Rewarding Learning

CCEA GCE Specification in Technology and Design: Systems and Control

For first teaching from September 2008

For first award of AS Level in Summer 2009
For first award of A Level in Summer 2010

Subject Code: 9060

technology and design

Foreword

This booklet contains CCEA's Advanced Subsidiary (AS) and Advanced GCE Technology and Design specification for first teaching from September 2008.

The AS is the first part of the full advanced GCE course and will be assessed at a standard appropriate for candidates who have completed the first half of the full Advanced GCE course.

The full Advanced GCE comprises the AS and the second half of the Advanced GCE course referred to as A2. However, the AS can be taken as a "stand-alone" qualification without progression to A2.

The A2 will be assessed at a standard appropriate for candidates who have completed a full advanced GCE course and will include synoptic assessment and an element of stretch and challenge.

The Advanced GCE award will be based on aggregation of the marks from the AS (50%) and the A2 (50%).

An A* will be awarded to the candidates who attain an overall grade A in the qualification and an aggregate of at least 90% of the uniform marks across the A2 units.

Subject Code	9060
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Further copies of this publication may be downloaded from www.ccea.org.uk

Contents

1 Introduction

This specification sets out the content and assessment details for CCEA's Advanced Subsidiary (AS) and Advanced Level (A Level) courses in Technology and Design: Systems and Control. This specification is for first teaching from September 2008. The latest version of this specification can be viewed and downloaded from the CCEA website: www.ccea.org.uk.

The AS course can be taken as a final qualification or as the first half of the A Level qualification. If students wish to obtain a full A Level qualification, they must also complete the second half of the course referred to as A2. The first AS award for this specification will be made in 2009. The first A Level award will be made in 2010.

The specification builds on the broad objectives of the revised Northern Ireland Curriculum. It is also relevant to key curriculum concerns in England and Wales.

Technology and Design offers the opportunity for exposure to the processes involved in beneficially harnessing the resources of people and the earth they inhabit, through the creation of appropriate artefacts and/or systems. It provides opportunities to undertake design and technological problems which meet human needs within a range of contexts, such as home, school, recreation, community, business and industry. In this specification the relationship between processes and means is emphasised. Consequently, the knowledge should be viewed as a resource to be integrated into the processes which constitute design and technological activity, and not considered solely as an entity in itself.

The aims of the specification are set out below.

1.1 Aims

Students should be encouraged to:

- make use of tacit knowledge and reflective practices in order to work with tasks that are challenging and often require definition;
- develop and sustain their creativity and innovative practice;
- recognise and overcome challenges and constraints when working towards the production of high-quality products;
- develop a critical understanding of the influences of the processes and products of design and technological activities from a contemporary and historical perspective;
- draw on a range of skills and knowledge from other subject areas;
- draw on and apply knowledge; understanding and skills of production processes to a range of design and technological activities;

- develop an understanding of contemporary design and technology practices; and

- use digital technologies and information handling skills to enhance their design and technological capability.

1.2 Key features

The key features of the specification are listed below. This specification:

- builds on the broad Technology and Design experiences gained by candidates who followed the CCEA GCSE Technology and Design specification;

- leads to an endorsement in Systems and Control both at AS and A Level;

- promotes a broad Technology and Design experience for AS, and a more focused experience, related to candidate preferences, for Advanced GCE;

- reduces the assessment burden on candidates compared to the previous specification from six units to four; and

- provides a solid foundation for study at a higher level in a range of engineering and industrial design areas of practice, or in areas of study related to engineering and design.

1.3 Prior attainment

Whilst it is assumed that most candidates will have acquired experience in this or a related subject area at an earlier stage no specific prior attainment is required.

1.4 Prohibited combinations

In any one series of examinations, a candidate may not take an examination on this specification together with an examination at AS or A2 Level on another specification of the same title, or a specification with the title Technology and Design: Systems and Control.

2 Specification at a Glance

The structures of the AS and A Level courses are summarised in the table below.

Unit	Assessment	Weighting	Availability
AS 1 Product Design and Systems and Control	2 hour examination	50% of AS 25% of Advanced GCE	January and Summer
AS 2 Coursework: Product Development	45 hour coursework internally assessed externally moderated	50% of AS 25% of Advanced GCE	Summer only
A2 1 Systems and Control	2 hour examination	25% of Advanced GCE	January and Summer
A2 2 Coursework: Product-System, Design and Manufacture	60 hour coursework internally assessed externally moderated	25% of Advanced GCE	Summer only

3 Subject Content

The AS course is divided into two units: AS 1 and AS 2. Students following the A Level course must study two further units: A2 1 and A2 2. The content of each of these units is set out below.

3.1 Unit AS 1: Product Design and Systems and Control

This unit is a study of product design including materials and their processing with an area of systems and control. Candidates must study Section A: Product Design and Practice and can choose between two specialist areas of Systems and Control in either Section B: Electronic and Microelectronic Control Systems or Section C: Mechanical and Pneumatic Control Systems.

