skills. Through experimentation you should be able to understand and explain what time constant is and how this is related to R and C, as an expected outcome of this activity. See Lesson Element: RC Applications.	2 hours	R114
3 Switches	You will begin by being shown the different types of switches available, and their typical applications. The teacher will start with simple examples such as a room light switch, or two-way switching in a hallway to explain different applications. The function and operation of switches will be demonstrated with practical switching circuits, or using software simulation. Explanation of using switches in digital circuits will be given. This includes the problem of 'switch bounce' and the requirement for clean signals obtained by using a monostable circuit, logic gates and a schmitt trigger. It is an expected outcome that you will be able to explain the function, operation and give some examples of different types of switches (spst, spdt, dpst, dpdt)	2 hours	R114

Unit 113 - LO2 Understand the operating principles of electronic components

Content	Activities	Timings	Relevance to
4 Protection	You will be learn what electrical circuit protection is, how it might be achieved and its purposes. (protecting circuit operation, protecting against faults and unsafe conditions). The operation of fuses practically can be seen in the following video:- http://www.youtube.com/watch?v=QjE1k17MsqM Similarly, diode protection could be demonstrated by watching the video:- https://www.youtube.com/watch?v=fGj99yUmhSw Through familiarity you should be expected to be able to explain circuit protection using fuses and diodes .	1 hour	R114
5 Systems Approach	You will learn what a computer control system is and the fundamentals behind the systems approach – INPUT, PROCESS, OUTPUT This will be related to real-life systems such as a computer, microwave oven and lead into process control with computer-aided manufacture. You will then work in groups to draw and present simple block diagrams of control systems. Visits to local factories, if possible, might be a way of seeing real control systems in operation. Alternatively, internet videos might be used https://www.youtube.com/watch?v=IfojHo9cVOk It is an expected outcome that you will be able to explain the key parts of a control system and be able to draw simple block diagrams showing input, process and output.	1 hour	R116

Unit 113 - LO2 Understand the operating principles of electronic components

Content	Activities	Timings	Relevance to
6 Input Devices	You will learn about different input devices (sensors) that could be used as the input to a control system. Scenarios and Pictures and/or real life examples might be provided and demonstrations or practical experiments could be performed. Learners should be able to appreciate the different conditions that can be sensed by each device, and give some typical applications. An expected outcome is that you could be able to explain and relate to typical applications a range of input devices. Light, temperature, sound, position and pressure sensors, amongst others, will be explored.	2 hours	R116
7 Output Devices	You will learn about a range of different output devices (actuators) used as part of control systems. Practical devices will be shown to learners and pictures of electronic systems output devices in products / real life. Experimentation or demonstrations with real devices will be a way of reinforcing understanding. You will need to be able to appreciate the output that will be generated by each device. An expected outcome is that you will explain the function and operation of output devices, and relate to practical applications. Solenoids, relays, buzzers and light-emitting diodes, amongst others, will be explored. The measured values of components will be learned. This will include the voltage required to operate the devices, how much current they require to work, and how they can be controlled in electronic circuits such as from a 555 timer, microcontroller, or switch.	2 hours	R116

Unit 113 - LO2 Understand the operating principles of electronic components

Content	Activities	Timings	Relevance to
8 Process Devices	You will learn about process devices which are split into two areas:- **Semiconductors** :- such as transistors, thyristors, diodes and transistors. **Integrated circuits**:- such as logic gates, op-amps, timers and microcontrollers. You will begin by looking at common components and the typical types of each from the available range. Referring to manufacturer's datasheets and catalogues and identifying components, will explain their function and operation. You will build and test circuits (real and using simulation software) to prove it is useful to develop not only theoretical understanding but also the use of real and virtual test equipment. This will begin to develop fault-finding skills. You will build circuit examples and use workbooks to support experimentation and also to test understanding. You will summarise these in the form of simple report thereby developing English skills.	3 hours	R116
9 DC Motors	You will learn about the applications of D.C. Motors in electrical products (e.g. vacuum cleaner, washing machine, electric car). You will research how a D.C. motor works and present findings back to the group. https://www.youtube.com/watch?v=9Wby4aHyXJQ You will also need to appreciate the principle of commutation, which is used as part of a commercial D.C. motor.	1 hour	R101 (LO2)
10 Smart materials	You will learn the meaning of the term 'Smart Materials' and how it is related to a change in the properties of a material. You will begin by investigating smart materials, how they function and their applications. The teacher will demonstrate real smart materials to show the way materials can change their properties. You will use research and samples to explore the range of smart materials:- For example smart memory alloys:- https://www.youtube.com/watch?v=424-3G0jNqU You will be expected to be able to explain typical applications and special characteristics of different types of smart material.	1 hour	R109 (LO1)

