GCE MARKING SCHEME

SUMMER 2016

DESIGN & TECHNOLOGY
DT1 - SYSTEMS AND CONTROL
1111/03

INTRODUCTION

This marking scheme was used by WJEC for the 2016 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

GCE DESIGN & TECHNOLOGY
DT1 - SYSTEMS AND CONTROL

SUMMER 2016 MARK SCHEME

1. (a) Identify two smart materials and state how they are used in modern control systems. 2 x [2]

(b) Describe the advantages of using these smart materials in named products. [4]

Award one mark for **each** named specific material (up to 4 marks)

(a) SMART materials could include shape memory alloys, photo chromic liquid/inks (accept specific liquids/inks as SMART materials), piezoelectric materials, magneto-rheostatic materials, electro-rheostatic materials, photoresistor, quantum tunnelling composites - one mark for each named specific material.

(b) Award up to **four** marks for **the** advantage of using that specific material in named products.

Answers could be based on:

- strength to weight ratio;
- specific hardness;
- reaction to external force;
- reaction to environment;
- reaction to external stimuli.

No material named max 2 marks.

2. Patents, Copyrights, Registered Trade Marks and Design Rights are all forms of design protection granted by the Patent Office.

Explain the features and level of protection of any two of these with reference to specific products. [8]

Features and benefits: Patents 4 marks

Monopoly rights to the exclusive use of an invention.
Can last for a maximum of 20 years if annual renewal fees are paid.
Becomes a property that can be bought, sold, hired or licensed.

An invention is patentable only if it is:
- New and previously undisclosed.
- Distinguished by an inventive step.
- Capable of industrial application (that it could actually be made).

Benefits may be to the company in terms of sales and staying at the forefront of developments.

Features and benefits Copyright **4 marks**

- Literary works, including novels, instruction manuals, computer programs, song lyrics, newspaper articles and some types of database.
- Dramatic works, including dance or mime.
- Musical works.
- Artistic works, including paintings, engravings, photographs, sculptures, collages, architecture, technical drawings, diagrams, maps and logos.
- Layouts or typographical arrangements used to publish a work, for a book for instance.
- Recordings of a work, including sound and film.
- Broadcasts of a work.
- Lasts up to 70 years after death of author.

Benefits the copyright owner in that

- Another person should only copy or use a work protected by copyright with the copyright owner's permission.
- Copyright applies to any medium - this includes, publishing photographs on the internet, making a sound recording of a book, a painting of a photograph and so on. Copyright does not protect ideas for a work. It is only when the work itself is fixed, for example in writing the copyright automatically protects it - you do not have to apply for copyright.

Features and benefits: Registered Trade Mark **4 marks**

- Any sign which can be represented graphically.
- Any sign which can distinguish goods or services.
- Includes words, personal names, designs, letters and the shape of goods and their packaging.
- Registered for 10 years and can be renewed every 10 years indefinitely.

Benefits may include the protection of a logo/catchphrase belonging to the company (that people associate with one brand) i.e. Tesco, McDonald's, and Nike.

Responses may combine both features and benefits.

Features and benefits: Design Right **4 marks**

- A form of protection for the shape or configuration of articles.
- Design must not be commonplace.
- It is not a monopoly but a right to prevent copying.
- It lasts 10 years.
- Becomes a property that can be bought, sold, hired or licensed.

Benefits short term protection for the rights to prevent copying the design. Can be sold, hired or licensed by the creator.

Note: maximum 2 marks if only the features are stated and not the level of protection.

3. All designers consider the use of ergonomics and anthropometrics in order to design successful electronic or mechanical devices.

Describe using examples why:

(a) ergonomic principles are important in the design of electronic or mechanical devices; [4]

(b) anthropometric data is important in the design of electronic or mechanical devices. [4]

(a) The importance of Ergonomics within environments. [4]

'The systematic study of human capabilities, behaviour, limitations and requirements, and the application of such knowledge on the design of products. The study of people in their working environments - the interaction between people and built products/artifacts, equipment.'

Areas or situations – hold of hand held device (for operators to have comfortable sight of controls), aircraft, checkout operators working in supermarkets - a description of the important needs of each user in these situations.
Hand held products.
User interface between user and product.

(b) Anthropometrics within products. [4]

(A scientific study of human measurement taken across a range of human groupings).