AS Unit 1
Compulsory Section A
Product Design and Practice

Content	Learning Outcomes
1.1 Material Choice and Selection	Students should be able to: • consider the following when selecting a material: - functional requirements (properties and characteristics); - manufacturing demands (scale of production and suitability of manufacturing process); - environment (corrosion resistance and stability); - availability (common form and sizes); - cost; • demonstrate knowledge and understanding of the following: - physical properties – density, electrical and thermal conductivity; - mechanical properties – strength, elasticity, plasticity, toughness, hardness, durability and brittleness;
1.2 Wood	• demonstrate knowledge of hardwoods and softwoods; • demonstrate knowledge and understanding of the properties, working characteristics and uses of the following woods – Pine, Ash, Beech, Oak and Mahogany; • demonstrate knowledge of the available form of supply of woods; • demonstrate an understanding of the main advantages and uses of the following manufactured boards plywood, blockboard, chipboard, hardboard and medium density fibreboard (MDF); and • demonstrate an understanding of the main purposes and types of finishes for woods-stains, oils, polishes, paints and synthetic resins.

Content	Learning Outcomes
1.3 Metal	Students should be able to: • demonstrate knowledge of the available form of supply of metals; • understand the difference between ferrous and non ferrous metals and alloying; • demonstrate knowledge and understanding of the properties, working characteristics and uses of the following metals – aluminium, aluminium alloys, copper, brass, zinc, steel (mild, medium and high) and stainless steel; • demonstrate an understanding of the main purposes and types of finishes for metals – painting, plastic coating, electroplating, anodising, enamelling and lacquering;
1.4 Plastic	• understand the difference between thermoplastic and thermosetting plastics; • demonstrate knowledge and understanding of the properties, working characteristics and uses for the following polymers – polythene, polystyrene, PVC, acrylic, nylon, ABS, melamine-formaldehyde and epoxy resins;
1.5 New Materials	• understand the difference between composites, alloys and combinations when creating new materials; • demonstrate knowledge and understanding of the characteristics and uses for the following smart materials – shape memory alloys, piezoelectric materials and light – emitting polymers;
1.6 Method of Processing Materials	• demonstrate knowledge and understanding of: - wasting to involve workshop hand tools, manual and CNC machine tools; - forming to involve rolling, blanking, press forming and forging; - moulding to involve injection moulding, blow moulding, rotational moulding, vacuum forming, sand casting and pressure die casting; - extrusion;
1.7 Methods of Joining Materials	• demonstrate knowledge and understanding of permanent and semi-permanent methods used to join materials to include: - soldering, brazing, welding; - riveting; - selection of adhesives; - nut, bolt and washer and self tapping screws; - knock down fittings.

Content	Learning Outcomes
1.8 Manufacturing Systems and Production	Students should be able to: • demonstrate knowledge and understanding of: - scales of production to include: continuous production; mass production, batch production and one-off production; - the way manufacturing is organised to include cell production, flexible manufacturing systems (FMS), just in-time (JIT) and concurrent engineering;
1.9 Design and Manufacture	• demonstrate knowledge and understanding of the following: - computer-aided design (CAD) to include drawing, solid modelling, virtual imaging and rapid prototyping; - computer-aided manufacture (CAM) computers used to assist in a manufacturing process; - computer-integrated manufacture (CIM) computers used for stock control, quality control, manufacturing, and assembly; - advantages of using CAD, CAM and CIM;
1.10 Quality Systems	• demonstrate knowledge and understanding of the use of: - quality assurance (QA) and quality control (QC) systems; - statistical testing methods; - factor of safety; - use of tolerances; • demonstrate knowledge and understanding of the purpose of testing and inspection of components or products;
1.11 Safety	• demonstrate knowledge and understanding of: - risks associated with common manufacturing and hand processes and methods used to minimise them; - employee and consumer safety; - Trades Description Act; - British Standards and European Kite-Marking; and
1.12 Aesthetics, Ergonomics, Anthropometrics	• demonstrate knowledge and understanding of: - the use of anthropometric data and ergonomics in product design; - the use of aesthetics (shape, form, colour, texture, symmetry and proportion) in product design.

Content	Learning Outcomes
1.13 Influences on Product Design	Students should be able to: • demonstrate knowledge and understanding of: - changes in fashion; - cultural and social changes; - scientific advances; - environmental influences (3Rs sustainability, life cycle analysis).

Either
Section B Electronic and Microelectronic Control Systems

Content	Learning Outcomes
1.14 Systems and Control	Students should be able to: • analyse electronic/microelectronic control systems in terms of input, control, output, on/off continuous control and open and closed loop systems using feedback; • use appropriate circuit symbols and circuit diagrams for electronic/microelectronic systems;
1.15 Safety	• demonstrate knowledge and understanding of the safety issues and procedures used for electronic and microelectronic control systems;
1.16 Electronic Components	• demonstrate knowledge and understanding of the following components: - resistors (colour code, E12 series, tolerance and power ratings); - capacitors; - diodes (circuit protection with inductive loads); and
1.17 Calculations	• use given data and information to complete calculations for the following: - $V = I \times R$ and $W = V \times I$; - power ratings of resistors in circuits; - $Rt = R1 + R2 + \ldots.Rn$; - $Rt = R1 \times R2 / (R1 + R2)$; - $Vout = Vin \times R2 / (R1 + R2)$; - time constant = $C \times R$; - LED including maximum current, forward voltage, series resistance and power dissipation for series resistance; - current flow through output devices; - transistors (base resistor).