Unit 113 - LO3 Know test methods for electronic circuits

Content	Activities	Timings	Relevance to
1 Electrical Hazards	You will learn about different types of electrical hazards, and their implications towards safety. Pictures or a suitable video showing electrical hazards will be shown https://www.youtube.com/watch?v=Hq8wN-pUaqw Real examples will be shown to you. Worksheets will be completed to learn about visually identifiable hazards. Risk assessment / control measures will be explained. You will learn about portable appliance testing (PAT), and the applications and operation of residual current devices (RCDs). See Lesson Element: Electrical Hazards.	2 hours	R114 (LO2)
2 Fault Finding and Test Equipment	You may already have developed fault-finding skills and used test equipment in others areas of this unit and so this might be an opportunity to consolidate existing knowledge. You will begin by learning fault finding techniques such as visual inspection, half-split and testing. You will be given practical circuits with faults to identify using suitable test equipment. You should be exposed to fault-finding using both physical and virtual equipment. Equipment including multi-meters, logic probes and oscilloscopes will be used to trace, measure and locate logic, signals and current in circuits. You will be expected to know how to fault find a basic electrical fault and diagnose the problem.	2 hours	R114 (LO3)

Unit 113 - LO4 Understand commercial circuit construction methods

Content	Activities	Timings	Relevance to
1 Component Types and Surface Mount Technology	You will learn about different component types (through-hole and surface mount). By handling real components and circuit boards you will develop an appreciation of physical size and construction issues. You will be taught the benefits and disadvantages of using surface mount components. Suitable videos might be used to demonstrate commercial circuit board manufacture using different component types https://www.youtube.com/watch?v=2qk5vxWY46A	1 hour	R114 (LO1 & LO2)
2 Circuit Manufacture	You will manufacture your own circuit boards using the photo-etch method. The teacher may arrange a visit to see circuit board manufacturing and testing in practice. Observing commercially made boards will demonstrate several important factors including layout, size, spacing, nesting and cost. You will research commercial circuit board manufacture using the internet by looking at pick-and place robots, flow soldering and manual component placement.	1 hour	R114 (LO1 & LO2)
3 Quality Assurance for Printed Circuit Boards	If an industrial visit were arranged then quality assurance would most likely be seen in practice alongside circuit board manufacture. Teacher will use industrial knowledge and experience to Videos will be shown of automatic testing of circuit boards in action https://www.youtube.com/watch?v=YegtDW42peg You will learn about the different types of circuit boards, quality assurance methods used including visual inspection and automatic testing.	1 hour	R114 (LO1 & LO2)

Unit 114 – Simulate, Construct and Test Electronic Circuits

PURPOSE OF THE UNIT

This unit covers construction techniques and processes used in the manufacture of electronic and electrical circuits. It uses computer based simulation software to prototype and test the operation of circuits and produce designs for printed circuit boards (PCB).

You will develop knowledge and understanding of the construction techniques and processes used in the manufacture of electronic and electrical circuits. On completion of this unit, you will understand how to build and evaluate the performance of a simple electronic circuit.

Studying this qualification will allow you to apply knowledge and understanding gained in this unit to help develop your skills further during the completion of Units R115 and R116.

Unit 114 - Learning Outcomes

Learning Outcome — You will:
LO1 Be able to use CAD for circuit simulation and design
LO2 Be able to construct circuits
LO3 Be able to test electronic circuits

Unit 114 – LO1 Be able to use CAD for circuit simulation and design

Content	Activities	Timings	Relevance to
1 Circuit schematics and CAD	You will be investigating how circuits can be designed, simulated and PCB layout produced using CAD software, including the key features of different types of software available. You will then explore practically software, such as Circuit Wizard or similar, before moving on to entering your own design schematically. You will be shown features of software including how to place components from a component library, connect components together and prepare for simulation. See Lesson Element Circuit schematics and CAD.	4 hours	R101 (LO2) R114
2 Circuit simulation and test using CAD	You will begin by explaining the purpose and benefits of circuit simulation compared with building a physical circuit. You will then take a design schematic and run this as a simulation. Concepts such as the use of virtual power sources and virtual measuring and test instruments will be part of this process.	4 hours	R101 (LO2) R114
3 PCB design using CAD	You will begin by researching the advantages and disadvantages of producing a PCB for a circuit design compared with using stripboard, breadboard or other types of experimental manufacture. You will then take a tested schematic circuit and using CAD software convert this to a PCB layout ready for manufacture. The use of component libraries and good layout techniques will be part of this process. You will also be required to export the design ready for manufacture.	4 hours	R101 (LO2) R114

Unit 114 – LO2 Be able to construct circuits

Content	Activities	Timings	Relevance to
1 Practical safe PCB manufacture	You will begin by researching the different techniques that are available for small-scale circuit board manufacture (i.e. photo-resist, etch resist and engraving/ milling). Advantages and disadvantages of each technique will be compared. Internet videos might be used to explore these (e.g. PCB milling and construction: http://www.youtube.com/watch?v=w4Ypo_4zHvo) if we are not able to show you these in school. You will learn about health and safety when producing a PCB. You will undertake a risk assessment activity of the process of making a PCB using the photo-etch method. You will take a CAD-based PCB design and manufacture this using the photo-etch method.	4 hours	R101 (LO2), R114
2 PCB construction techniques and safe use of tools	You will learn electronic construction techniques. Practical activities will include the use of hand-tools (e.g. soldering irons, snips, side cutters, screwdriver) and the process of drilling, soldering and assembly of components. The correct use of PPE will also be included. Safety will be a key feature of any practical activity, and so you will be encouraged to undertake a risk assessment activity. You will practice using hand-tools and soldering before moving on to constructing a PCB for real. You can watch Internet videos that support these activities (e.g. soldering: http://www.youtube.com/watch?v=fYz5nIHH0iY)	2 hours	R101 (LO2), R114
3 Practical safe PCB construction	You will construct PCB's using the techniques that will have been developed and practiced. You will be expected to identify the tools and PPE required, and to undertake a risk assessment. You will populate a PCB with components. Care and attention to detail will be important for you to achieve a satisfactory result that meets a required standard of quality. Other techniques that you will be shown:- Use of heat sinks to protect sensitive components; Desoldering incorrectly placed components; joining wires and connections to the PCB; fitting the PCB to a case.	4 hours	R101 (LO2), R114