- In general things measured include dimensions, weight, strength, range of movement, physical size - *the physical fit between people and the hand held products*.

- Layout and physical size of buttons and controls to enable the product to be used. (could be referred to as **point**)

Issues essential for success from handle size/form, weight, movement required to pour successfully, internal physical dimensions.

Look for understanding and differentiation between the two terms.

Maximum 2 marks for explanation of terms.

4. (a) State two benefits of using circuit simulation software when developing a design proposal. [4]

(b) State two benefits of making a final three-dimensional prototype prior to manufacturing. [4]

(a) Computer circuit simulation – *up to two marks per benefit.*

- Used to simulate and test a particular electronic, pneumatic or mechanical system using suitable software.
- Can be sent directly (digitally to clients) to other locations across the world.
- Does not require the purchase of the components, no damage to components.
- Can be converted from schematic to PCB layout.

(b) Benefits of Prototyping – *up to two marks per benefit.*
Accept all forms of three dimensional modelling.
Physical models, computer generated models, styro-foam models and prototyping.

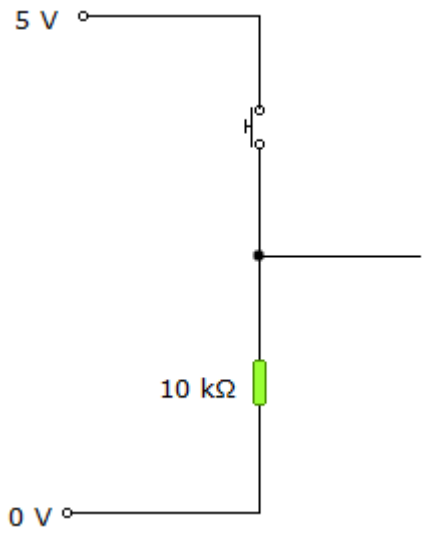
Note: Prototyping – look for understanding of the term (not just a 3 dimensional model)

- Testing product performance before manufacturing.
- Materials tests carried out.
- Check on the quality of the product.
- Processes may be planned for each component part (tooling produced, jigs and templates).
- Specific physical tests may be carried out (compression and tensile tests).
- Working out costs.
- Provides opportunities to test product with intended user/target market.
- Hall tests carried out to ensure product works and is tested out.

5. (a) Sketch a diagram which includes the components needed to trigger an input to a microcontroller and describe the roles of the components required. [4]

(b) Using notes and sketches explain how a microcontroller is able to activate a 1 amp motor. [4]

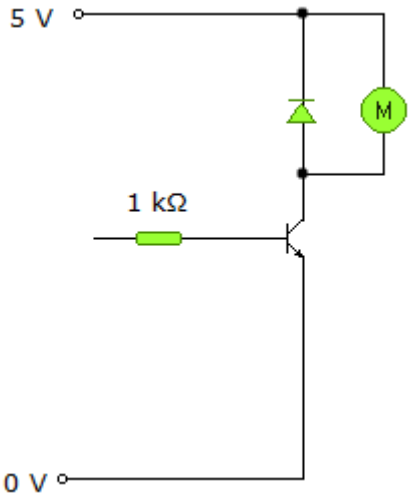
(a) Input Circuit



Up to 2 marks for sketch
1 mark for hold down resistor value

Resistor
Up to 2 marks for an explanation of the necessity for a hold down resistor to stop the open end of the switch connected to the input floating and giving false inputs.

(b) Output Circuit – Transistor, FET, H bridge or Darlington pair driver.
Use of reverse diode to protect against back EMF.



Up to 3 marks for sketch

6. Reverse Engineering involves the disassembly of a product.

Explain in detail how product disassembly benefits the designer. [8]

Reverse Engineering

(Award up to a max four marks without any examples)

- The process of discovering the technological principles of a product, device or system.
- Analysis of its structure and form.
- Take something apart and analyse its workings (mechanical, electrical or software).
- Product development can be accomplished more efficiently and at a substantial cost savings.
- The process of discovering the technological principles of a product/component or system
- Involves taking something apart and analysing its workings in detail with the intention to construct a new device
- The new device does the same thing without actually copying anything from the original.