Content	Learning Outcomes
1.18 Combining Components as Input Devices	Students should be able to: • demonstrate knowledge and understanding of: - resistors in series and parallel (limited to two in parallel); - voltage divider circuits incorporating light dependent resistors (LDR) , thermistor (negative temperature coefficient only) and variable resistors; - series resistor capacitor (RC) circuits for timing purposes only. V/T graphs of charging and discharging RC circuits; - switches (SPST, SPDT, DPDT); - switch type (toggle, slide, push to make, push to break, rotary, reed and micro); - a range of switching applications such as position control and logic control; - pull up and pull down resistors as inputs to logic circuits; - incorporate these devices into applications;
1.19 Output Devices	• demonstrate knowledge and understanding of the following output devices: - lamps and relays (including latching relays); - motors, heaters, solenoids (including solenoid valves), buzzers, loud speakers, piezo sounders and LEDs; - incorporate these devices into applications with suitable driving circuitry; and
1.20 Electronic Systems	• demonstrate knowledge and understanding of the following systems: - AND and OR arrangements of SPST switches; - truth tables with a maximum of three variables; - logic gates (AND, OR, EOR, NOT, NAND, NOR, ENOR); - comparator; - flip flop (SR based on NAND gates only); - transistor (npn in switching circuits only) including hfe Ic (max) Vbe; - darlington pair; - thyristor; - monostable and astable circuits using 555 timer; - mark/space, frequency and period, f = I/T; - programmable systems – awareness of the advantages and disadvantages of programmable systems including PICs compared with hard-wired solutions.

Or
Section C Mechanical and Pneumatic Control Systems

Content	Learning Outcomes
1.21 Systems and Control	Students should be able to: • analyse Mechanical and Pneumatic control systems in terms of input, control, output, on/off continuous control and open and closed loop systems using feedback; • use appropriate circuit symbols and circuit diagrams for Mechanical and Pneumatic systems;
1.22 Safety	• demonstrate knowledge and understanding of the safety issues and procedures used for Mechanical and Pneumatic control systems;
1.23 Calculations	• use given data and information to complete calculations for the following: - mechanical advantage and velocity ratio; - efficiency; - simple and compound velocity ratios and transmission speeds for gears, pulleys and chains and sprockets; - force, pressure and area associated with cylinders;
1.24 Pneumatic Components	• demonstrate knowledge and understanding of the operation of a compressor installation and the use of filter, regulator and lubricator units; • demonstrate knowledge and understanding of the following pneumatic components: - three and five port valves with the following actuators (roller trip, one way trip, plunger, push button, lever, solenoid, diaphragm and pilot operated); - single and double acting cylinders; - shuttle valves; - flow restrictors and reservoirs; - piping and T connections; and • represent these components using relevant standards to create the following: - time delay circuits; - logic circuits (AND, NOT and OR); - speed control of cylinders; - air bleed; - automatic reciprocation; - circuits to control the movement of single and double acting cylinders.

Content	Learning Outcomes
1.25 Mechanical Components	Students should be able to: • demonstrate knowledge and understanding of the following mechanical components: - gears (spur, bevel, worm, rack and pinion); - pulleys and belts (single pulley, flat, round, vee and toothed belts; - fixed and self-adjusting jockey wheel or pulley; - crank and slider; - different types of motion (linear, rotary, oscillating and reciprocating); - first, second and third class levers; - linkages – bell crank and parallel; - cams (pear, heart, eccentric and plate) and followers to include knife, roller and flat. Cam terminology to include rise, fall, dwell and stroke length; - fixings to shafts: grub screws, cotter pins and keys and keyways; and
1.26 Combining Mechanical Components	• demonstrate knowledge and understanding of how to: - convert motion using mechanical and/or pneumatic components; - combine simple and compound systems involving gears, pulleys and chains and sprockets; - use gears, pulleys (belts) chains and sprockets to change speed and/or direction of rotation; - use levers with linkages to meet specific requirements; - combine mechanical components to produce systems with specific requirements.

3.2 Unit AS 2: Coursework: Product Development

The emphasis in this unit is on the analysis and development of an **existing** product, with a view to re-designing either the product or an aspect of it. It is the responsibility of the teacher to ensure the choice of product allows sufficient scope for development and challenge at AS Level.

Students will produce a 3-dimensional model or prototype which represents the practical outcome of the product analysis and development.

A portfolio should accompany the practical component with written and graphical information produced on not more than 10 A3 sheets. Students can present the portfolio in electronic format.

This unit draws on the knowledge and skills covered in Unit 1 and should represent approximately 45 hours of work. It will be internally assessed and externally moderated.

Candidates should have opportunity to:

Investigation and analysis of product

- Explore a range of existing similar products.
- Examine function, purpose and design features.
- Identify relevant materials and industrial production methods.
- Evaluate fitness for purpose.
- Provide detailed analysis of ergonomic and aesthetic suitability.