Unit 114 – LO3 Be able to test electronic circuits

Content	Activities	Timings	Relevance to
1 Visual inspection of PCBs	You will be show a range of faults that can be identified by visual inspection of PCBs. These could include: checking for correct fitting of components, misplaced components, dry joints and bridged tracks. You will be given an activity to identify faults from, and suitable internet videos (e.g. dry solder joint:) to see the different mistakes that can prevent circuits from working correctly. http://www.youtube.com/watch?v=9VYA9ufb4Jc With guidance, you will then visually inspect your own PCB's before moving onto applying power and testing.	2 hours	R101 (LO2), R114
2 Using test equipment	You will research test equipment available for testing circuit operation. This will include: power supplies, multi-meter, logic probe, signal generator and oscilloscope. You will be shown the application and function of a range of appropriate test equipment that is available for you to practically test your own circuit board. Safe use of test equipment will also be important in order to avoid injury or circuit damage and so you might undertake a risk assessment activity. You will be guided to practice using test equipment on simple circuits prior to testing on your circuits and PCB's.	2 hours	R101 (LO2), R114
3 Fault finding techniques for electronic circuits	Testing and fault finding of the your PCB's will build upon techniques that have already been developed in visual inspection and using test equipment. You will be asked to consider how you will test your PCB, and to justify the techniques and test equipment you will use. You will test your circuits for correct operation against expected parameters. Test and fault-finding techniques might include, but are not limited to: continuity testing, test point voltage measurement, current measurement, signal tracing and half-split method.	4 hours	R101 (LO2), R114

Unit 114 – 2019 Set Assignment #1

Scenario for the Assignment

A torch manufacturer has been given feedback regarding their rechargeable torch. Customers have commented that it would be useful to be able to locate the torch charging station in the dark. You have been asked to produce a modification to the charging unit to support this.

Read through all of the tasks carefully, so that you know what you will need to do to complete this assignment.

Task 1: Circuit Simulation and Test

Learning Outcome 1, Be able to use Computer Aided Design (CAD) for circuit simulation and design, is assessed in this task.

The circuit design provided (Fig.1) has been produced in response to the design problem.

1. You are to use appropriate Computer Aided Design (CAD) software to produce a circuit schematic diagram and test the operation of the circuit 'on-screen' to prove that it functions correctly.

2. Once the circuit operation has been proved you are to use the CAD package to produce a Printed Circuit Board (PCB) layout design to include track and component views.

3. Review PCB layout to ensure correct functionality.

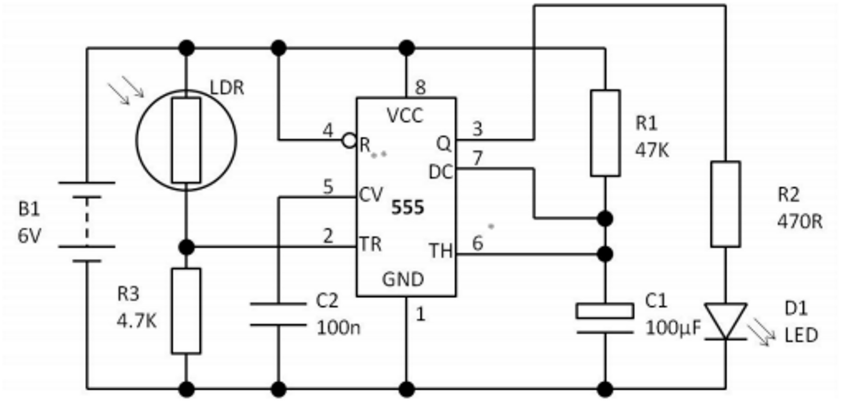


Fig.1

Unit 114 – 2019 Set Assignment #2

Task 2: Circuit Construction

Learning Outcome 2:- Be able to construct circuits, is assessed in this task.

1. You are to use your PCB layout design to manufacture a PCB using an appropriate method.
2. You are then to assemble components to the PCB using appropriate techniques.

Task 3: Circuit Testing

Learning Outcome 3:- Be able to test electronic circuits, is assessed in this task.

On completion of the PCB and circuit construction you must undertake testing and evaluation of the final constructed circuit using appropriate test equipment and test methods.

Unit 114 - 2019 Assignment Introduction

This assignment will be used for the qualification of Unit 114. You have a maximum of 12 hours in class to complete this. (12 Lessons) You will use the scenario to then complete Tasks 1,2,and 3.

You will begin by showing an understanding of the circuit by simulating it in Circuit Wizard and by testing the voltage, current will show your understanding. You will simulate the components working on a breadboard and may also build this in real life.

You will then design a PCB which you will make using the photo-etch method, drill, assemble, solder and test the circuit. You should be able to fault-find the circuit and use correct methods for testing throughout manufacture.