Benefits through reverse engineering:

- Designers analyse its function.
- A study of its structure.
- How the product operates (under different conditions).
- To discover how 'light-weighting' and design for disassembly has been used to make the product more sustainable.

7. (a) Explain why bought-in or standardised part-assembled components are used when manufacturing products. [4]

(b) Describe one advantage and one disadvantage of using bought-in or standardised part-assembled components to the designer or manufacturer. 2 x [2]

(a) Definition of term

Components that are standardised can be substituted one for another i.e. using the same threat, fixings, input/driver circuits, drive chains etc. These can be sourced from other companies and bought in making it possible to complete products very quickly.

Buying in means that the main company can specialise in its core operations, leaving other companies to take responsibility for the quality of a *bought in* component.

Could include pre-made PCB prior to population.

(b) Advantages

- Aspects of quality previously checked and signed off (the responsibility for quality lies with the other supplier). Consistent quality is maintained.
- Components may be produced by a specialist manufacturer from another location, allowing the main manufacturer to concentrate on assembly.
- Lower costs from buying in bulk and investment possible elsewhere within the manufacturing process allowing for flexibility (the ability to shop around for lower costs).
- Issues related to standardisation and interchangeable components.

Disadvantages

- Difficult to adapt or change products during production.

Up to 2 marks for each full description

8. The use of Computer Aided Design (CAD) and Computer Aided Manufacture (CAM) has now become an integral part of the design process for both designers and manufacturers when creating products.

(a) Describe the benefits of using CAD to the designer. [4]

(b) Describe the benefits of using CAM to the manufacturer. [4]

Benefits to the designer:

- CAD can be used to illustrate a design to a client.
- Renderings and different finishes can be applied quickly.
- Colour ways explored by designers.
- CAD speeds up the process.

- Design Ideas communication between designer and client/manufacturer
- CAD Design work can be altered easily.
- Library of parts available from database.
- CAD drawings can be e mailed across the globe to different locations for use.
- Candidates may explain the type of software used:
  Pro Desk Top, Pro Engineer, Solid Edge, Solid Works, Autodesk Inventor etc.

Up to 2 marks for each detailed response

Benefits to manufacturer:

- Computer controlled manufacturing via laser cutters, rapid prototyping.
- CAM speeds up the process.
- CAM can be used to manufacture multiple products that are identical.
- Allows the manufacturer to send designs and receive them by email across the globe to different locations.
- CAM improves the accuracy of the manufacturing process and improves the quality of the product.
- Changes can be made easily to designs if adjustments are needed.

2 marks for each detailed response

No duplication of responses credit once only.

SECTION B

Section B involves extended written answers in which the mark awarded must take into account the quality of written communication – as indicated to candidates in the rubric on the front of the question paper. This should form an integral part of the judgement on the question, the following criteria being applied in deciding whether the points outlined in the marking scheme are communicated sufficiently clearly to award the full credit:

- Legibility; accuracy of spelling, punctuation and grammar.
- Organisation of information clearly and coherently (appropriate to purpose and to complexity of subject matter); use of specialist terms.

At the same time it should be noted that over-rigidity in interpretation of the mark scheme is not intended, and it is accepted that points may be made in a variety of different ways. Thus, except where terms are specifically requested, correct responses using different words are acceptable providing that points are clearly communicated.

The following levels of achievement grid should be used in conjunction with question specific guidance listed below. In each case you are asked to check the mark you have arrived at against the grid before finalising it.

ESSAY LEVELS:

Level 1 0-10	• Candidate has a simplistic knowledge of the issues associated with the question. • The use of terminology and technical language is basic. • The candidate has little understanding of the general elements of industrial and commercial practices. Little knowledge of ICT in manufacturing systems. • The candidate has limited knowledge of the form and function of products. • The candidate will express ideas clearly, if not always fluently. Answers may deviate from the question or not be relevant. • Grammar, punctuation and spelling may be weak impacting on effective communication.
Level 2 11-16	• The candidate has a basic understanding of the issues associated with the question. • The use terminology and technical language is variable. • The candidate understands the general elements of industrial and commercial practices related to manufacturing systems and some aspects of ICT in production. • The candidate has some general knowledge of the form and function of a product, trends and styles of products. Environmental, cultural and/or ethical /moral issues not always considered. • The candidate will express straightforward ideas clearly, if not always fluently. Answers may deviate from the question or be weakly presented. • There may be some errors of grammar, punctuation and spelling but is still able to communicate the issues.
Level 3 17-23	• The candidate demonstrates a clear understanding of the issues associated with the question. • The use terminology and technical language is reasonably accurate. • The candidate understands the general elements of industrial and commercial practices related to manufacturing systems and is aware of aspects of ICT in production. • The candidate has developed a common knowledge of the form and function of a product, trends and styles of products. Environmental, cultural and/or ethical /moral issues are also considered. • The candidate will express moderately complex ideas clearly and fluently, through well linked sentences and paragraphs. Answers will be generally relevant and structured. • There may be occasional errors of grammar, punctuation and spelling.
Level 4 24-30	• The candidate demonstrates a specific ability to analyse questions, takes into account of a wide range of factors and has a clear understanding of the issues associated with the question. • Uses correct terminology and technical language. • The candidate understands the main feature of industrial and commercial practices related to manufacturing systems including the use of ICT and stages of production. • Candidate has developed a detailed knowledge of the form and function of a product, trends and styles of products. Environmental, cultural and/or ethical /moral issues are also considered where appropriate. • The candidate will express complex ideas extremely fluently. Sentences and paragraphs will follow on from each other smoothly and logically. Answers will be consistently relevant and structured. • There will be few, if any, errors of grammar, punctuation and spelling.

9. Production lines rely on getting the right material or component delivered at the right time and place. This is often referred to as 'Just in Time' (JIT).

Describe the importance of this and explain how it is achieved along with the advantages to the manufacturer. Use examples of products to fully explain how this principle is used to its full effect. [30]

Achieved: Key features of Just in Time (JIT) manufacture - manufacturing according to an agreed plan that is governed by material and resource availability. Features may be descriptions of aspects of production and meeting the needs of customers, control of stock, and the arrival of materials and components *just in time.*

Advantages to the manufacturer:

Less storage space, efficient and faster manufacturing system thereby getting products to the customer/consumer quickly, releasing capital for use elsewhere, no depreciation in material costs, increased profit margins.

- Systems of storage and ordering.
- Description of *just in time* manufacturing.
- Ordering systems.
- Issues of saving on storage space for the manufacturer.
- Efficiency of manufacturing, production lines and cells.
- Product or range of products.
- Link to article numbering, barcodes and logistics.

Note: responses may not necessarily state the JIT process (or any other related process) in order to access the higher band of marks.

10. Discrete components are being replaced by Integrated Circuits (ICs) in control systems.

Discuss the benefits of ICs for the manufacturer, the environment and the end user. [30]

Discussion around:

1. Manufacturer – fewer components, efficient and faster manufacturing system thereby getting products to the customer quickly. Upgrading functionality of system through software upgrade. Increased reliability creates better product image. Greater product flexibility and adaptability, multi-functional product manufacturing. New opportunities in performance, functionality. New ICs will allow components to provide greater functionality.

2. Environment – Smaller foot print of circuits, smaller cases, less materials used. Reprogrammable system to extend product life. Planned obsolescence. Lower power systems. Surface mount components are more sustainable due to reduced assembly procedure.

3. End user – general range of products available, products with a range of functions available, miniaturisation, greater reliability of product due to fewer components. Reduced costs. Software upgradable.

If only two of the above areas (manufacturer, environment and end user) is included in the response the candidate may not be awarded the full range of marks.

11. Discuss how trends, styles and new technical capabilities have all influenced the design, production and sale of products.

[30]

- Fashion Trends – Development of wearable electronics.
- New Products – demand for use of up to date technology.
- Product Range: To suit a range of users.
- Technical advances in production techniques and materials technology.
- Faster and more efficient products.
- Technology push and pull to satisfy market trends and demands.
- Simple to use interfaces.
- Different finishes and colour ways.
- Material selection and style to suit male and female users.
- Planned obsolescence and life span of products before they are changed or updated.
- Introduction, growth, maturity, saturation and decline of products.
- Product Life Cycle and its effect on the market.
- New products are first exported to similar countries, countries with similar needs, preferences, and incomes.
- Product range with different features or unique selling points (USPs).

Examples should be used within the response to exemplify points made.

Some candidates may also use diagrams to support their response.