Redesign solutions and development

- Write a redesign specification.
- Generate a range of design modifications using annotated sketches.
- Evaluate the viability of each development.
- Present a plan for manufacture.
- Produce working drawings for manufacture.

Manufacture

- Realise a 3-dimensional outcome in a range of materials.
- Demonstrate a range of production skills and processes.
- Record any changes in design developments brought about during manufacture.

Testing and Evaluation

- Test systems and products against appropriate criteria.
- Analyse testing outcomes and consider further developments and modifications.

Marking Criteria AS Unit 2: Development

	Marking Criteria		Level	Mark
1	Investigation and analysis of product	20	High	14-20
			Medium	7-13
			Low	1-6
2	Re-design solutions and development	30	High	21-30
			Medium	11-20
			Low	1-10
3	Manufacture	40	High	29-40
			Medium	13-28
			Low	1-12
4	Testing and Evaluation	10	High	7-10
			Medium	4-6
			Low	1-3
			Total	100

Communication: All information presented for assessment should be presented in a coherent and concise manner using a range of ICT, illustrations, extensive photographs, annotated sketches, text and other appropriate means of communication.

Assessment Criteria

Investigation and analysis of product

High (14–20)

- Present a wide range of existing similar products in detail.
- Give a detailed description of function, purpose and features.
- Consider in detail relevant materials and industrial production methods.
- Present a detailed evaluation of fitness for purpose.
- Present high level analysis of ergonomics and aesthetic suitability.

Medium (Level 7–13 marks)

- Present a suitable range of existing similar products in moderate detail.
- Give some description of function, purpose and features.
- Consider aspects relevant to materials and industrial production methods.
- Present a reasonable evaluation of fitness for purpose.
- Present reasonable analysis of ergonomics and aesthetic suitability.

Low (Level 1–6 marks)

- Present only a basic range or list of existing similar products.
- Give limited description of function, purpose and features.
- Consider a limited range of materials and industrial production methods.
- Present a vague evaluation of fitness for purpose.
- Present limited analysis of ergonomics and aesthetic suitability.

Redesign solutions and development

High (21–30)

- Write a detailed redesign specification.
- Generate a wide range of technical design modifications.
- Evaluate in detail the viability of each modification.
- Present a detailed plan for manufacture.
- Produce high level working drawings for manufacture.

Medium (11–20)

- Write an appropriate redesign specification.
- Generate a suitable range of design modifications.
- Evaluate in some detail the viability of each modification.
- Present an adequate plan for manufacture with suitable detail.
- Produce adequate working drawings for manufacture.

Low (1–10)

- Write a limited redesign specification.
- Generate a limited range of design modifications.
- Present only vague evaluation of the viability of each modification.
- Present a limited plan for manufacture.
- Produce only limited working drawings for manufacture.

Manufacture

High (29–40)

- Produce a high quality outcome in a wide range of materials.
- Demonstrate clear competence in a range of production skills and processes.
- Record in detail any changes in design developments brought about during manufacture.

Medium (13–28)

- Produce a good quality outcome in an appropriate range of materials.
- Demonstrate reasonable competence in a range of production skills and processes.
- Record changes in design developments brought about during manufacture.

Low (1–12)

- Produce a low standard outcome and limited use of materials.
- Demonstrate poor competence in a range of production skills and processes.
- Limited detail of changes brought about during manufacture.

Testing and Evaluation

High (7–10)

- Produce a high level critical and objective evaluation of the outcome.
- Carry out and present an extensive range of detailed testing, showing meaningful conclusions.
- Make high level proposals for further development as an outcome of testing.

Medium (4–6)

- Produce a satisfactory evaluation of the outcome which is mainly objective.
- Carry out and present some outcomes of tests, which show mostly meaningful conclusions.
- Make appropriate proposals for further development.

Low (1–3)

- Produce a limited evaluation of the outcome.
- Show limited evidence of meaningful testing with only simplistic conclusions.
- Demonstrate limited awareness of possibilities for further development.

3.3 Unit A2 1: Systems and Control

An in-depth study of Systems and Control in either Section A: Electronic and Microelectronic Control Systems or Section B: Mechanical and Pneumatic Control Systems.

Either
Section A: Electronic and Microelectronic Control Systems

Content	Learning Outcomes
3.1 Systems and Control	Students should be able to: • analyse electronic/microelectronic control systems in terms of input, control, output, on/off continuous control and open and closed loop systems using feedback; • use appropriate circuit symbols and circuit diagrams for electronic/microelectronic systems;
3.2 Safety	• demonstrate knowledge and understanding of the safety issues and procedures used for electronic and microelectronic control systems;
3.3 Input Components	• demonstrate knowledge and understanding of the properties and applications for the following components: - strain gauge; - phototransistor; - optical switches; - switches to include reed switch; - LDR, thermistor and variable resistor; and
3.4 Calculations	• use given data and information to complete calculations for the following: - voltage divider circuits; - bridge circuits for strain gauge; - Op amp in inverting, non-inverting and differential modes (Formula will be provided for any calculations, derivations will not be required).