You should aim to work as independently as possible to achieve maximum marks in the assessment. You should capture evidence of making by producing an assignment showing all the stages of design and making. This should include diagrams, screen captures, voltage/time graphs, calculations, with photographs of making your PCB. All the evidence must be submitted to the teacher. You can use an office package such as Word/PowerPoint or preferably One Note.

The mark scheme is included in the assignment and you should aim to meet the criteria to meet your expected target grade. The assignment is marked out of 60. Make sure you follow the marking criteria throughout the assignment and fulfill all the Tasks as described.

It is essential you complete this assignment in the time allocated and you can use the resources in the room under guidance from Mr. Hodgson.

Unit 114 - Guidance on the 2019 Set Assignment task

Specific guidance on the task

Task 1
Learners will be required to use CAD software that has been specifically designed for circuit simulation, testing and PCB design.

Examples of software could include Circuit Wizard or Tinker CAD Circuits

For the circuit given (555 timer in monostable mode) light level is detected by the LDR.

When light falls to a given level, the 555 is triggered and the LED activated. The LED illumination time is determined by T = R1 x C1 (seconds) – and the effect of altering these values might be also investigated.
Screen shots should be taken to evidence each learner's use of the software. Learners should compare the final PCB layout with the circuit schematic diagram to ensure correct functionality.

Task 2 Learners will need to use their PCB layout design to construct a printed circuit board for the circuit.

- They will need to select an appropriate manufacturing method such as CNC engraving or photo-resist.
- Appropriate risk assessment and safe working procedures must be followed.
- Learners will require access to circuit construction equipment and components in order to complete the task.
- Evidence of circuit construction detailing quality of joining methods must be provided in the portfolio by digital photographs, supported by signed witness statement.
- High quality refers only to fully operational circuits.
- Appropriate pre-testing of the constructed PCB should cover correct component placement, quality of construction, bridge tracks etc.

Task 3 Learners are required to use test equipment to prove the operation of their constructed circuit.

- All details of testing should be recorded including any details of modifications required in order to achieve a functioning circuit.
- Evidence of circuit testing and evaluation will be provided in the portfolio supported by a signed witness statement.
- Learners must provide evidence in the form of text, photographs or video and screenshots.

Total marks for assignment: 60

Unit 114 – #1 Risk Assessment during Making Activities

Process	Equipment Used	Risk Identified	Level of Risk	Control Measures including use of PPE (Personal Protective Equipment)	Comments / Advice / Guidance / Method
			Low/Medium/High		
Design of Circuit on Circuit Wizard	Computer Mouse Keyboard Monitor Desk	• Electrical failure • Personal injury by incorrect posture / eye strain	Low	• Ensure computer hardware is in good condition and no defective parts or damage is visible prior to use • No eating or drinking at computers or in classroom • Sit correctly at computer adjusting the height of monitor to suit good posture • Only work at computer for short periods of time to avoid eye strain	Computers are checked by the teacher each day for any signs of damage Report of any damage or faults must be done immediately Computers must be left ready to be used again and not tampered or interfered with.
Printing of PCB onto paper / transfer onto transparency	Printer Paper Transparencies Photocopier Guillotine	• Electrical failure • Personal injury by misuse of equipment / cutting	Low	• Ensure printer can use transparencies • Take care when trimming using paper guillotine	1. Print out PCB onto A4 paper - Artwork and PCB text 2. Transfer image onto transparency using photocopier 3. Trim the transparency around the edge of the PCB mask 4. Take care of the PCB mask to avoid scratching
Using UV light box	UV light box PCB mask	• Electrical failure • Exposure to UV light	Low	• Follow guidance from teacher • Keep the lid locked closed when in use • Avoid exposure of UV light	1. Cut PCB board to fit the mask 2. Remove protective film from PCB avoid touching the light sensitive coating 3. Place the PCB board face down on the mask ensure facing toward board 4. Close the lid and lock 5. Set timer to 150 seconds 6. Start - At end open lid and remove board and Mask 7. Place unused PCB mask in safe place
Using liquid developer	Concentrated liquid developer Water Tray	Chemical process - using harmful concentrated solution ratio 1:19	High	• Follow guidance on liquid developer leaflet / COSHH • Ventilate area • Wear gloves / apron • Avoid inhaling fumes	1. Dilute the concentrated developer by 1:19 in a A4 tray with cold water 2. Place the PCB mask face up in the solution 3. Immerse and brush for 30 seconds or until the image emerges and the light sensitive coating is washed away 4. Remove from tray and wash in cold water 5. Inspect for quality of image under/over exposure