Content	Learning Outcomes
3.5 PICs	Students should be able to: • demonstrate knowledge and understanding of flow charting incorporating: - input – output, loops, time delays, increment, flow control and subroutines; - awareness of commonly used PICs with digital I/O and with mixed digital and analogue I/O; - interfacing with electronic systems employing a PIC; - employing PICs to control systems to meet specified requirements;
3.6 Output Devices	• demonstrate knowledge and understanding of: - seven segment display; - LED bar array and LCD displays; - DC and stepper motors; • incorporate these devices into applications with suitable driving circuitry; and
3.7 Electronic Systems	• demonstrate knowledge and understanding of: - Karnaugh maps to simplify truth tables with a maximum of three variables in logic systems; - Op amp circuits for various applications including calculation of appropriate component values; - Binary/BCD and up/down counters; - Binary counter as a frequency divider.

Or

Section B: Mechanical and Pneumatic Control Systems

Content	Learning Outcomes
3.8 Systems and Control	• analyse Mechanical and Pneumatic control systems in terms of input, control, output, on/off continuous control and open and closed loop systems using feedback; • use appropriate circuit symbols and circuit diagrams for Mechanical and Pneumatic systems; and
3.9 Safety	• demonstrate knowledge and understanding of the safety issues and procedures used for Mechanical and Pneumatic control system.

Content	Learning Outcomes
3.10 Calculations	Students should be able to: • use given data and information to complete calculations for the following: - mechanical advantage and velocity ratio; - efficiency; - torque; - moments; - work, energy and power; - simple and compound velocity ratios and transmission speeds for gears, pulleys and chains and sprockets; - force, pressure and area associated with cylinders; - air consumption of cylinders;
3.11 Pneumatic Components and systems	• demonstrate knowledge and understanding of the following pneumatic components: - vacuum pumps and vacuum lifting cups; - proximity sensors; - use of 5/3 valves; • design sequential circuits to control up to four cylinders using positive feedback techniques; • design sequential/interlocking circuits using cascades; • represent these components using appropriate symbols;
3.12 Combining Mechanical Components	• accurately draw cam profiles and performance diagrams: - to achieve dwell, uniform velocity, uniform acceleration and retardation and simple harmonic motion; - if the line of stroke of the follower is offset or in line with the centre of the cam; - using a range of followers including knife edge, flat and roller; and • accurately draw cam profiles and performance diagrams to achieve a range of outcomes.

Content	Learning Outcomes
3.12 Combining Mechanical Components (cont.)	Students should be able to: • demonstrate knowledge and understanding of: - gears to include pitch circle diameter, pitch point, metric module, pinion wheel, simple and compound gear trains; - pulleys to include simple and compound pulley systems, multiple pulley block and lifting systems; - chain and sprockets to include simple and compound systems; - ratchet and pawl; - levers and linkages to include bell crank, toggle and treadle; - shafts and couplings to include aligned shafts, flexible couplings, universal joints, ball and socket, constant velocity joints and Sliding couplings; - friction to include static and dynamic; - brakes to include cantilever, band, disc and drum; - clutches to include cone, single plate, diaphragm and centrifugal; - methods employed to activate clutches and brakes; - bearings to include plain, rolling element, self-aligning, thrust, taper and bearing housings; - lubrication to include mechanics of lubrication, viscosity, classification of lubricants and applications. - seals to include O-ring, gasket, garter and seal housings; and • combine mechanical and/or pneumatic/hydraulic components to produce systems with specific requirements.

3.4 Unit A2 2: Coursework: Product–System, Design and Manufacture

Candidates will be required to design and manufacture a technological product or system. They must identify a problem or need and ensure it provides sufficient scope to meet the assessment criteria.

It is the responsibility of the teacher to ensure that the topic chosen allows sufficient scope and intellectual challenge appropriate to an A2 course.

A technological product must have an energy source to make it function and include a control system comprising input, process and output.

A portfolio should accompany the practical component with written and graphical information produced on not more than 20 A3 pages. Students can present the portfolio in an electronic format.

This unit draws on the knowledge and skills covered in all units but must reflect the chosen option in A2 Unit 1. It represents approximately 60 hours of work and will be internally assessed and externally moderated.

Candidates should have opportunities to:

Identification of problem, need and specification

- Explore a range of problems and needs in a range of design contexts.
- Consider a range of design briefs.
- Generate design specifications.

Initial ideas, appraisal and selection

- Through a range of research methods identify and analyse existing solutions.
- Explore a range of control methods relevant to the design and development of new appropriate solutions.
- Evaluate and appraise proposed ideas and solutions.

Development

- Develop, using appropriate methods, control systems and product outcomes.
- Present formal working drawings to support manufacture.
- Consider production and planning for manufacturing.

Manufacture

- Realise systems in product outcomes.
- Use a range of tools and equipment and develop manufacturing skills.
- Record any changes in design developments brought about during manufacture.

Testing and Evaluation

- Test systems and products against appropriate criteria.
- Analyse testing outcomes and consider further developments and modifications.