Unit 114 – #2 Risk Assessment during Making Activities

Process	Equipment Used	Risk Identified	Level of Risk	Control Measures including use of PPE (Personal Protective Equipment)	Comments / Advice / Guidance / Method
			Low/Medium/High		
Using PCB Etching Tank (Ferric Chloride)	Bubble etch tank Ferric chloride	Chemical process - using harmful Ferric Chloride	High	• Follow guidance on ferric chloride information leaflet / COSHH • Ventilate area / extraction • Wear gloves / apron • Avoid inhaling fumes	1. Switch on and Pre-heat the tank 2. Ensure the developed PCB has been washed in water to avoid contamination of the ferric 3. Place the PCB in the basket and immerse in the tank 4. Switch on the bubbles 5. Check after each 5 minutes that the copper is being stripped from the unwanted areas 6. Once complete then remove from the basket 7. Wash under cold water 8. Inspect the quality of final PCB
Drilling PCB holes	PCB drill and stand 1mm drill 2mm drill	Drill is operating at high speed / noise / dust / rotating parts	Medium	• Wear safety glasses • Check the PCB and drill stand are in good working order • Ensure 1mm/2mm drills are in good condition • Avoid inhaling dust	1. Place the PCB on the wood board of the PCB Drill 2. Drill the 1mm holes through all the round/squashed PCB pads 3. Drill the 2mm holes through the square pad strain holes 4. Inspect all holes are through on centre of pads
Soldering components to PCB	Soldering iron Soldering iron stand Wooden board Sponge Clipboard Solder wire Wire cutters Wire strippers Components	• Heat from soldering iron is 400 degrees • Lead in soldering wire Fumes from • Flux in soldering wire is acid	High	• Check the soldering iron cable and case is in safe working order & electronically tested (PAT tested date sticker on plug) • Wear safety glasses • Wear apron • Avoid inhaling fumes • Avoid wasting solder • Ensure iron is always returned to the stand • Take care carrying equipment around the room	1. Wire wool the PCB tracks to reveal the copper 2. Place components through holes across gaps according to PCB test / circuit diagram 3. Start with resistors - Gold band should be towards bottom of board if vertical and towards right is horizontal. Body of resistor against PCB 4. Electrolytic Capacitors legs should be sleeved to identify + and -. (+ is red, - is black). 5. Off board components on wires should use strain holes to the PCB and components should be sleeved and attached to the end of wires with a minimum of metal showing. 6. The 555 timer I.C should be fitted into an 8 pin socket that is soldered to the PCB. 7. Soldering should be neat, consistent and all excess legs should be trimmed to the PCB 8. Any bridged or broken PCB tracks should be repaired. 9. PCB pads should be fully soldered around the components leg with adequate solder attaching to the board.

Unit 114 – #3 Risk Assessment during Making Activities

Process	Equipment Used	Risk Identified	Level of Risk	Control Measures including use of PPE (Personal Protective Equipment)	Comments / Advice / Guidance / Method
			Low/Medium/High		
Testing PCB	Multi meter Logic probe Bench power supply Oscilloscope	• Electrical failure • Connecting test equipment to a PCB with a power supply	Medium	• Check that the test equipment is in good working condition and has been electronically tested (PAT tested date and sticker on plug) • Wear safety glasses • Wear apron • Use an earth to ground the appliance during testing	1. Connect the test equipment to the circuit across the positive and negative rails 2. Set the equipment onto the correct voltage range 3. Use the test probe at the point to be tested and diagnose the voltage/current/signal 4. Remove the test leads safely 5. Return the test equipment safely

Unit 114 – #1 Risk Assessment Pupil Table

Process	**Equipment Used**	**Risk Identified**	**Level of Risk**	**Control Measures including use of PPE (Personal Protective Equipment)**	**Comments / Advice / Guidance / Method**
			Low/Medium/ High		
Design of Circuit on Circuit Wizard	Computer Mouse Keyboard Monitor Desk				
Printing of PCB onto paper / transfer onto transparency	Printer Paper Transparencies Photocopier Guillotine				
Using UV light box	UV light box PCB mask				
Using liquid developer	Concentrated liquid developer Water Tray				

Unit 114 – #2 Risk Assessment Pupil Table

Process	**Equipment Used**	**Risk Identified**	**Level of Risk**	**Control Measures including use of PPE (Personal Protective Equipment)**	**Comments / Advice / Guidance / Method**
			Low/Medium/ High		
Testing PCB	Multi meter Logic probe Bench power supply Oscilloscope				

Unit 114 – #3 Risk Assessment Pupil Table

Monday, February 24, 2020 4:00 PM

Process	Equipment Used	Risk Identified	Level of Risk	Control Measures including use of PPE (Personal Protective Equipment)	Comments / Advice / Guidance / Method
			Low/Medium/ High		
Soldering components to PCB	Soldering iron Soldering iron stand Wooden board Sponge Clipboard Solder wire Wire cutters Wire strippers Components				
Testing PCB	Multi meter Logic probe Bench power supply Oscilloscope				

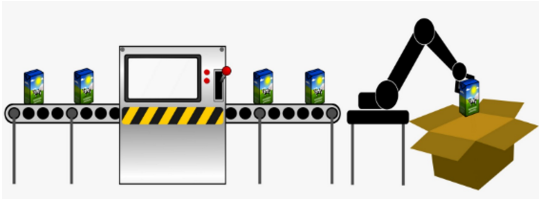
Unit 114 – Circuit Website Links

Monday, December 16, 2019 11:27 PM

The following websites will be useful reference for this unit of work. Some of the links will contain animations of circuits and information that will help you to learn about components / Integrated circuits.

https://www.bbc.co.uk/bitesize/guides/zbj8jty/revision/1	Electronic Systems online tests, quiz
http://electronicsclub.info/	Projects, components, circuit diagrams useful site for reference and learning about electronics
https://electronicsclub.info/components.htm	Components page of the electronics club website
www.technologystudent.com	A reliable site with lots of sections on all aspects of Design Technology and Systems
http://www.technologystudent.com/despro_flsh/mobapp4.html	Interactive learning of electronics – Recently updated to work better on mobile devices using an 'app'. Really useful learning for the subject content.
http://www.technologystudent.com/pics/picdex1.htm	Learn about Programmable Microcontrollers
https://reviseomatic.org/rOmV4/	Learn all the basics about circuits. If you use this page, then the GCSE level is the content to learn.
Electronics simulation Programs	
https://www.tinkercad.com/	Sign up for an Autodesk account with your school email address. Use the 'Circuits' simulator. There are lessons and tutorials for many basic and advanced circuits. Excellent free resource
http://www.falstad.com/circuit/e-index.html	Circuit diagram Applet for simulations

Unit 115 – Engineering Applications of Computers



PURPOSE OF THE UNIT

This unit covers the range of computer and microprocessor applications within engineering and considers how systems are used across a range of engineering activities from product design and development to automated manufacturing, maintenance and stock control.

You will develop knowledge and understanding of the range of computer and microprocessor applications within engineering and will consider how computer systems are used across a range of engineering activities.

This unit will show you how computers are used within engineering industries to design and manufacture new products with Computer Aided Design (CAD) and Computer Aided Manufacture (CAM) and the use of automate manufacturing such as Programmable Logic Controllers (PLC), Programmable Interface Controller (PIC).

On completion of this unit, you will understand the specific processes involved in electronic systems control and have an appreciation of how computers communicate and transfer data in HMI and expert systems.

Unit 115 - Learning Outcomes

Learning Outcome — You will:
LO1 - Understand how computers are used in engineering design, manufacture and process control
LO2 - Understand how computers are used for maintenance of engineering systems
LO3 - Know how computers are used to communicate and use data for production and maintenance

Unit 115 – LO1 Understand how computers are used in engineering design, manufacture and process control

Content	Activities	Timings	Relevance to
1 Computers in the design of new products	You will be able to use the previous experience of using Computer Aided Design (CAD) software and graphical packages from unit 114 in this unit. You will research how computers are used in the design phase of developing new products through investigating suitable case studies. (Companies that have invested in design software / systems design) If possible an industrial visit will be completed to show the application of computers in the whole design, manufacturing and process control cycle. This will be a local manufacturing company. It could even be a virtual visit. You will then present your findings in a portfolio (OneNote) as a report.	2 hours	R107 R110
2 Computers in manufacturing	You will learn about using Computers in manufacturing which follows on from using computers in design. Some of this work may be so to control a machine which may remove (waste) or add material to make parts or components. The machines may assemble and join parts together. The machines may move, rotate or pack parts. Machines will be used to increase the productivity and quantity of parts/products made. The reliability, repeatability and consistency of machines is the benefit of this type of manufacturing. Computers are used to control the machine tool and the direction that the mechanical parts move so that it can perform its function. Machines will be used in a sequence to complete a number of operations to produce a product. Companies will invest in machines to replace stages of the manufacturing process that was done by manual methods. (Human operators) You will investigate into Computer Aided Manufacture (CAM) computer applications in manufacture, and could further investigate Computer Integrated Manufacture (CIM) including Computer Numeric Control (CNC). You will make the connection between design, manufacture and process control and how these separate parts of the process may all require several computers to control the individual stages. You will use Internet videos to see computers in action if an industrial visit is not possible. The following video is an example of multi axis CNC machining: https://www.youtube.com/watch?v=CqePrbeAQoM.	2 hours	R111

Unit 115 – LO1 Understand how computers are used in engineering design, manufacture and process control

Content	Activities	Timings	Relevance to
3 Computer monitoring of production and managing process control	You will learn about the automation of manufacturing processes. This includes the use of Programmable Logic Controllers (PLC) and Programmable Interface Controllers (PIC). These devices are also often used in the automation of process control, for monitoring processes and in test operations (e.g. automated test systems). At school we have access to practical equipment (such PLC controlled machinery) which could be demonstrated to learners. You will be given an automation activity which will give you experience of programming a PLC machine tool. An industrial visit, if possible, might also prove useful to show computers monitoring and managing process control.	3 hours	R114
4 Features of computer controlled automation	An extension to understanding computer controlled automation is consideration of the features and functions of automation controllers (e.g. temperature control, weight control, position sensing, size sensing, workflow, warehousing and product movement, safety systems, machine interlocks). You will research these as part of an industrial visit, or through using a virtual tour / factory video.	3 hours	R114

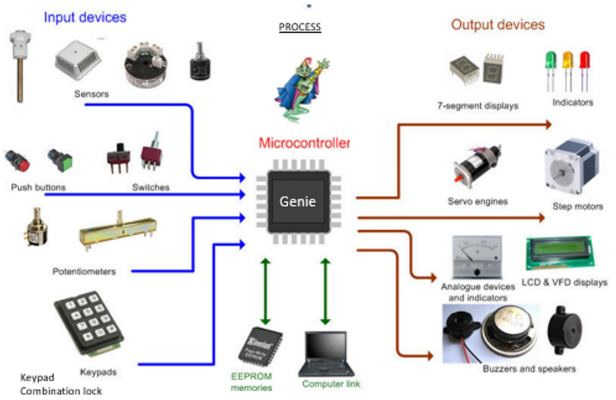
Unit 115 – LO2 Understand how computers are used for maintenance of engineering systems