Marking Criteria A2 Unit 2: Product-System Design and Manufacture

	Marking Criteria		Level	Mark
1	Identification of problem, need and design specification	6	High	5-6
			Medium	3-4
			Low	1-2
2	Initial ideas, selection of ideas for development	20	High	14-20
			Medium	7-13
			Low	1-6
3	Development	20	High	14-20
			Medium	7-13
			Low	1-6
4	Manufacture	40	High	27-40
			Medium	13-26
			Low	1-12
5	Testing and Evaluating	14	High	10-14
			Medium	5-9
			Low	1-4
			Total	100

Communication: All information presented for assessment should be presented in a coherent and concise manner using a range of ICT, illustrations, extensive photographs, annotated sketches, text and other appropriate means of communication.

Assessment Criteria

1 Identification of problem, need and design specification

High (5–6)
- Problem/need clearly identified leading to precise brief.
- A fully detailed design specification allowing development of ideas.

Medium (3–4)
- Problem/need identified with appropriate design brief.
- A suitable design specification allowing some development of ideas.

Low (1–2)
- Problem/need superficially identified, imprecise brief.
- An incomplete specification, allowing limiting design development.

2 Initial Ideas – selection of idea(s) for development

High (14–20)
- Analyse in detail existing solutions.
- Produce viable new solutions incorporating a broad range of control systems.
- Produce viable new product outcomes integrating system and application of function.
- Detailed evaluation of each idea based on relevant criteria.
- An appropriate selection of a solution for development.

Medium (7–13)

- Analyse with some detail existing solutions.
- Produce some generally viable and new solutions incorporating a moderate range of control systems.
- Produce some generally viable and new product outcomes with reasonable development in application of function.
- Some evaluation of ideas based on generally appropriate criteria.
- A potentially viable selection of solution for development.

Low (1–6)

- Limited analysis of existing products.
- Produce some limited solutions incorporating control systems.
- Produce some product outcomes with limited integration of system and application of function.
- Superficial evaluation of ideas based on limited criteria.
- An inappropriate selection of solution for development.

3 Development

High (14–20)

- The control system is highly developed to outcome.
- Clear evidence of numerical analysis in development.
- The product is highly developed to integrate system with the user and environment.
- Clear evidence of ergonomic and aesthetic development.
- Present a detailed plan of manufacture.
- Produce at a high level working drawings for manufacture.

Medium (7–13)

- The control system is reasonably developed to outcome.
- Some evidence of numerical analysis in development.
- The product is developed with some integration of system with the user and environment.
- Some evidence of ergonomic and aesthetic development.
- Present with suitable detail a plan for manufacture.
- Produce suitable working drawings for manufacture.

Low (1–6)

- The control system is superficially developed to outcome.
- Limited evidence of analysis in development.
- The product is developed with limited integration of system with the user and environment.
- Limited evidence of ergonomic and aesthetic development.
- Present with limited detail a plan for manufacture.
- Produce with limited detail working drawings for manufacture.

4 Manufacture

High (27–40)

- Produce a high quality outcome in a wide range of components and materials.
- Demonstrate clear competence in a range of production skills and processes.
- Produce a highly functional product with system.
- Record in detail modifications made during manufacture.

Medium (13–26)

- Produce a good quality outcome in an appropriate range of materials and components.
- Demonstrate reasonable competence in a range of production skills and processes.
- Produce a functional product with system.
- Record some detail of modifications made during manufacture.

Low (1–12)

- Produce a low standard outcome in a limited range of materials and components.
- Demonstrate a limited competence in a range of production skills and processes.
- Partly functional product with system.
- Limited and superficial record of modifications made during manufacture.

5 Testing and Evaluation

High (10–14)

- Produce a high level critical and objective evaluation of the outcome.
- Carry out and present an extensive range of detailed testing, showing meaningful conclusions.
- Make high level proposals for further development as an outcome of testing.

Medium (5–9)

- Produce a satisfactory evaluation of the outcome which is mainly objective.
- Carry out and present some outcomes of tests, which show mostly meaningful conclusion.
- Make appropriate proposals for further development.

Low (1–4)

- Produce a limited evaluation of the outcome.
- Show limited evidence of meaningful testing with only simplistic conclusions.
- Demonstrate limited awareness of possibilities for further development.

4 Scheme of Assessment

4.1 Assessment opportunities

Students can choose to be assessed in stages during their AS and A Level courses or to leave all assessment to the end of these courses. The availability of assessment units is shown in Section 2 of the specification.

Students can choose to resit AS and A2 assessment units. The best result for each assessment unit will count towards the AS and A Level qualifications.

Results for each assessment unit can continue to contribute to an AS or A Level qualification while the specification is offered.

4.2 Assessment objectives

The assessment objectives of the specification are listed below:

Assessment Objectives		**Weighting**
AO1	Candidates should demonstrate specific knowledge and understanding, be able to apply that knowledge and understanding in combination with appropriate skills in their designing, communicate ideas and outcomes, and demonstrate strategies for evaluation.	50%
AO2	Candidates should be able to demonstrate and apply skills, knowledge and understanding of relevant materials, processes and techniques; use materials and equipment to produce suitable and appropriate outcomes; communicate ideas and outcomes; and demonstrate strategies for evaluation.	50%

The assessment objectives apply to the whole specification for AS and A Level.

4.3 Assessment objective weightings

The assessment objective weightings for each assessment unit and the overall AS and A Level qualifications are set out in the table below.