Content	Activities	Timings	Relevance to
1 Computers in maintenance: human machine interface	You will learn about Human Machine Interfaces (HMI) which include the visual interface that we interact with machines. If a machine has a control panel then that is a HMI. If it is a screen that has a choice of ways to interact with the machine (cash machine, vending machine, photocopier, photo booth, machine tool) then you have used a HMI. By using simple examples you will be tasked to debate the features required from an HMI to make it simple and intuitive to use. You will then be taught about HMI in industrial operations including: system operation, diagnostics, maintenance, use of system operation data, modification or correction of system operation. Manufacturer's data might be used to show commercial applications e.g. http://www.automation.siemens.com/mcms/automation/en/humanmachine-interface/ pages/default.aspx Learners could be introduced to how HMI interfaces are developed using software (e.g. the following video shows HMI software: https://www.youtube.com/watchv=mhA9MQgAAeU&list=PLHA865kGArdZNNeC4K0BfRSbpoquVnRq) School has access to some suitable HMI systems that can be practically demonstrated to or used.	4 hours	R111
2 Computers in maintenance: expert systems	Expert systems are now commonplace in process and maintenance operations. You will be given an introduction to their application in system operation, diagnostics and maintenance. This will include the collection and use of operation data and interpretation of results to modify or correct system operation. If access to an expert system is not available then a case study approach might be adopted to showing these in operation. An example from the following website shows the Rolls Royce expert (neural network) system monitoring aircraft engines: http://www.rollsroyce.com/about/technology/systems_tech/monitoringssystems.jsp	4 hours	R111 R104 (LO2)

Unit 115 – LO3 Know how computers are used to communicate and use data for production and maintenance

Content	Activities	Timings	Relevance to
1 Production data: communication and exchange	You will investigate how production data is collected, communicated, exchanged and stored in industrial process control systems. Production data could include assembly/production recording, efficiency information and cycle times. You will be shown examples of real data from industrial systems (local manufacturing companies). Online magazines will be used to provide a relevant insight into hi-tech companies from which learners can study interesting articles relating to production and maintenance:- http://www.maintenanceonline.co.uk/ home.asp An industrial visit if possible will prove useful in explaining the application and use of computers for production and maintenance operations which are covered throughout this learning outcome.	3 hours	R111
2 Using production data for maintenance	Production information such as assembly/production data, efficiency information, and cycle times is often used in performing and planning maintenance operations. School might have access to suitable equipment to demonstrate the use of data in performing maintenance on equipment, such as data logging equipment. You will be tasked with a research activity to explore and present how production data is used in maintenance in order to ensure safe and efficient production.	3 hours	R111 R104 (LO2)
3 Computers and maintenance	You will further investigate how computers communicate and exchange data for maintenance operations including: remote monitoring of engineering systems, transmission of service data, monitoring and recording of maintenance operation, parts used, stock control, prediction of failure and work scheduling.	2 hours	R111
4 Hand held devices in manufacturing and maintenance	Hand-held devices are now commonplace in manufacturing and maintenance systems and are used in applications such as: bar code scanning (e.g. monitoring stock usage and movements, updating service records) and managing service information and instructions (e.g. data loggers, data collection and analysis, work scheduling, maintenance checklists) Teachers might have access to hand-held devices that can be demonstrated or used by learners in a practical setting. Internet sources might also be useful in showing a range of commercial hand held device applications (e.g. Honeywell's hand held devices)	3 hours	R111

Unit 116 – Process Control Systems



PURPOSE OF THE UNIT

This unit will develop your knowledge of microprocessor/microcontroller control systems in engineering systems such as production, engine control, domestic appliances and office equipment.

You will study a range of systems designs and consider how each system uses appropriate input and output devices.

You will also develop knowledge and understanding of the design, simulation and testing of microprocessor/microcontroller control systems and consider how a systems design problem is best solved through the use of appropriate sensor, transducer and programmable logic controllers (PLC)/programmable interface controllers (PIC) devices.

You are required to test the performance of their design system and be able to transfer your program to a programmable device.

On successful completion of this unit you will understand how microprocessor/microcontroller control systems are used in engineering systems and be able to properly design and test a simple control system.

Unit 116 - Learning Outcomes

Learning Outcome — You will:
LO1 - Understand the application and operation of microcontrollers and microprocessors in engineered products
LO2 - Be able to design, develop and simulate a control system solution
LO3 - Be able to test control systems

Unit 116 – LO1 Understand the Application and Operation of Microcontrollers and Microprocessors in Engineered Products

Content	Activities	Timings	Relevance to
1 - Lesson Element: System layouts	You will be set a research-based activity to explore the layout of microprocessors and microcontrollers in commercial products or systems. Manufacturer's websites might prove a useful starting point with the following showing the system layout of a Texas Instruments microcontroller in a microwave oven application: http://www.ti.com/solution/microwave_oven You will explore a range of applications and produce a poster of their findings. They might draw simple block diagrams, summarise key features and compare similarities and differences between systems using a microprocessor and microcontroller.	2 hours	
2 - Applications of microprocessors and microcontrollers	You will extend your knowledge by continuing to research a range of applications of microprocessors and microcontrollers in products and systems. (e.g. production/assembly systems, engine control systems, office machines, domestic appliances, children's toys). Web-based resources may prove useful with the following explaining microcontroller applications: http://www.electronicshub.org/microcontrollers/ The following video provides a very thorough introduction to microcontroller and comparison with microprocessor: https://www.youtube.com/watch?v=CmvUY4S0UbI You will focus on features and applications rather than the internal workings of the microprocessor or microcontroller.	2 hours	R115 (LO1)

Unit 116 – LO1 Understand the Application and Operation of Microcontrollers and Microprocessors in Engineered Products

Content	Activities	Timings	Relevance to
3 - Basic function of component parts of a control system	You will learn about the basic function of component parts within micro-based system include: • input devices (e.g. switch, temperature, position, light, flow, pressure) • control device (e.g. microprocessor, microcontroller) • output device (e.g. lamp, sounder/speaker, solenoid, relay) You will use internet based resources might prove useful in explaining the function and application of input and output devices. At school we have access to physical devices whose operation could be demonstrated to reinforce learning.	2 hours	R113 (LO2)
4 - Operation of a control system	Operation of a control system within a product using a microprocessor or microcontroller could be demonstrated with physical systems if available. Alternatively simulation or web-based sources could be used to explain or demonstrate system operation. An example of a company from Bosch Automotive explains the overall operation of a number of automotive electronic systems that use a microcontroller. The following is for a start-stop system and includes web-based videos: http://de.bosch-automotive.com/en/parts/parts_and_accessories/motor_and_sytems/start_stop_system/functionality_start_stop_system/functionality_start_stop_system	2 hours	R115 (LO1)

Unit 116 – LO2 Be able to Design, Develop and Simulate a Control System Solution

Content	Activities	Timings	Relevance to
1 - Producing control system solutions	You will take a practical approach throughout this learning outcome by developing a complete system solution using a microprocessor or microcontroller. You will be shown techniques (including hardware and software) that you will then use to develop your own control system solution to solve a given problem. You will be shown different problems to give an overview of the process that will use a range of hardware and software.	2 hours	
2 - System diagrams	You will learn how to develop system diagrams prior to or alongside producing a working solution. This will help with troubleshooting and fault finding problems with the proposed system. You will learn how to develop diagrams including: use of block diagrams to define control systems, diagrams showing input, process (including feedback and variables) and output and ones showing system instructions for control systems (i.e. repeat loops and subroutines). You will then use diagrams to represent your solution to a set problem (design situation)	2 hours	R113 (LO2)
3 - Input sensors and output actuators	You will learn about the use of input and output devices (eg sensors for temperature, position, light, flow, pressure, light and indicators/actuators such as light emitting diodes, solenoids, and motors) You will complete practical tasks to explore the function and operation of a range of different sensors and actuators that you might use on their own control system problem. You will be shown suitable examples supported by data sheets to explain the application and technical aspects of sensors and actuators in greater detail.	2 hours	R113 (LO2)

Unit 116 – LO2 Be able to Design, Develop and Simulate a Control System Solution

Content	Activities	Timings	Relevance to
4 - Using programming tools	You will learn a range of programming tools to create a control system programme (e.g. linear, symbolic, flow-chart) You will be tasked to produce flow charts for everyday problems before producing one for a control system problem. Web-based resources might prove useful, with the following explain how to produce flow charts: http://www.mindtools.com/pages/article/newTMC_97.htm Depending on the system being used, you might also use linear or symbolic programming techniques.	2 hours	
5 - Simulating a control system and device programming	You will bring together skills at developing system diagrams and programming tools and your knowledge of sensors and actuators to simulate and construct a physical control system. This will also include the transfer of the control program from software to a physical hardware-based system. (Genie Microcontroller, Arduino). The flowchart program will be downloaded into the Microcontroller of choice and then will have the Input & Output devices attached to represent the stages of the system. This system will then be tested and improved until it represents a solution to the initial problem. You will be given guidance throughout this activity when required. The final control system you develop will be then put together as an assignment as means of teacher assessment.	6 hours	

Unit 116 – LO3 Be able to Test Control Systems

Content	Activities	Timings	Relevance to
1 Developing test plans	You will adopt a practical approach throughout this learning outcome by developing test plans to evaluate and refine your own control system. You will begin to develop a test plan alongside system development which could include sub system test and full system testing. Web-based resources might prove useful such as the following which explains software test plans: http://www.teach-ict.com/as_a2_ict_new/ocr/A2_G063/33_systems_cycle/testing/miniweb/index.htm You will be provided with a template to use for testing which you will develop for your own control system.	3 hours	R113 (LO3)
2 Evaluating system performance	You will then use your plan to test a control system solution in order to evaluate its correct operation against a set of performance criteria. You will record and document results and findings against your test plan. You will then compare your findings in terms of system performance against that of others (if identical systems have been developed) with an overall performance ranking table being produced. The class will compare and discuss this, including any reasons for systems that perform better or worse.	3 hours	
3 Interpretation and refinement	You will interpret results of your own system against performance and test data, and also against that of others if similar systems have been developed. This information will be discussed and used to refine the control system. This could involve further iterations of testing, evaluation and further refinement. You will be required to present your final solutions along with discussion of refinements as a class-based presentation activity. This will be part of the teachers formative assessment.	2 hours	