Assessment Objective	**Assessment Units Overall**				**A Level Overall**	
	AS 1	**AS 2**	**A2 1**	**A2 2**	**AS**	**A2**
AO1	25%	25%	25%	25%	50%	50%
AO2	10%	40%	10%	40%	50%	50%

4.4 Quality of written communication

Assessment in AS and A Level qualifications in Technology and Design requires students to demonstrate their quality of written communication. In particular, students are required to:

- ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
- select and use a form and style of writing appropriate to purpose and to complex subject matter; and
- organise information clearly and coherently, using specialist vocabulary where appropriate.

Students' quality of written communication is assessed qualitatively as an integral part of those questions or tasks requiring responses in extended written form.

4.5 Synoptic assessment

The A2 assessment units include an element of synoptic assessment. This allows students to demonstrate expertise in the essential knowledge, understanding and skills of Technology and Design.

In Technology and Design synoptic assessment requires that students demonstrate that they can:

- combine their designing and making skills with knowledge and understanding in various tasks; and
- achieve the above in tasks which vary in duration.

4.6 Stretch and challenge

The A2 assessment units will include opportunities for stretch and challenge. This will be achieved by:

- providing opportunities for extended writing eg A2 coursework;
- the use of questions which elicit a full range of response types; and
- providing connectivity between sections of questions.

4.7 Reporting and grading

The results of individual assessment units are reported on a uniform mark scale that reflects the assessment weighting of each unit.

AS qualifications are awarded on a five grade scale from A to E with A being the highest. A Level qualifications are awarded on a six grade scale from A* to E with A* being the highest. We determine the AS and A Level grades awarded by aggregating the uniform marks obtained on individual assessment units. To be awarded an A*, candidates will need to achieve a grade A on their full A Level qualification and an A* on the aggregate of their A2 units. For students who fail to attain a grade E, we report their results as unclassified (U).

The grades we award match the performance descriptions published by the regulatory authorities (See Section 6.4).

5 Guidance on Internal Assessment

5.1 Setting of tasks

It is essential that the teacher acts as a facilitator and ensures that the task undertaken by the candidate is appropriate and achievable. Teachers will be expected to give guidance in the planning and realisation of each coursework component to ensure that:

- it is a reasonable task for the individual candidate to undertake and can be completed effectively in the time available;
- the work meets the relevant requirements of the specification;
- it can be assessed using the specified assessment criteria;
- except in as far as the candidate received appropriate guidance from the teacher, it is the unaided work of the candidate;
- projects must not contravene the Health and Safety at Work legislation;
- the task can be designed and realised with the capabilities of the candidate's own school or college.

5.2 Supervision of students

Manufacturing should take place within the candidate's own school or college. Accreditation cannot be given for manufacturing completed outside the school or college workshop unless the teacher has directly supervised such work.

Teachers will be required to sign a declaration to certify that, to the best of their knowledge, all work submitted for assessment is the candidate's own.

5.3 Marking and internal standardisation

It is the responsibility of the centre to ensure that all coursework elements have been marked using the same standards.

Where there is more than one teaching group involved, the centre must carry out internal standardisation of assessments before submitting them to the Council.

The purpose of this exercise is to ensure, as far as possible, that each of the teachers has applied the assessment criteria consistently when making assessments.

As a result of this internal standardisation it may be necessary to adjust the marking of individual teachers to bring their assessments into line with those of the other teachers in the department and to match the standards promulgated at the Agreement Trial.

All coursework units to be entered in any one year must be assessed and standardised marks sent to the Council by 1st May using the Centre Internal Assessment Forms provided by the Council or by EDI.

Work should be submitted two weeks before the 1st May to enable teachers to mark, annotate mark sheets and complete internal standardisation.

A copy of the Candidate Record Sheets for all candidates in the centre should be sent to the Council with the marks.

Each coursework unit must be marked against the appropriate Assessment Criteria.

The mark awarded must be recorded in the appropriate column of the Candidate Record Sheet supplied by the Council.

A zero mark should only be awarded when a candidate has submitted no evidence for a particular criterion.

5.4 Visiting moderation

The Council will inform the centre after the submission of marks to identify the sample work that must be displayed for external moderation.

During the moderation the Moderator can request further samples of candidates' work, if required, to aid moderation.

A date and time will be arranged for the moderation visit, the centre will be notified in advance.

The Council will expect the following materials representing each candidate from the requested sample to be available for scrutiny:

- Design Portfolio;
- Completed Product outcome [AS] or Product/System outcome [A2]; and
- Completed Candidate Record Sheet with comments justifying the marks awarded.

During the moderation the area used for the display should be subject to the same controls and regulations as for other areas used for examination purposes.

The centre must ensure that all candidates' work is arranged in rank order.

The Moderator will assess the sample employing the detailed marking criteria and attempt to confirm the centres marking.

If an adjustment is required, the Moderator will consult with the designated teacher and in discussion attempt to reach agreement on the extent of the adjustment.

Centres will receive a written report on the moderation after the award has been made.

If agreement cannot be reached, the centre can request an appeal. This can only be done at the time of initial moderation.

In the event of an appeal, this will be carried out by an Assistant Principal Moderator or the Principal Moderator. This decision will be final.

The Council reserves the right to change the Assessment and Moderation procedures outlined in this document. All centres will be notified of any substantive changes.

6 Links

6.1 Support materials

CCEA currently provides the following materials to support this specification:

- specimen papers;
- mark schemes; and
- a resource list.

CCEA will expand its range of support materials to include:

- dedicated microsite;
- teacher support days;
- schemes of work; and
- additional guidance.

Details of CCEA's Annual Support Programme of events and materials for Technology and Design can be found on the CCEA website at www.ccea.org.uk.

6.2 Curriculum objectives

This specification addresses and builds upon the broad curriculum objectives for Northern Ireland, England and Wales. In particular, it allows students to study aspects of:

- Spiritual, moral, ethical, social, legislative [including equality and disability discrimination], economic and cultural issues.
- These issues are addressed throughout the specification, especially in AS 1 Unit 1.13: Influences on Product Design.
- Sustainable development, health and safety considerations and European developments.
- Health and Safety is a major consideration within the specification. Candidates need to use safe working practices and to ensure that any product produced is safe in use. This is addressed in AS 1 Unit 1.11: Safety; in A2 Unit 3, and throughout the coursework Units AS 2 and A2 2.
- The skills agenda is addressed throughout the specification. The subject, by its fundamental nature, is involved with the design and production of a product. These skills are those required by any employer within the manufacturing sector. AS 2 and A2 2, being practical units, addresses this fully.
- The skills agenda and employability.

The specification addresses these objectives across all of its units.

6.3 Key skills

All units in this specification provide opportunities for the development of and generating evidence for assessing the following Key Skills at Level 3:

- Application of Number
- Communication
- Improving Own Learning and Performance
- Information and Communication Technology
- Problem-Solving
- Working with Others.

A table that fully signposts and exemplifies the types of opportunity for developing and generating evidence for assessing Key Skills, that may arise during the AS/A Level course, in Technology and Design can be found on the CCEA website at www.ccea.org.uk.

6.4 Performance descriptions

Performance descriptions for the AS and A2 judgemental A/B and E/U boundaries can be obtained from the QCA website at www.qca.org.uk.

6.5 Examination entries

The following entry codes apply to individual assessment units and the overall AS and A Level cash-ins in Technology and Design:

AS 1:	AAV11
AS 2:	AAV12
AS cash-in:	S8902
A2 1:	AAV21
A2 2:	AAV22
A Level cash-in:	A8902

You can view details of how to make entries on our website. Alternatively, you can contact our Entries Team using the details provided in Section 6.8.

6.6 Students with particular requirements

We have designed this specification to minimise the need to adjust the assessment of students who have particular requirements. Details of the arrangements you can make for such students are available in the Joint Council for Qualifications document *Access Arrangements and Special Consideration: Regulations and Guidance Relating to Candidates Who Are Eligible for Adjustments in Examinations.*

6.7 Disability Discrimination Act (DDA)

AS/A Levels often require assessment of a broad range of competences. This is because they are general qualifications and, as such, prepare candidates for a wide range of occupations and higher level courses.

The revised AS/A Level qualification and subject criteria were reviewed to identify whether any of the competences required by the subject presented a potential barrier to any disabled candidates. If this was the case, the situation was reviewed again to ensure that such competences were included only where essential to the subject. The findings of this process were discussed with disability groups and with disabled people.

Reasonable adjustments are made for disabled candidates in order to enable them to access the assessments. For this reason, very few candidates will have a complete barrier to any part of the assessment. Information on reasonable adjustments is found in the Joint Council for Qualifications document *Access Arrangements and Special Consideration: Regulations and Guidance Relating to Candidates Who are Eligible for Adjustments in Examinations.* Candidates who are still unable to access a significant part of the assessment, even after exploring all possibilities through reasonable adjustments, may still be able to receive an award. They would be given a grade on the parts of the assessment they have taken and there would be an indication on their certificate that not all of the competences have been addressed. *This will be kept under review and may be amended in the future.*

In A Level Technology and Design, candidates with a visual impairment may find this subject difficult to access fully.

6.8 Contact details

The following list provides contact details for relevant members of CCEA staff:

- Specification Support Officer: Catriona Skelton
  (telephone: (028) 9026 1200, extension 2292, email: cskelton@ccea.org.uk)

- Officer with Subject Responsibility: Ed Paynter
  (telephone: (028) 9026 1200, email: epaynter@ccea.org.uk)

- Examination Entries, Results and Certification: Nicola Laight
  (telephone: (028) 9026 1262, email: nlaight@ccea.org.uk)

- Examiner Recruitment
  (telephone: (028) 9026 1243, email: appointments@ccea.org.uk)

- Distribution (past papers and support materials)
  (telephone: (028) 9026 1242, email: smurray@ccea.org.uk)

- Support Events Administration: Events Information Service
  (telephone: (028) 9026 1401, email: events@ccea.org.uk)

- Information Section (including Freedom of Information requests)
  (telephone: (028) 9026 1200, email: info@ccea.org.uk)

- Business Assurance (appeals): Jeffrey Hamilton
  (telephone: (028) 9026 1205, email: jhamilton@ccea.org.uk).

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